ECONLOCKHATCHEE RIVER BASIN NATURAL RESOURCES DEVELOPMENT AND PROTECTION PLAN

VOLUME I
RESOURCE INVENTORIES

Final Report to St. Johns River Water Management District

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by

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TABLE OF CONTENTS

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INTRODUCTION

Managing the Resources of the Econlockhatchee River Basin

This document is the first of three volumes of planning documents prepared for the St. Johns River Water Management District. It is a Phase I report in the two-phase program to develop a Basinwide Natural Resources Development and Protection Plan for the Econlockhatchee River. The three volumes are entitled as follows:

VOLUME I: Resource Inventories
VOLUME II: Economic and Regulatory Framework
VOLUME III: Synthesis: Critical Areas Management and Protection Plan

Volume I contains reports prepared by scientists and planners who studied the environment and resources of the Econ Basin. Their studies were intended to provide an inventory of and generalized management suggestions for the resources of the basin that form the basis for preparing a regulatory framework with which the special qualities and environmental resources of the Econ River Basin might receive protection.

Studies were undertaken to investigate three basic concerns related to environmental degradation. This volume presents an inventory and makes management suggestions addressing the following: (1) protection and enhancement of water quality; (2) protection of biological diversity and endangered species; and (3) protection of aesthetic, recreational, archaeological, scientific, or economic values. Each subsection in Volume I is organized to first present the issues surrounding each resource, review related literature, describe the resource, and finally, make management and regulatory suggestions to effectively manage and protect the resource. These management suggestions are general in nature and reflect the level of analysis in this first phase of the overall project. Volume II contains an analysis of the existing Regulatory Framework of the basin including land use regulations and planning policies, environmental regulations, and significant development, structures and activities. Volume III contains specific management and regulatory suggestions gleaned and sharpened from these Resource Inventories.

Chapter 1 discusses the water resources of the basin. There have been significant changes in water quality in the Little Econ River over the past several decades--first deteriorating, then showing marked improvement as state agencies worked to remove sewage outfalls from the river. Better stormwater management is still needed. The Big Econ River has altered little in quality over the period of record, but new development within the basin suggests this may soon change.

Chapter 2 is the resource management plan for terrestrial and wetland ecological systems. Major community types are discussed and the overall landscape scale organization of the basin is given as a means of developing a rationale for basinwide landscape management.

Chapter 3 discusses wildlife resources of the Econ Basin. Wildlife management should be approached from two perspectives: protection of habitat and maintenance of viable populations through landscape-scale wildlife management. This chapter provides the habitat values of the Econ Basin as well as suggestions for maintaining viable populations.

Chapter 4 presents the historical and archaeological resources of the Econ Basin with emphasis on the documented Indian sites. Additionally, suggested sites based on soil and elevations are provided with recommendations for a basinwide survey since this region of Florida has such a large number of potential sites and few systematic surveys have been completed to date.

While the organization of this report is divided along resource lines for the purposes of efficient research effort, the authors recognize that it is not a series of separate layers of resources, but an aggregate... a mosaic of historical resources and wetlands, wildlife, and water whose sum is far greater than its parts.

Background

In August 1989, the St. Johns River Water Management District contracted with the Center for Wetlands at the University of Florida to develop a basinwide management plan for the Econlockhatchee River. Often referred to as the "Econ" River, it is located in the eastern portions of Orange, Seminole, and Osceola counties in central Florida (see Figure 1) near the rapidly growing Orlando metropolitan area.

The overall program for development of a basinwide management plan was organized into two phases. The first phase was to be a five-month study to prepare a Critical Areas Management and Protection Plan (CAMP Plan) that would provide short-term suggestions for management, regulation, and acquisition as a first step in developing a long-term management strategy. The second phase will provide a more detailed look over a longer time period at the basin and its resources, fill gaps in the knowledge base, and develop a basinwide surface water improvement and management plan.

Concurrent to the work on Phase I, a citizen task force was appointed by the Water Management District to lend critical insight and public support to the process of developing a Basin Management Plan.

The Econlockhatchee River Basin

The Econlockhatchee River Basin is located in central Florida, in portions of eastern Seminole, Orange and Osceola counties (see Figure 1.1). The Big and Little Econlockhatchee rivers divide into two sub-basins, converge in Seminole County, and flow eastward into the St. Johns River. The Big Econ River flows from south to north through a basin that is approximately 38 miles long and 25 miles wide; while the Little Econ River flows from western portion of the basin north and east to the confluence. Faced with concerns over urbanization of the Econlockhatchee River Basin, especially within the Big Econ Basin, a fresh look at its resources and its future are necessary. As one of the few intact river systems in central Florida, its water, wetlands, and wildlife have recently become the focus of intense scrutiny related to how best to protect its resources in the face of strong development pressure. Basinwide management that acknowledges the interrelationships between components of wild landscapes and developed land and that minimizes the impacts of human uses is required. To achieve a landscape that is simultaneously a place for humans and a wild habitat, and that maintains good water quality will require an approach to planning, designing, and engineering that is cognizant of the ecological communities and hydrology of the basin.

The Econ River: A Study in Juxtaposition

Water quality is a telltale sign of how well a landscape is managed. The Econlockhatchee River exhibits both good water quality and less-than-adequate water quality simultaneously. The Big Econ, flowing through a relatively undeveloped landscape from its origins in large headwater swamp, runs clear with few if any water quality problems. The Little Econ, for years impacted by sewage outfalls from 11 sewage plants, is channelized through much of its headwaters and receives stormwater runoff from a relatively urbanized watershed.

The challenge is to develop a management scheme that will improve the quality of the Little Econ and prevent water quality deterioration in the Big Econ. While stormwater management over the past several years has helped to improve water quality and offers significant protection, the fact still remains that it is not 100% effective. Better development patterns, better means of trapping and filtering stormwaters, and better engineering are needed if the Big Econ is to remain the high quality river it now is, and if the Little Econ is to ever flow clear again.

The Econ Basin: Vital Link in a Regional Wildlands Network

The Econlockhatchee River Basin is strategically located in eastern Orange, Osceola, and Seminole counties to become the focal point of a regionwide wildlands network and management program. To the east are the wildland resources of the St. Johns River floodplain, Tosohatchee State Wildlife Area, and the Orlando Wilderness Park. To the south are the lands of the Desseret Ranch containing large areas of wetlands; and to the north and east are the wildlands associated with the Wekiva River system. Because of its location, central to these important regional resources, the Econ River system is a critical link in a regional network of wildlands that preserve biotic diversity and ensure access to a wilderness experience for all central Floridians. On the other hand, it could easily resemble a stumbling block that, because of insensitive development, becomes a broken link in the chain of wildlands which will someday be as widely known and regarded in the public perception of central Florida as the theme parks of western Orange County.

Unlike higher relief landscapes to the west, the Econ River Basin is extremely flat and "poorly" drained. As a result, the water resources of the Econ River are affected to a larger degree by alterations of surface water flow rates, and groundwater table elevations in the surrounding landscape. Because of the low relief there are large numbers and total acreage of wetlands that provide surface water storage. In addition the water table is very close to ground surface for much of each year. Changes, runoff rates, extent of surface water storage, and levels of groundwaters are possible with development. With such changes, changes in the quality and quantity of water in the river is likely.

It is the goal of this natural resource development and protection plan to establish a framework to ensure no net loss of water quality or wetland wildlife species. To achieve this goal, the resources are first inventoried, their sensitivities documented and management suggestions formulated.

The challenge of developing a basinwide management plan for the Econ Basin is to provide a framework within which both humanity and nature exist in a partnership relationship where both benefit from our experience and expertise.

Development Issues

The resource management issues surrounding development of the Econ Basin might be summarized as follows:

1) Development impacts on surface and groundwater quality and quantity,
2) Development impacts on terrestrial and wetland ecological communities,
3) Development impacts on wildlife, and
4) Development impacts on historical and archaeological resources.

Effective and vital development of the Econ Basin should establish a balance between full development on the one hand and full preservation of the environment on the other. The balance sought is one of compatible development at a scale and intensity, and with appropriate environmental safeguards, that will ensure the long-term viability of the terrestrial and water resources of the basin.

Ultimately, the affairs of humans, their economies and their social fabric depend on the surrounding environment. It is quite obvious that the tourism and the service economy it stimulates are dependent upon a healthy environment. Where environmental deterioration has occurred, and where environmental values are low, economies do not flourish. The greater the environmental values, the greater the potential for a flourishing economy. That is why it is of utmost importance that the environment, both the terrestrial and water resources of central Florida, are protected and their continued health become the concern of all citizens.

Sustaining a healthy terrestrial environment (that is, one which is productive, green, not prone to erosion, and does not pollute downstream aquatic environments) is an integral part of balancing development with environmental protection. Increased pollution and erosion of the terrestrial environment ultimately means increased pollution and sedimentation of the aquatic environment.

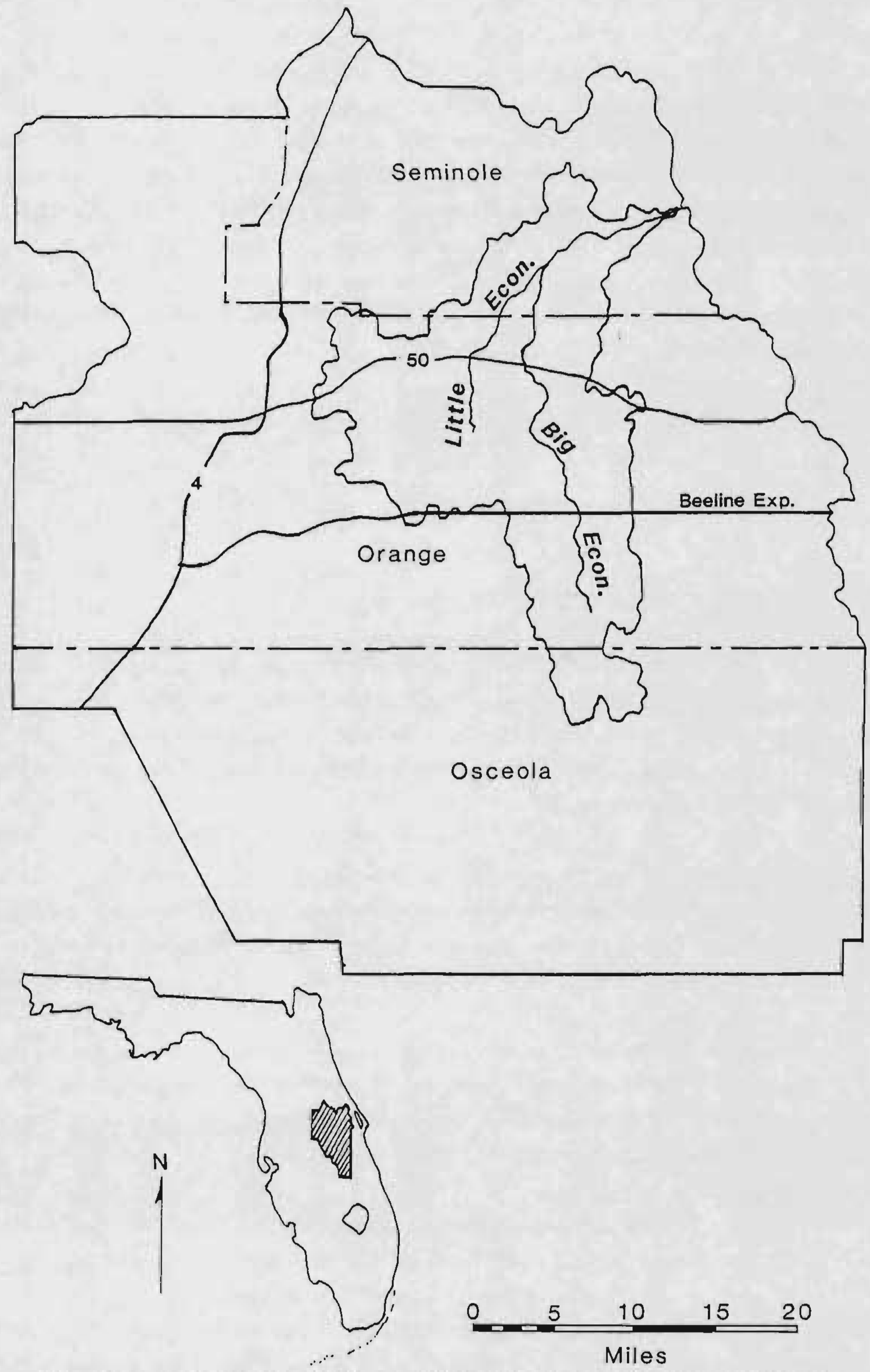

Figure 1. Location map of Seminole, Orange, and Osceola counties and the Econlockhatchee River Basin. The Econlockhatchee River has two main tributaries--the Little Econ and the Big Econ.

Scientists and planners associated with this project embarked on this first phase of this study of the social, cultural, physical, and biological environment of the Econ River Basin with these implications in mind. Our goals were to discover, study, and communicate the special qualities of the basin that are important to the economy and citizens of central Florida and to develop management strategies, plans, and a regulatory framework that would protect those special qualities. Taken one at a time, each of the Resource Inventories explores the issues, suggests sensitivities, and suggests management alternatives for individual aspects of the Econ Basin. Taken as a whole, and searching through each for common suggestions and a collective approach to landscape management, we have produced the CAMP Plan that is published as Volume III of this tripartite set of planning documents. The following summary is a synthesis of the most critical issues and collective suggestions from each of the Resource Plans and is intended as an overview from which an overall strategy for balancing development interests and environmental protection may be derived.

Summary and Recommendations

Issues and Management Suggestions

In this volume, each of the four issues listed above are discussed separately and management suggestions are summarized from the resource management plans that follow. The resource management plans give detailed discussions of the issues and recommendations for management from which the following have been summarized. Volume III gives not only management suggestions but also recommended regulatory actions.

ISSUE 1: Development impacts on surface and groundwater quality and quantity

The impacts of urbanization on surface water quality are well known. In general, as the result of increased runoff from impervious surfaces and other developed lands, stormwaters carry numerous pollutants and increased nutrient loads; the net result of which is a decrease in water quality in downstream receiving water bodies.

Groundwater quality is also affected, but probably of greater importance is the lowering of groundwater tables that results from construction of stormwater management systems. Lowered groundwater tables in the long run decrease base flows of streams and rivers, cause loss of hydroperiod in wetlands, and cause drought stress in terrestrial vegetation.

Management Suggestions:

1) Dechannelize streams, rivers, and tributaries of the basin.
2) Manage surface waters based on their nutrient status.
3) Avoid alteration of river and stream flow patterns.
4) Avoid alteration of natural vegetation in stream and river floodways and adjacent areas.

5) Design stormwater systems as networks of streams and wetlands and increase the use of wetland retention and detention basins and forested drainage swales.

6) Manage surface and groundwaters to minimize runoff.

7) Protect surficial aquifer levels.

8) Re-hydrate the landscape through recycling of wastewaters on the land in headwater areas and flatwoods/isolated wetland landscape associations to receive maximum treatment potential.

9) Maintain separate surface and deep aquifer groundwater systems.

10) Maintain "pre" development hydrology on all developed sites.

ISSUE 2: Developmental impacts on terrestrial wetland ecological communities

The loss of natural lands that may occur in the Econ Basin as developed lands increase will result from three different mechanisms. First, there will be the direct losses associated with clearing of vegetation and cuts and fills for building sites, roadways and miscellaneous facilities. Second, there will be secondary impacts caused by erosion and sedimentation from newly cleared lands and uncontrolled stormwater runoff. Third, there will be impacts associated with alteration of the landscape hydrologic regime. In all cases, the net result is increased fragmentation of the landscape, loss of ecologic functions, loss of visual amenities, and loss of wildlife habitat.

Management Suggestions:

1) Institute a controlled burning program and better controls on burning throughout the Econ Basin, but especially in the Big Econ Basin.

2) Develop performance standards for the design and construction of stormwater management systems as natural wetland sloughs and streams to minimize runoff, filter stormwaters, and maintain high water tables.

3) Begin a program of public education to reinforce the value of natural lands to wildlife and their scenic qualities in general and of the Big Econ in particular as a means of focusing public attention on management of the basin.

4) Cluster development whenever and wherever possible to minimize the aerial extent of clearing.

5) Areas of most intense development should be located at the greatest distance from surface water bodies and floodplains.

6) Seek protection of best examples of scrub forests, pine flatwoods, and other terrestrial communities.

ISSUE 3: Development impacts on wildlife

As development spreads across the Econ Basin, local extinctions of wildlife will result from several mechanisms. Natural habitats will become fragmented into sizes too small to provide adequate spatial requirements for some species. Genetic viability of wildlife populations in isolated habitat islands surrounded by development will diminish. Traditional wildlife travel lanes will be severed. Reductions in landscape diversity will eliminate essential wildlife nesting and feeding areas. The quality of habitats will decrease as the intensity of land use increases. Noise, cat predation and other factors associated with encroaching development will penetrate into adjacent natural areas and adversely affect wildlife. The increase in recreational activities such as canoeing and hiking along the Econ will create greater disturbances for wildlife.

Management Suggestions:

1) Identify and delineate a contiguous Basin Preserve consisting of large diverse habitat areas connected by effective corridors.
2) Identify the best lands within the Basin Preserve and place them into public ownership.
3) Develop and implement standards for the Basin Preserve that are compatible with wildlife protection objectives.
4) Extend boundaries of the Basin Preserve where necessary outside the Econ Basin to include sites where listed species have been documented.
5) Apply buffers (development set-backs) to significant wetlands within the basin.
6) Design and implement an effective corridor that ecologically connects the southern part of the Econ Basin to the Tosohatchee State Preserve and Seminole Ranch.
7) Design and construct a system of underpasses for the major roads intersecting the Econ Basin that will provide for safe passage of wildlife.
8) Develop and implement standards for land uses that minimize impacts on wildlife.
9) Landscape with plants indigenous to communities in the basin and restrict the removal of understory vegetation so that developed areas will blend into the natural areas.
10) Develop stormwater control ponds that use native emergent vegetation, littoral zones, and native vegetation along the shore.
11) Develop educational programs and incentives to encourage pet owners to keep pets confined to their property.

ISSUE 4: Development impacts on historical and archaeological resources

The historical resources of the Econ Basin are poorly documented by comparison with other areas of the state. Only 17 sites have been recorded within the entire study area, and only four of these are significant sites. The major reason for this lack of information is the limited amount and level of surveying that has been completed within the basin. The majority of the recorded surveys consist primarily of surface inspections along roads, ditches, and streams. Little systematic subsurface testing has been completed. As a result of this lack of basic data and lack of data collected in a consistent manner, it is extremely difficult to make valid predictions of the potential losses of historical and archaeological resources within the basin that may result from development. With development of a predictive model, targeted areas could be systematically surveyed and other areas given only cursory attention. The protection of these resources is extremely important, for just like species extinction, loss of historical resources is forever.

Management Suggestions:

1) Future development projects within areas having high probability of historical resources should conduct systematic surveys including subsurface testing to locate cultural resources.

2) Implement a project to develop a predictive archaeological and historical location model for the basin.

In all, the issues and policy decisions facing the people of central Florida relating to development of the Econ River Basin are complex and will be difficult to make. The greatest concern and the toughest question is simply how to balance development interests and environmental protection. It is the same question faced by all developing regions and growing economies. The Resource Inventories that follow were researched and written in the hopes that the detailed information they contain will be of value to the Econ River Task Force, the St. Johns River Water Management District and the citizens of central Florida as they begin to make the difficult decisions necessary to ensure a robust economy and healthy environment. Each Resource Inventory contains detailed analysis and discussion of issues and more detailed regulatory and management suggestions than are summarized above.

ECONLOCKHATCHEE RIVER BASIN NATURAL RESOURCES DEVELOPMENT AND PROTECTION PLAN

Chapter 1

WATER RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Prepared for

St. Johns River Water Management District

October 1990

Chapter 1

WATER RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Charles S. Luthin & Mark T. Brown

INTRODUCTION

Importance of Water Resources

Along with sunlight and clean air, clean water is often taken for granted. This is especially true in Florida because of abundant rainfall, numerous spring-fed rivers, and seemingly unlimited supplies of pure, underground drinking water. The case for water conservation and proper water quality standards often seems counterproductive and a waste of time and energy. Nothing could be further from the truth. Water is the single most important driving energy of the landscape; both the affairs of humans and the processes of nature depend upon it.

In earlier times, when the numbers of humans and the spatial extent of their land uses were small, it was often assumed that "the solution to pollution was dilution." There is a limit, however, and throughout Florida (especially in central Florida), the limits are being realized. To reverse trends of the past, to begin the process of restoring good water quality, and to protect existing water quality requires cooperative efforts on the part of all agencies involved in development regulation and re-evaluation of old thought patterns. No longer can we assume the land and its resources are unlimited or that the affairs of humans are somehow apart from the cycles and processes of the landscape mosaic. The affairs of humans are part of the cycles of the landscape. To better understand how to fit the patterns of human affairs into a landscape dominated by water, we begin with the hydrologic cycle.

The Hydrologic Cycle

Rainfall powers the hydrologic cycle, recharging the land and surface waterways, and eventually the deep artesian aquifers. Much of what falls as precipitation is lost to the atmosphere due to evaporation from land and water surfaces and transpiration by vegetation. That portion which runs off the landscape (about 25% on the average) develops a network of lakes, streams and rivers that carry valuable nutrients and organic matter ultimately to the sea.

Human activities that alter this delicate and dynamic cycle at any stage result in impacts throughout the system. Often the kind and magnitude of these impacts are unknown. Water extracted from one area results in reduced water quantities elsewhere. Water which is contaminated is eventually carried downstream or recharged to the Floridan Aquifer, the primary source of much of Florida's drinking water. The draining of surficial groundwater by ditches and canals lowers the water table for a considerable distance from the waterway, resulting in the eventual desiccation of adjoining wetlands and other ecological communities.

The loss of wetlands with their inherent ability to slow flood waters, filter and clean surface runoff, and maintain hydrologic homeostasis in the local environment further contributes to problems of rapid runoff, water contamination, soil erosion and reduced base flow of rivers. This is in essence "desertification," often read about in relation to the "Third World" but seldom considered a problem in Florida.

Contaminants

Potential contaminants of surface waters are many. These include inorganic and organic substances, both naturally occurring and man-made. The variety and quantity of environmental contaminants have increased in the past several decades as new agricultural and industrial chemicals have been introduced into the environment. Some of these pollutants are by-products of industrial and/or technological activities, including complex organic compounds and heavy metals.

The primary nutrients associated with eutrophication of water bodies are phosphorus and nitrogen, as they are required nutrients for plant growth. Both elements can occur in organic and inorganic form, but for general purposes in this report reference is made to "Total Phosphorus" (TP) and "Total Nitrogen" (TN) by combining all forms of these nutrients. Whereas small quantities of these nutrients are necessary for a healthy aquatic environment, surplus nitrogen and phosphorus can lead to degradation of water quality due to accelerated plant growth, thereby "choking out" the waterway with vegetation.

Many diverse organic compounds in water are degraded through biological or chemical processes requiring (or "demanding") oxygen. One parameter in establishing water quality criteria is Biological Oxygen Demand (BOD), or the oxygen demand for degradation/decomposition of dissolved or suspended substances (Brown et al. 1987). A high BOD is an indication of large quantities of organic compounds in the water; their source may be natural (e.g., wetlands associated with the waterway) or unnatural (industry, agriculture, urbanization).

In converse, Dissolved Oxygen (DO) is an indication of a healthy river or lake; the higher DO the better the water quality in supporting higher biological diversity and activity. DO is another parameter frequently monitored in waterways. DO may be naturally low in blackwater systems.

Various metals are known contaminants of waterways, as they can impair normal biological processes in numerous species of organisms. These substances usually originate in urban or industrial areas, and can be extremely toxic in even minute quantities in water systems. Examples include lead, copper, cadmium, mercury, and many others.

Point and Non-point Source Pollution

Most attention on sources of pollutants in waterways in general, and in the Econ River specifically, has focused on point sources. Point sources include site-specific discharges from sewage treatment plants, agricultural drainage canals and ditches, industrial waste discharge points, and channelized runoff from impervious surfaces. The amount of contamination coming from a point source is relatively easy to determine, as samples can be taken directly from the area of discharge, and monitored at known distances from source. Most studies of water quality use a point source (e.g., sewage treatment plant) as a point of reference for comparisons of nutrient loadings further downstream (e.g., Alt et al. 1974).

As suggested by the name, non-point sources have no single defined site of discharge. Rather, the origin of non-point pollutants may be over large areas, such as agricultural fields, construction sites, parking lots, or other surfaces. These pollutants may eventually be concentrated via channelized runoff or drainage ditches prior to discharge into a stream or river, or may enter a waterway through diffuse means.

Izzo (1975) uses the EPA definition of non-point source pollution: "A pollutant which enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances." Major agricultural non-point sources of contamination for the Southeast United States include soil erosion and sedimentation, and seepage of agricultural wastes and man-made chemicals into the waterways. These can be conveyed to water surfaces by direct runoff, by infiltration to subsurface water, or by wind (Izzo 1975).

Construction activities near waterways can contribute considerable non-point source contaminants to the water system. Impacts from construction are most detectable during and immediately following construction activities. Brown et al. (1987) list three broad classes of construction impacts:

1) Impacts associated with erosion of loose soils and their subsequent deposition in downslope wetlands (and waterways);
2) Suspended sediment increases in surface waters, resulting in increased turbidity; and
3) Introduction of unusual levels of chemical compounds that may have negative effects on resident fish and wildlife populations.

The sediments which spill into a water body from construction sites will result in direct negative biological impacts on the waterway due to increased turbidity, more suspended solids, and sedimentation. The final water quality effect during the construction phase is related to the release of chemicals, the levels of which may be harmful to downstream fish and wildlife or negatively affect ecosystem function. When areas are cleared, runoff increases, carrying with it increased volumes of soil and sediment (Brown et al. 1987).

Water Quality Criteria

Federal and state regulatory agencies (e.g., U.S. Environmental Protection Agency, Florida Department of Environmental Regulation) establish standards for nitrogen, phosphorus and BOD levels in waterways, as well as for numerous other contaminants, for different "classes" of water (Fernald and Patton 1984, Hand et al. 1988).

A waterway is assigned an overall water quality index (WQI) that represents an average of six water quality index categories (clarity, dissolved oxygen, oxygen demand, nutrients, bacteria, and biological diversity) which, in turn, are averages of the component parameter index values taken from a table of fixed values. The WQI is a percent value; low WQIs have the best quality, and high WQIs have the worst quality (Hand et al. 1988). Reference is made to WQIs for the several parameters discussed in this volume.

For the purposes of this report, we have selected three parameters commonly used for water quality analysis: Total Nitrogen (TN), Total Phosphorus (TP) and Biological Oxygen Demand (BOD). Both point and non-point sources contribute to loading of these three nutrients. State criteria for Florida streams for these three parameters are listed in Table 1.1.

Water Quantity

The Econ River Basin receives on average 50-52 inches of rainfall per year. This rainfall occurs during a relatively short season; more than 60% falls between June and October (COE 1973). This short-season rainfall coupled with a relative lack of topography and slightly notched rivers make the Econ Basin prone to occasional natural floods.

Flood conditions are dependent upon numerous interconnected factors: existing water table level, level of soil saturation, period and intensity of rainfall, amount of vegetated surface adjacent to the waterway, and degree of human impact on the natural flow of waters (channelization, dams, urban and agricultural runoff, point discharges, etc.). Flooding in the Econ Basin is not uncommon at 10-25 year intervals.

> Floods of large magnitude occur due to an unusual combination of meteorologic and hydrologic phenomena. However, man-made alterations in river basin hydrologic characteristics can also contribute to increased flooding. For instance, urbanization and associated floodplain encroachment, if not accompanied by proper design, can increase the rate and volume of runoff produced during a storm event. (Rao 1986) [emphasis ours]

Drainage and channelization of the Econ River Basin, particularly in the Orlando metropolitan area and more recently in rapidly developing areas further east and north, could potentially contribute to increased impacts from major storm events. Large impervious surfaces (parking lots, highways, buildings, etc.) deflect water during storms. These waters, if not properly diverted and retained elsewhere, can result in flooding of the natural waterways. Furthermore, removal of vegetation from the

Table 1.1 Florida Stream Water Quality Index Criteria (Percentile Distribution of STORET Data)

		GOOD			FAIR				POOR	
		Best Quality			Median Quality				Worst Quality	
Parameter*	Unit	10%	20%	30%	40%	50%	60%	70%	80%	90%
OXYGEN DEMAND										
BOD	mg/l	0.80	1.10	1.10	1.30	1.50	1.90	2.30	3.30	5.10
NUTRIENTS										
TN	mg/l	0.55	0.75	0.90	1.00	1.20	1.40	1.60	2.00	2.70
TP	mg/l	0.02	0.03	0.05	0.07	0.09	0.16	0.24	0.46	0.89
METALS										
CD	ug/l	2	4	8	12	17	20	--	--	40
CU	ug/l	12.5	25	50	75	100	125	--	--	250
PB	ug/l	50	100	150	200	250	300	--	--	1000

Parameters*

BOD = Biological Oxygen Demand　　CD = Cadmium

TN = Total Nitrogen　　PB = Lead

TP = Total Phosphorus

Sources: Hand et al. 1986, Hand et al. 1988 soil during construction phases of urban or industrial development will accelerate runoff, thereby increasing short-period water flow following a period of rainfall.

Ironically, a contrasting problem in the Econ Basin is a significant drying trend throughout the region. Water drawdown of the surficial water table occurs through pumping (e.g., for agricultural and urban use), drainage via ditches, and loss of surface storage in wetlands. The huge water needs of the Orange-Seminole urban area are met by pumping water from the Floridan Aquifer; since this is ultimately recharged by the surficial waters, a lowering of the Floridan water level causes a drawdown in the surficial water table. Disruptions of the normal hydrologic balance are most noticeable in the eastern portion of the Orlando metropolitan area. The rapid urban development of the Orlando area "will require extensive drainage since a significant portion of the watershed consists of marginal lands containing a very large number of small swamps" (ECFRPC 1978a). Expanding drainage will result in further impacts on the natural hydrologic balance. Lowered water tables will result in reduced flow in the rivers. Reductions in the water table will stress water-dependent vegetation, and may result in its eventual death. Loss of wetlands will further result in reduced water levels and accelerated runoff during heavy storms. Finally, a reduction in base flow in the rivers will tend to concentrate contaminants, thereby accelerating eutrophication of the waterways and degrading water quality. Steward (1984) states:

> Among the natural factors affecting water quality in the southern Middle St. Johns River, water quantity is most significant. It directly influences water quality through dilution and indirectly through hydraulic residence times.

With a predicted doubling of population in 20 years, the unnatural stress on the hydrologic patterns in the Econ Basin due to human perturbations will increase. This will result in greater extremes in water excesses and shortages. Only through carefully controlled growth and wise resource use can the water balance in the region be maintained.

Additional summaries are included for three metals: lead (PB), copper (CU), and cadmium (CD). These three metals are indicators of non-point source pollution, usually from urban areas. Criteria are listed in Table 1.1.

To avoid losses of water quality and subsequent loss of overall environmental quality, the following list of principles of good water management are offered as components of a wise water management program.

Principles of Good Water Management Strategy

* Keep deep groundwater and surface waters separate.
* Plan activities and developments within, not around, the limitations and capabilities of existing water resources and cycles.
* Conserve water resources at all stages, from consumption to disposition of waste waters.
* Allow the water table to maintain its normal fluctuation.
* Eliminate sources of contamination in and near sources of water.

* Manage surface waters based on their natural nutrient status.
* Avoid alteration of river and stream flow patterns.
* Avoid alteration of natural vegetation in stream and river floodways and adjacent areas.
* Design stormwater systems as networks of streams and wetlands.

Rationale

The Econlockhatchee River Basin is composed of two major subbasins: the Big Econ, which flows from its origins in a huge, intact headwaters swamp through a relatively undeveloped landscape of pine flatwoods and wetland sloughs; and the Little Econ, whose headwaters and channelway have been urbanized for several decades (Map 1.1). In essence, the two tributaries could not be more different. Much of the Little Econ has been ditched and channelized, and in the past was the receptacle of treated wastewaters. The Big Econ remains one of the few unchannelized and "pristine" rivers in central Florida. In these differences there are lessons to be learned. There is still much potential to reverse trends of the past by restoring the urbanized Little Econ River and protecting the future of the Big Econ.

For years, the Little Econ River has been a waterway of special concern because it once carried some of the most contaminated waters in the St. Johns River Basin. Eleven years ago the Little Econ was ranked first of 17 waterways for levels of point source pollution and overall third in priority for cleanup within the St. Johns River watershed (ECFRPC 1978c). Although the quality of water in the Little Econ has improved within the past six years as the result of removal of wastewater discharges (Hulbert 1988) non-point pollution continues to be a major concern within the watershed.

Non-point source pollution from urban stormwater run-off and agricultural drainage is now one of the most significant water quality concerns within the Econ Basin (FRSC 1985). The problem is especially acute in the Orlando metropolitan area which constitutes a major portion of the headwaters of the Little Econ.

In contrast to the Little Econ, the Big Econ has consistently been noted for its clean waters and pristine condition. In the same study cited above (ECFRPC 1978c), the Big Econ was the lowest ranked river of concern of 17 within the St. Johns watershed; that is, it was the cleanest of all rivers in the basin with the least threat of reduced water quality.

Until several years ago, the Big Econ was subject to extremely low pressure from urban development. Presently, however, there are no less than 10 major residential and industrial developments within its watershed (Map 1.2). These combined developments constitute a major threat to both water quality and quantity within the river resulting from increased stormwater runoff and loss of natural filtration due to soil and vegetation disturbance.

Stormwater management regulations within the Big Econ Basin, while requiring reductions of 80% of pollutant loadings in surface waters leaving developed lands, will still allow increased cumulative loading of the river. Without a non-point pollutant loading allocation for specific reaches on the entire basin, the cumulative impacts resulting from the 20% of pollutant loadings allowed could cause significant declines in water quality.

Scope of the Study

This volume summarizes the water resources of the Econ River watershed, which includes the Big and Little Econ Rivers and several smaller tributaries and lakes in a three-county area: Osceola, Orange and Seminole. This information was taken from historic and recent studies of these resources. The regional climate, hydrological characteristics of the waterways and adjacent areas, flood data, water quality, and the impacts of recent and future development are discussed.

A special emphasis of this volume is on water quality, as this has been the primary focus of numerous studies and management activities by state and county agencies, particularly in Orange County. A significant amount of water quality data over many years exists for the Econ River; these data are presented in graphic form and summarized to illustrate recent water quality trends and to highlight historic and potential threats. Several parameters, including Total Nitrogen (TN), Total Phosphorus (TP), Biological Oxygen Demand (BOD) and several metals (cadmium, copper, lead) will be discussed for both the Little and Big Econ rivers. Although data exist for numerous other water quality parameters, these will be analyzed in Phase II of this study.

Very few studies have addressed water quantity in the region, other than its relationship to flood conditions. Significant drainage has occurred in much of the Little Econ and parts of the Big Econ (e.g., Ranger Drainage District). This has reduced water table levels in the vicinity, lowered base flow rates for the river, and resulted in the desiccation and destabilization of wetland areas. Waters of the Econ Rivers are prone to flooding at frequent intervals, various studies have been undertaken to delineate floodway, flood prone areas, and floodplains of the rivers (U.S. Army Corps of Engineers 1973 and ongoing, FEMA 1987); other studies have investigated flood frequency, stage maxima, and ways to alleviate damage due to flooding within the floodplain (Ghioto et al. 1985, Rao 1985 and 1986). Water quantity issues are of importance in developing a regional water management plan.

Definition of Terms

Acronyms Used in this Chapter

COE	=	U.S. Army Corps of Engineers
DER	=	Florida Department of Environmental Regulation
DNR	=	Florida Department of Natural Resource
ECFRPC	=	East Central Florida Regional Planning Council
EPA	=	Environmental Protection Agency
FRSC	=	Florida Rivers Study Committee
SJRWMD	=	St. Johns River Water Management District
USGS	=	United States Geological Survey

Terms Used in this Chapter

(Definitions from Snell and Anderson 1970, Fernald and Patton 1984)

Aquaclude -- A layer impervious to the flow of water, for example, the thick confining beds between the surficial and Floridan aquifers.

Aquifer -- A formation or group of formations that is water-bearing. Often called "ground-water reservoir."

Artesian water -- Water under hydrostatic pressure confined in an aquifer by relatively impervious materials, which rises in a well above the top of the aquifer.

Drainage basin -- An area in which surface runoff collects and from which it is carried by a stream and its tributaries.

Eutrophic -- Rich in nutrients. When used to describe a body of water, a eutrophic condition often is accompanied with seasonal deficiencies in dissolved oxygen.

Eutrophication -- The natural aging process which results in the total sedimentation of a water body. Nutrient enrichment results from eutrophication.

Floodplain -- Relatively level valley floor built of material transported by a stream and deposited beyond the stream channel during floods.

Groundwater -- Water beneath the land surface in zones of saturation.

Nonartesian water -- Water in the surficial aquifer which is not artesian.

Non-point source pollution -- Pollution that is generated over a relatively wide area (such as a city or cropland) rather than at a specific site, and that is discharged into receiving waters at irregular intervals as a consequence of storm runoff.

Oligotrophic -- Deficient in nutrients. When used to describe a body of water, a oligotrophic condition often is accompanied with abundant dissolved oxygen with no marked stratification.

Piezometric level -- (See potentiometric level.)

Point source pollution -- Contamination from a single source, for example sewage plant discharge or industrial waste pipeline, discharged into receiving waters generally at a continuous rate.

Potentiometric level -- The level to which water will rise in tightly cased wells that penetrate aquifers.

Potentiometric surface -- The cumulative levels to which water will rise in an infinite series of imaginary wells that penetrate the same confined aquifer.

Recharge -- Water added to an aquifer by infiltration of precipitation into the soil or rock, by seepage through the soil or sinkholes, by seepage from streams and other surface water bodies, by flow from one aquifer to another, and by artificial introduction into recharge wells.

Runoff -- The part of precipitation that appears in surface streams after having reached the stream channel either by surface or subsurface routes.

Surface-water discharge -- The rate of flow of streams, expressed in cubic feet per second (cfs).

Surficial aquifer -- (See Water Table.)

Water table -- The surface of an unconfined aquifer, defined by the level at which water stands in wells that penetrate the water body far enough to hold standing water.

Review of Literature

Physical Characteristics of Econlockhatchee River System

The Econlockhatchee (Econ) River Basin is comprised of the Big and Little Econ Rivers and 83 small to large lakes (Map 1.1). The Big Econ River, a typical blackwater system, originates in an extensive flat lowland in northern Osceola County, the Econlockhatchee Swamp. The Big Econ, intermittent south of SR 50, flows northward 35.8 miles through eastern Orange County into southeastern Seminole County, then eastward into the St. Johns River, south of Lake Harney. The Little Econ originates in the relative highlands of central Orange County on the eastern edge of the Orlando metropolitan area. The Little Econ is 14.8 miles long and drains an area of 71 square miles (18,389 hectares or 45,420 acres) (Lichtler et al. 1968 and Gerry 1983).

The total watershed covers approximately 260 (Snell and Anderson 1970) to 280 sq. mi. (72,520 ha or 179,000 acres) (Alt et al. 1974, ECFRPC 1978a), and is the second largest tributary of the Upper St. Johns River Basin. (The Econ River is considered by some as the southern limit of the Middle St. Johns River Basin, e.g., FRSC 1985.)

The headwater elevation of the Big Econ is 68 feet above mean sea level (msl). Much of the Big Econ drains a region of coastal lowlands called the Osceola Plain. This broad, flat plain reaches its highest elevation (90 feet msl) at the western edge of the Big Econ watershed and its lowest elevation in the Econ River Valley (30 feet msl). This north-south aligned ridge of slightly rolling hills forms a divide between the Big and Little Econ watersheds. The Osceola Plain is characterized by nearly level topography, very poorly drained soils (Manatee, Delray, Leon, Rutledge, Plummer), and scattered swamps with limited flow (Alt et al. 1974, Knockenmus 1975, ECFRPC 1978a). The average fall gradient for the Big Econ is 1.8 ft./mi. (Gerry 1983).

The headwaters of the Little Econ near Conway Manor and Azalea Park drain eastern Orlando. The southern reaches of the Little Econ are underlain with somewhat poorly drained soils (Leon, Immokalee, Pomello, and St. Johns), whereas the northern portion occurs on moderately drained soils. These latter soil types (Lakeland, Eustis, Blanton, and Orlando) constitute recharge soils (ECFRPC 1978a). The Little Econ is a typical blackwater system, as it has traditionally drained swampland.

Little remains of the original stream channels at the headwaters, as the Little Econ is now a series of box-cut drainage ditches in much of Orange County (Fitzgerald et al. 1988). Elevations range from 50 to 90 feet msl, and fall gradient is 3.5 ft./mile. Elevation at the confluence of the Little Econ with the Big Econ at State Road 419 in Seminole County is 25 feet msl (Gerry 1983).

Several miles past the community of Oviedo the Econ River makes an abrupt eastward turn south of the Geneva Hill, at which point the river channel changes from a broad, flat valley to a valley with steep narrow walls. The river cuts through the escarpment dividing the Osceola Plain and the Eastern Valley and debouches into the St. Johns River (White 1970, Knockenmus 1975). The elevation at the confluence with St. Johns is 5 feet msl (U.S. Army COE 1986).

Climate of the Econlockhatchee River and Vicinity

Climatic and rainfall data for the St. Johns River Basin, which includes the Econ River system, have been gathered and summarized by the St. Johns River Water Management District and published as several technical publications: Rao et al. (1984), Rao and Clapp (1986), Jenab et al. (1986), and Rao et al. (1989). Ghioto et al. (1985) summarizes rainfall data in relation to flood conditions.

The climate of this region is characterized as subtropical; the average annual temperature is 22°C (71°F) (Knockenmus 1975). Average rainfall was between 50.04 inches (Orlando area) and 52.41 inches (Bithlo) for a 38-year period 1947-84. The eastern region of the watershed receives slightly more rainfall than in the west. The majority of this rainfall occurs during a four-month period, June through September. Using the 1947-84 data for rainfall at Bithlo and Orlando, an average of 28.99 inches (57%) was recorded for these months (Jenab et al. 1986). The months of November through May are considered the dry season (Rao et al. 1989). These rainfall patterns have an important influence on the flow rates of the Econ River, which may fluctuate widely over a 12-month period.

The region is susceptible to occasional brief periods of extremely high rainfall, which may result in varying degrees of flooding. Twenty-four hour, high rainfall events have reached 12.05 inches (Bithlo 1961) and 11.86 inches (Orlando 1951) in the past 40 years. Ten-day highs in rainfall were 15.36 inches and 18.62 inches for Bithlo and Orlando, respectively (Rao and Clapp 1986).

Water Resources of the Econlockhatchee River Basin

White (1970) describes the geomorphology of the Florida Peninsula. Original hydrologic studies that encompassed the Econlockhatchee River Basin were prepared by Snell and Anderson (1970) for Northeast Florida, by Joyner et al. (1968), Lichtler et al. (1968) and Tibbals and Crain (1971) for Orange County, and by Stubbs (1938), Heath and Barraclough (1954), Barraclough (1962) and Tibbals (1976) for Seminole County. Additional hydrologic studies that have covered the Econ Basin include Anderson and Hughes (1975), Knockenmus (1975), Foose (1983), Rao et al. (1984), Phelps (1984), Phelps and Rohrer (1987) and Skipp (1988).

The Econlockhatchee River Basin is underlain by two distinct aquifer systems, the uppermost surficial (nonartesian) aquifer and the deeper Floridan (artesian) Aquifer. The surficial aquifer is 40-100 feet thick and is composed of fine quartz sands (late and post-Miocene sediments) which become finer with depth, eventually dominated by low-permeability clays. Generally, below 20 feet this aquifer contains a zone composed partially or entirely of shells with considerable permeability (Tibbals and Crain 1971, Knockenmus 1975).

A confining layer 10-150 feet thick composed of clay often mixed with sand and shells lies below the surficial aquifer. This is the Hawthorn Formation of Miocene age (Stubbs 1938, Barraclough 1962). This relatively impermeable layer separates waters from the surficial and Floridan aquifers (Joyner et al. 1968).

The Floridan Aquifer is from 100 to 350 feet below the surface, and is composed of dolomitic limestone of Eocene age. This layer ranges from 1300 to 2000 feet thick, and supplies the majority of drinking water in Seminole and Orange counties (Joyner et al. 1968, Lichtler et al. 1968, Tibbals and Crain 1971).

Surficial Water

The surficial water table is usually within 0-20 feet of the surface over much of the Econ Basin, although it may be slightly lower in areas of highest elevation (Knockenmus 1975, Phelps and Rohrer 1987). In much of the basin, where pine flatwoods predominate, the water table is at or near the surface for much of the year (Tibbals 1976).

The surficial aquifer is recharged primarily by local rainfall. Water leaves the aquifer by evapotranspiration (as much as 70% of total rainfall) from open water surfaces and vegetation, seepage to lakes and rivers and by human extraction from wells or drainage ditches (Joyner et al. 1968). The water table has been lowered by drainage ditches in many urban and agricultural areas (Tibbals 1976).

Downward leakage of water into the Floridan Aquifer is negligible in many parts of the basin due to limited permeability of the confining layer (Lichtler et al. 1968, Knockenmus 1975). However, certain regions of the Econ Basin have a thinner and/or more permeable confining layer between surficial and Floridan aquifers. In these areas, and where the potentiometric surface is below the water table, there is recharge to the Floridan Aquifer from the surficial aquifer. The areas of highest recharge to the Floridan Aquifer within the Econ Basin are eastern Orlando south to Lake Conway (Orange County) and the Geneva Hill (Seminole County) (Phelps 1984, Phelps and Rohrer 1987). The majority of the Upper Econ Watershed contains areas of low to moderate recharge, and the Lower Econ below the confluence of the Little and Big Econ rivers has virtually no recharge to the Floridan (Phelps 1984).

Floridan Aquifer

The Floridan Aquifer is the major source of fresh drinking water throughout much of central and north Florida. Because this water is under pressure due to the impermeable aquaclude above it, water will rise above the top of the aquifer when penetrated by a well. The level to which water rises under such conditions is called the piezometric or potentiometric level. If the potentiometric level is above the surface of the land, water tends to flow freely from a well at that point. Many Florida springs are artesian flow of water from the Floridan Aquifer through thin, permeable or noncontinuous confining sediments.

In the Econ River, the potentiometric surface ranges from 60 feet below the land surface in areas of high relief (e.g., eastern Orlando) to several feet above the land surface near the St. Johns River (Joyner et al. 1968, Lichtler et al. 1968).

The Floridan Aquifer is not recharged by waters from as far away as Georgia as is commonly believed, but rather almost entirely by rainfall within the region. Recharge occurs when the Floridan Aquifer is relatively close to the surface, when the confining beds are thin or permeable, and when the water table is higher than the potentiometric surface creating a "downhill" gradient. Recharge potential within the Econ Basin varies from good in western portions of the Little Econ Basin to poor in most of the Big Econ River (Phelps 1984).

Big Econ River

Until recent years, the Big Econ has remained in relatively pristine condition with limited impacts due to development. The majority of activities in the Upper Big Econ up to the 1970s had been grazing and some agricultural use (citrus groves).

The Ranger Drainage District, a major drainage project encompassing more than 6,000 acres east of the Big Econ in Orange County (Alt et al. 1974), was constructed in the early 1970s. Secondary and tertiary canals form a drainage network throughout the area; these empty into straight canals which lead directly into the Big Econ or smaller tributaries (SJRWMD 1980b).

Little Econ River

The water quality of the Little Econ, has received considerable attention throughout the past three decades. Reports include: Smith et al. (1954), Goolsby and McPherson (1970), Kaleel (1972), Alt (1974), Izzo (1975), Auth (1976), ECFRPC (1978a, 1978b, 1978c), SJRWMD (1979, 1980), Seminole County (1982), Hand and Jackman (1982), Gerry (1983), Hand and Jackman (1984a, 1984b), Steward (1984), ECFRPC (1985), Fall (1985), Hand et al. (1986), U.S. Army COE (1986), Fitzgerald et al. (1988), Hand et al. (1988), and Hulbert (1988).

In direct contrast to the Big Econ, the Little Econ has been one of the most heavily impacted waterways within the SJRWMD. Many miles of the original watercourse have been channelized, essentially creating a network of drainage ditches carrying surplus waters from the Orlando metropolitan area into the Econ system and ultimately to the St. Johns River.

For many years, the Little Econ received much treated sewage effluent from the Orlando metropolitan area. Prior to 1978, no less than 12 Sewage Treatment Plants (STPs) in eastern Orlando were delivering a total of nearly 8 million gallons per day (MGD) of secondarily treated wastewater directly to the Little Econ. The total existing capacity at the time was 13.4 MGD with an additional 4.8 MGD proposed. At the time that was the highest domestic wastewater load for the entire St. Johns River Basin (ECFRPC 1978a).

Aggravating the problem of sewage effluent in the Little Econ was urban runoff carrying surface pollutants from the Orlando area into the Econ Basin. Since the river is channelized in much of its headwater zone and the original vegetation cover was altered, the normal filtering "service" of natural wetlands adjacent to the river was lost and the runoff discharged directly into the river and washed downstream. This has contributed a significant load of contaminants to the already overtaxed waterway (Seminole County 1982, Gerry 1983, Steward 1984).

Numerous reports have detailed the historic conditions of the Little Econ River. Its pollutant loading has been so great that, despite considerable dilution by the Big Econ at the confluence with the

Little Econ near Oviedo, the Econ waters have had detrimental impact on Lake Harney in the St. Johns River system 20 miles downstream (Goolsby and McPherson 1970, Alt et al. 1974, Auth 1976, ECFRPC 1978a, SJRWMD 1979 & 1980, Seminole County 1982, Hand and Jackman 1982 & 1984b, Gerry 1983, COE 1986). The Florida Game and Fresh Water Fish Commission considered the Econ River the single most disruptive influence on the Upper Basin [of the St. Johns River]; a massive fish kill (ca. 10 million) in 1980 below Lake Harney was attributed to the nutrient loading in the Econ River (Gerry 1983).

Considerable improvement in average water quality was observed following the completion of Orlando's 24 MGD capacity Orlando Easterly Advanced Water Treatment (AWT) Sewage Treatment Plant (STP) in 1977 (ECFRPC 1978c), and the 24 MGD Iron Bridge Regional Wastewater Treatment Plant in January 1982 which began tertiary treatment of 12 MGD of sewage originally treated at the Bennett Road STP. Additional lines from other STPs to Iron Bridge were completed in the subsequent year or two (Gerry 1983, Hand et al. 1986). As a result, the quality of water in the Econ River has improved considerably compared to the previous two decades.

St. Johns River

The Econ River is a major tributary of the Upper (Middle) St. Johns River. Many of the studies of water quality in the St. Johns River, therefore, have included specific information about the Econ. The highly eutrophic conditions in Lake Harney, which originates shortly below the mouth of the Econ River, have been directly related to significant nutrient loading from the Econ River for decades (Goolsby and McPherson 1970, ECFRPC 1978b, Gerry 1983).

Whereas "the area from Lake Washington Dam [on the St. Johns River] to the confluence with the Econ River is generally in fair condition," Hulbert (1988) continues,

> This [Econ] drainage system, in the past, has been a source of nutrients from urban runoff and effluents from sewage treatment plants to downstream Lake Harney. Lake Harney has experienced accelerated eutrophication consisting of massive algal blooms causing pea-soup green water, especially during the summer.

Furthermore, the Florida Rivers Study Committee (1985) appointed by the Governor stated that Lake Harney has been, "plagued with intermittent destabilizing events associated with eutrophication (algae blooms, highly fluctuating D.O. [dissolved oxygen] levels, and fish kills)."

In its Draft Upper St. Johns River Basin Surface Water Management Plan, the SJRWMD (1978b) reports that:

> The high levels of phosphorus at SR 46 appear to be due to the influence of the Econlockhatchee River, which had an average total phosphorus concentration of 1.5 mg/l (milligrams per liter). This is nearly 17 times higher than the average for the basin (0.09 mg/l). [emphasis ours]

In discussing water quality on the Middle St. Johns River during the 1980-81 drought, Steward (1984) states, "...the Little Econ River contributed significantly to nutrient levels in the St. Johns downstream from its confluence, particularly during low flows." Although total phosphorus levels decreased in Lake Harney between 1975 and 1979, they increased two- to threefold during the 1980-81 drought. Total nitrogen, rising since 1974 in Lake Harney, doubled the 1974-75 level during the same drought. Steward (1984) concludes:

> During low flow months the Econ has its greatest impact on Lake Harney as a result of lowered dilution of nutrient loads from treated sewage effluent.

RESOURCE DESCRIPTIONS

Water Quality

One of the greatest issues facing the Econ River Basin is related to restoration and maintenance of water quality. Many aspects of human activity in the region are dependent upon this single resource. Clean water is required for individual use and consumption, for use in industry and agriculture, for recreation, and for the maintenance of ecological function. Water use and consumption inevitably results in the production of waste waters, which must be properly disposed of if negative impacts to the clean water supply are to be avoided. Termed point sources of pollution, waste waters result from industrial processes, human waste treatment plants, and some agricultural operations such as feedlots.

Development of lands within a river's watershed can affect both the quantity and quality of surface waters that drain into the water course. Referred to as non-point source pollution, stormwater runoff from developed lands carries with it many constituents that can degrade water quality if present in sufficient quantities. The data suggest that the Big Econ is relatively unimpacted by non-point source pollution. Its watershed, especially its headwaters, have until recently remained undeveloped. Current development trends, however, suggest that changes in its "pristine" character are in the offing. On the other hand, water quality in the Little Econ is significantly below that of the Big Econ despite considerable improvement in the past five years.

As the discussion which follows demonstrates, water quality in and downstream from the Econ River has historically been degraded. Although some positive changes have taken place in recent years, considerable threats to the future regional water quality and supply exist.

Water Quality Analysis

Water quality data for the Econ River System have been recorded for many years by state and county agencies. Summaries of these data have appeared in numerous reports (e.g., Alt et al. 1974, Seminole County 1982, Gerry 1983, Steward 1984, Fall 1985, Hulbert 1988). This report summarizes recent water quality data from 1972 to 1988 for the Econ River, taken from 14 sample sites: six sites along the Big Econ upstream from the confluence with the Little Econ, six sites along the Little Econ, one site at the confluence, and one site below the confluence. These sample sites are described in Table 1.2 and located on Map 1.1.

The data are stored in EPA's "STORET," a nationwide data base of water samples that include those of Florida state and county agencies. The STORET identification codes for the sites used in this report are included in Table 1.2. The data were analyzed and plotted by the St. Johns River Water Management District. Raw data for Figures 1.1 to 1.6 exist in tabular form in Appendix A-1.

Table 1.2 Econlockhatchee River Water Quality Sample Site Descriptions (See Map 1.1 for locations.)

BIG ECONLOCKHATCHEE RIVER

Sample Site #	Storet Primary Station # (Agency Code)	Location and Description
1	BEH (FLORAN) SOR58010 (FLWQA)	Big Econ R. at Weewahootee Rd., Orange Co.
2	BEA (FLORAN) SOR58020 (FLWQA)	Big Econ R. at Beeline (528), Orange Co.
3	BEG (FLORAN)	Big Econ R. at powerline rt-of-way, below Ranger D.D., Orange Co.
4	BEF (FLORAN) SOR58030 (FLWQA)	Big Econ R. at "Old Cheney", SR 50, near Bithlo, Orange Co.
5	BEB (FLORAN) SOR58040 (FLWQA)	Big Econ R. at SR 420, Orange Co.
6	BEC (FLORAN) SOR58050 (FLWQA)	Big Econ R. above confluence with L. Econ R., Seminole Co.
7	BED (FLORAN) SOR58120 (FLWQA)	Big Econ R. confluence with L. Econ R. at bridge, SR 419, Seminole Co.
8	BEE (FLORAN) SOR58130 (FLWQA) ECH (21FLSJWM)	Econ. R. at Snowhill Rd., Chuluota, Seminole Co.
A	LEE (FLORAN)	Little Econ R. at North-South Canal, SWD 2, Orange Co.
B	LET (FLORAN) SOR58060 (FLWQA)	Little Econ R. at gauging station, Berry-Deese Rd., SWD 6, Orange Co.
C	LEH (FLORAN) SOR58080 (WQA)	Little Econ. R. at SR 50, above Orlando STP, Orange Co.
D	LEP (FLORAN)	Little Econ R. at Econlockhatchee Trail, below STP, Orange Co.
E	SOR58100 (FLWQA)	Little Econ R. upstream from Iron Bridge STP, Seminole Co.
F	LEZI (FLORAN) SOR58110 (FLWQA)	Little Econ R. 100 yds below Iron Bridge STP, Seminole Co.

For the purposes of this report, three parameters commonly used for water quality analysis: Total Nitrogen (TN), Total Phosphorus (TP) and Biochemical Oxygen Demand (BOD). Both point and non-point sources contribute to loading of these three nutrients. State criteria for Florida streams for these parameters are listed in Table 1.1 Additional summaries are included for three metals, lead (PB), copper (CU) and cadmium (CD). These three metals are indicators of non-point source pollution, usually from urban areas. Water quality criteria are also listed in Table 1.1 for these metals.

Figures 1.1 to 1.6 illustrate trends in TN, TP, and BOD for the Econ River prior to and after 1984. Between 1982 and 1984, the 24 MGD Iron Bridge Regional Advanced Water Treatment Sewage Treatment Facility came into operation, diverting wastewaters from Orlando-area secondary treatment plants for tertiary treatment. The secondary STPs have since gone off-line. Conversion to advanced wastewater treatment was a turning point in water quality in the Econ River. The figures represent data averaged from 1972-83 ("pre-1984"), prior to Iron Bridge, and averaged during 1984-88 ("post-1984").

A Median Water Quality Index (WQI) value of 50% ("fair" water quality) is shown on several graphs as a standard of reference for the various parameters discussed. These values are taken from Florida Water Quality Index Criteria listed in Table 1.1.

There are obvious differences in water quality between the Little Econ and the Big Econ for all three parameters prior to 1984 (Figures 1.1, 1.3, 1.5). Water samples at each site along the Little Econ were in excess of the median value for TN, TP and BOD. These same parameters were within median values for the entire Big Econ upstream from the confluence with the Little Econ, suggesting a river in excellent condition during the period 1972-1983.

Although the levels of all three contaminants dropped after 1984, the median values are still exceeded in the Little Econ and Lower Econ (downstream from the confluence). Discussions of each parameter for both sample periods follow.

<u>Nitrogen.</u> Total Nitrogen Concentrations along the Little Econ were above the 80% WQI value (poor), and four of the six were above the 90% value, or "worst quality" before 1984. A large increase in nitrogen levels between sites C and D undoubtedly reflects the discharge from the Orlando STP (which has subsequently been phased out).

Before Iron Bridge came on-line, there was so much nitrogen loading upstream from the confluence of the Big Econ that even after the rivers met and waters mixed, TN levels were still in the "worst quality" category (Figures 1.1 and 1.2). These high nitrogen levels have been implicated in eutrophication of Lake Harney many miles downstream (Hulbert 1988). In the past two years that nitrogen levels downstream from the confluence of the two rivers have begun to compare with TN levels of the Big Econ upstream from the Little Econ (Figure 1.2).

Figure 1.2 shows a doubling of TN concentration in 1981 compared to the previous year for the Little Econ River. The period 1980-81 was a period of drought which resulted in reduced flow rates in the Upper St. Johns River system, including the Econ River (Steward 1984). Annual rainfall in Orlando for 1980 was 41.2 inches, almost 10 inches below normal (50.85 inches). Furthermore, rainfall in 1981 was more than 3 inches below the mean (Rao et al. 1989). A similar doubling of TN in Lake Harney on the St. Johns below the Econ River was observed during the drought years 1980-81, probably reflecting water quality conditions in the Econ. Whereas the total nitrogen loading likely remained much the same or increased slightly in 1980-81 compared to previous years, the increase in apparent TN concentration may be a result of flow rate reductions and reduced dilution of nutrients. The Little Econ seems to be particularly prone to low flow that may be the result of loss of wetlands in its headwaters, channelization which has increased the efficiency of drainage, and increased wet season runoff.

Total nitrogen in the Big Econ prior to 1984 consistently hovered near the median value (Figures 1.1 and 1.2); these slightly high values probably reflect a natural nitrogen level in the blackwater system, although there may have been some loading due to grazing by cattle or other agricultural activities in the basin. Interestingly, the Big Econ did not experience any significant changes in TN concentration during the 1980-81 drought as did the Little Econ. This is further indication of a healthy river experiencing little supplemental nutrient input.

Nitrogen levels decreased in the Little Econ after 1984 (Figure 1.1). Only at sample sites E and F (above and below the Iron Bridge STP) were the nitrogen levels excessively high, above the 90% WQI value ("worst" quality). These high nitrogen levels remained above the WQI at the confluence with the Big Econ. Figure 1.2 indicates that there may be a recent reduction in nitrogen loading in the Little Econ.

Nitrogen levels in the Big Econ remained near the standard median value during the post-1984 period, rising above the median only after the confluence. This has further improved in the past two years (Figure 1.2).

Phosphorus. Total phosphorus in the Little Econ prior to 1984 exceeded the "worst quality" value at four of six sample sites (Figure 1.3). During the same time period, phosphorus in the Big Econ remained at a relatively stable level near the median value. Phosphorus levels below the confluence were well above the 80% WQI prior to 1982 (Figure 1.4). Total phosphorus more than tripled below the confluence of the Little and Big Econ during the drought period 1980-81, compared to the previous year (Figure 1.4).

During the post-1984 period, phosphorus levels dropped considerably in the Little Econ (Figure 1.3). The point source loading between sites A and B and between C and D prior to 1984 were subsequently eliminated, and phosphorus levels decreased at these sites. The relatively high values for phosphorus are consistently in the "poor" category for these WQI values.

The reduction of distinct peaks in Figure 1.3 (post 1984) in the Little Econ suggests that point source pollution has been curtailed; the remainder of phosphorus likely comes from non-point sources from the urban areas drained by that portion of the Little Econ. The phosphorus levels in the Big Econ during the post-1984 period were almost identical to those prior to 1984 (Figures 1.3 and 1.4), indicating that land use has probably changed little during the past two decades. Figure 1.4 shows a general reduction in overall phosphorus levels in the Lower Econ River with time.

BOD. BOD levels in the Little Econ before 1984 varied from site to site, but were extremely high along its entire course to the Big Econ (Figure 1.5). A surge in BOD between sites C and D is related to discharge from a former STP. All six sites had WQI values above 80% ("poor") and three above 90% ("worst" quality). BOD at the confluence of the Big and Little Econ Rivers was also in the poor category during this period. BOD, as with TN and TP, increased three-to fourfold in the Econ River during the drought years 1980-81 (Figure 1.6). Again, a reduction in flow in the river likely resulted in higher concentrations.

Median concentrations of BOD in the Big Econ appear somewhat higher than the median WQI value prior to 1984 (Figure 1.5). The peak during drought year 1981 has undoubtedly skewed the average BOD value for the Big Econ during the pre-1984 period, suggesting a higher BOD loading than what may have actually occurred. BOD levels were slightly higher at the headwaters of the Big Econ (Figure 1.5) compared to downstream, reflecting the naturally high biological activity in the river. The BOD levels decreased slightly further downstream until the confluence with the Little Econ.

Post-1984 BOD levels are rather high for both the Little and Big Econ rivers. The BOD levels in the Little Econ and downstream from the confluence are still considered "poor." Variations in seasonal rainfall and subsequent runoff may influence levels of BOD and the other nutrients; drought years tend to result in higher BOD loading in the river.

Metals. Figures 1.7, 1.8, and 1.9 illustrate the percent of time that cadmium (CD), copper (CU) and lead (PB) levels exceeded the standards set for these parameters in samples from the same sites along the Little and Big Econ rivers. Specific values are not plotted, but are listed in Appendix A-2. The data do not suggest any clear differences with respect to tributary in CD and CU concentrations. Lead, a common contaminant of urban and industrial zones, shows progressively increasing exceedences from upstream to downstream along the Little Econ River. These values are consistently higher than from the Big Econ. Lead is one trace metal so ubiquitous in urban surroundings that this is a good indicator of specific land use activities; the same is not true for copper and cadmium.

Point vs Non-point Source Pollution in the Econ Basin

Most discussions of, present and future water quality problems in the Econ River Basin suggest non-point source pollution originating primarily from urban sources in rapidly developing areas as the primary problem. The following are a selection of comments supporting this concern.

> "...better technology, increased efficiency, and increasing regulations will soon minimize their [point source] effect on the environment. ...non-point source pollution appears to be the prime cause of water quality degradation. Stormwater run-off, agricultural drainage, and the many waterfront lots contribute the majority of pollutants to [Seminole] County waters." (Seminole County 1982) [emphasis ours]

> "Much of the nutrient loading into the southern Middle St. Johns River [including the Econ River] is of non-point origin.... Despite efforts toward reducing point source discharges, net increases in phosphorus and BOD_5 loadings are expected as urban development in the basin continues, ...primarily through non-point source urban runoff." (Steward 1984) [emphasis ours]

"Land use intensification, particularly the urban expansion in Seminole County and in the Econ River basin (Orlando metroplex) is the most important factor deleteriously affecting water quality." (Steward 1984)

"Nutrient and coliform levels have improved in the Econ in recent years, probably due to improvements in sewage treatment plants. However, increases in non-point source pollutant loadings are expected to offset reductions in point source loadings as urbanization continues." (Fall 1985) [emphasis ours]

"Studies have concluded that mitigation of point sources alone is not sufficient. Non-point sources from urban, agricultural, and silvicultural activities are significant and may dominate the total nutrient input." (Governor's Florida Rivers Study Committee 1985) [emphasis ours]

"... untreated urban stormwater and cattle grazing in the area [Econ River above Lake Harney] continue to pose a problem." (Hand et al. 1988)

Steward (1984) states that "urban-related annual loadings for total nitrogen (TN), total phosphorus (TP) and biological oxygen demand (BOD_5) are expected to nearly double by the year 2000;" this parallels the projected doubling of the human population in the basin within 20-30 years.

The greatest potential immediate non-point source pollution loading may come from the large number of extensive developments, some considered "Developments of Regional Impact" (DRIs), both for residential and industrial expansion, which are either under construction or are planned for the Econ River basin south of Oviedo (Seminole County) to the Beeline (Orange County). These will contribute non-point source pollutant loading from construction activities and stormwater runoff as a result of increased impervious surfaces (roads, parking areas, buildings), loss of natural vegetation, and disturbed soil conditions.

The Econ River is classified as a "Class III" waterway by the Florida Department of Environmental Regulation. A Class III waterway should meet water quality standards for "recreation, fish and wildlife" (Fernald and Patton 1984). Class I (potable water) and Class II (shellfish) have criteria more stringent than Class III, whereas Class IV (agriculture) and Class V (industry) criteria are less stringent (Hand and Jackman 1984).

MANAGEMENT ALTERNATIVES FOR WATER RESOURCES

With the removal of wastewater discharges from the Little Econ, there has been marked improvement in water quality, yet it has also revealed how much is left to be done. Without wastewater to overshadow the poor water quality, it becomes apparent that stormwater runoff impacts are still to be dealt with. Removal of the waste treatment plant discharges was direct and significant. The management of stormwater is much more difficult and requires more concerted effort to maintain high water quality.

The impacts of urbanization on surface water quality are well known. In general, as the result of increased runoff from impervious surfaces and other developed lands, stormwaters carry numerous pollutants and increased nutrient loads; the net result of which is a decrease in water quality in downstream receiving water bodies.

Groundwater quality is also affected, but probably of greater importance is the lowering of groundwater tables that results from construction of stormwater management systems. Lowered groundwater tables in the long run decrease base flows of streams and rivers, cause loss of hydroperiod in wetlands, and cause drought stress in terrestrial vegetation.

As we see it, there are three main goals to achieve in this Management and Protection Plan that will ensure high quality and a sufficient quantity of water resources in the Econlockhatchee River Basin:

1) Restore water quality where it has been degraded.
2) Prevent any declines in water quality in the rest of the basin.
3) Manage water tables at their historic levels.

To achieve these goals we offer the following management suggestions.

Management Suggestions

Dechannelize Streams, Rivers, and Tributaries of the Basin

Dechannelization is not easy to do, and is not recommended lightly. The net effect of dechannelization of the Little Econ and other ditches and tributaries is an increase in water table levels, an increase in residence time of stormwaters within the systems, and most assuredly an increase in flooding. It will take serious and creative "ecological engineering" to achieve a natural drainage network given the levels of urbanization that now exist in much of the basin. If the basin were brought up to current stormwater standards, much of the need for channelization would be eliminated.

The benefits of dechannelization would be threefold:

1) improved water quality,
2) decreased flooding in downstream areas, and
3) a rehydrated landscape having higher water tables.

Likewise, existing constructed drainage ditches are good candidates for dechannelization. There are numerous ditches throughout the basin that traverse miles without so much as a one degree bend. Their effect is to lower water tables, increase storm peak flows, and degrade surface water quality. They should be re-engineered as first- and second-order forested streams.

A regional approach to non-point source treatment where large wetland detention basins are constructed for stormwater treatment in conjunction with dechannelization may offer both treatment and storage protection from flooding.

Avoid Alteration of River and Stream Flow Patterns

Not only should existing channelized portions of the River Basin be restored, but it goes without saying that further channelization should be avoided. Where road crossings have constricted flows, additional bridging and culverts should be installed to reduce velocities and the potential for downstream scouring.

Manage Surface Waters Based on their Nutrient Status

High nutrients and sunlight combine to produce high biomass. Where surface waters are high in nutrients, there is always sufficient sunlight (unless of course the water body is a forested stream) to drive large gross productions and thus standing stocks of biomass. If nutrients are not used (that is, stored in plant tissue or dead organic matter) they are passed through the system.

When eutrophic surface water bodies are managed as if they should be oligotrophic (for instance, when vegetation is prevented from growing) the net result is shunting the problem downstream to another portion of the system. Nutrients should be treated as close to their origin as possible. Once eutrophic, keeping a water body free of vegetation is not only extremely difficult but may be undesirable water and ecological management. Most often it requires herbicides or other chemicals which have many side effects on organisms other than the target. Additionally, the dead plants most often sink in place, adding to water quality problems as they decompose. We strongly suggest that state agencies rethink their current policies of maintaining appearances of oligotrophic lakes and streams when if allowed to vegetate, waters farther downstream would have lower nutrient concentrations and higher quality.

Avoid Alteration of Natural Vegetation in Stream and River Floodways and Adjacent Areas

Vegetated water courses have better water quality and are better protected against erosion and sedimentation. Vegetation acts to increase friction over the surface of the landscape, slowing down runoff water and stream velocities. Often in the belief that vegetation "clogs" stream channels and causes flooding, channels and ditches are maintenance dredged to improve their drainage capacity. The net effect of such management activities is to reduce treatment capacity of the channelway and to increase water velocities.

Design Stormwater Systems as Networks of Streams and Wetlands

Current stormwater networks only superficially resemble natural drainage networks. In appearance they are composed of straight ditches, swales, and lakes that most often have to be maintained to keep them open water bodies rather than vegetated wetlands. The average watershed size for a first-order stream in lands like those of much of the Econ Basin is one square mile. Its slope is roughly 1.3 feet per mile and sinuosity is about 1.3 (i.e., for every mile of distance as the crow flies, the stream channel is 1.3 miles long). It starts as a wetland slough with no definable stream channel. At its mouth, it has a storm channel measuring approximately 5 m and a base flow channel of less than 1 m, and a 10-year floodplain measuring about 70 m wide on the average.

In most first-order Florida watersheds the majority of wetlands are associated with the headwaters, not the outfall. Storage is accomplished where runoff occurs and not at the bottom of the system. Wetland storage is first in isolated wetlands, then through slight depressions (swales) where it may coalesce into sloughs (elongated wetlands with imperceptible flows) and finally into the headwaters of the stream.

Designed in this manner, stormwater management systems would minimize runoff, maintain higher water table elevations, have higher quality runoff, and incorporate wildlife habitat into development plans. Most importantly, post-development hydrology would more closely approximate to predevelopment conditions.

Manage Surface and Groundwaters to Minimize Runoff

Current stormwater management regulations more or less are designed to ensure that the quantity of water leaving a site, following a rainfall event, does not cause a decline in receiving bodies. However, there is little in current regulations that suggests that runoff should be minimized. There is no emphasis of storage and recharge, or maintenance of desirable water table elevations. Rules should emphasize the goal matching post-development runoff with predevelopment conditions.

Protect Surficial Aquifer Levels

In the process of stormwater management, often the net result is lowered groundwater tables. Reversing these trends requires that roadway and building elevations may need to be raised to accommodate some flooding during extreme events. Now that the lands with higher topographic relief have been mostly developed, the trend is to use less and less suitable lands. The application of more and more engineering while possibly solving the short-term problem, can only lead to gross losses of environmental quality as the landscape undergoes desiccation.

Increase the Use of Wetland Retention Basins, and Forested Drainage Swales

To protect water quality and still provide for stormwater management, systems should be designed purposely as vegetated stream channels and wetland storage systems instead of ditches and detention/retention ponds. The added treatment, friction and aesthetics, not to mention wildlife benefits are important contributions to a regionwide water quality program.

Re-hydrate the Landscape through Recycling of Wastewaters on the Land in Headwaters Areas and Flatwoods/isolated Wetland Landscape Associations to Receive Maximum Treatment Potential

It has now become more and more acceptable to recycle wastewater through wetland systems as integral parts of our development patterns. These trends need be encouraged. Smaller treatment facilities scattered throughout the landscape make recycling easier to accomplish because sewage is not concentrated, more wetlands are available, and wetland sizes can be smaller. In view of our past experiences with treatment plants discharging directly to surface water bodies, and lacking the many improvements in technology that present day plants have, small plants have acquired a bad reputation. Large regional plants are encouraged and landscape recycling made extremely difficult and costly.

These trends need be reversed so that sewage does not have to be pumped from one location to others many miles away in zones of favorable percolation rates or sites for constructed wetlands.

Maintain Separate Surface and Deep Aquifer Groundwater Systems

Until recently, surface waters and groundwaters were more or less separated by intervening layers of sands, clays, shells, and so forth. Now as a means of stormwater management, surface waters are shunted directly into underground aquifers where they might mingle with drinking water. Numerous deep "recharge" wells in Orange Co. directly carry surface water into the Floridan Aquifer. These waters are frequently contaminated with urban, agricultural or industrial wastes, thereby contaminating our drinking water. Where these conditions exist and as a means of protecting groundwater quality, wetland filters sufficient in size to have treatment potential should be used to provide some filtering action prior to release, and every effort should be made to eliminate "recharge" wells.

SUMMARY AND RECOMMENDATIONS

Management procedures for the water resources of the Econlockhatchee River Basin offer the opportunity and challenge to design and ecologically engineer better systems for both humans and nature; but to do so, we must be willing to work toward that common goal.

Admittedly, the management suggestions given above are quite general in their tone. We believe that they can be used to set guidelines and policy for attainment of good water quality throughout the basin, and can act as a catalyst for research that will be necessary if good design and sound ecological engineering is the end point we seek to achieve.

In this report, we have tried to describe the resource and its past and present condition, and then lay the groundwork for further detailed studies of the basin, potential re-engineering of its parts, and adoption of a regulatory framework for administering a management program. Obviously, the detailed studies that will follow need time to come to fruition; unfortunately, development of the basin does not seem to be slowing down. Might it be appropriate to consider slowing the speed at which things are changing within the basin long enough to determine how best to manage it?

Drawing from this inventory of the water resources and knowledge of potential future problems associated with further development of the basin, Volume III, the Critical Areas Management and Protection Plan, provides short-term management and regulatory suggestions to achieve the desired goal of no net determination of water quality within the basin.

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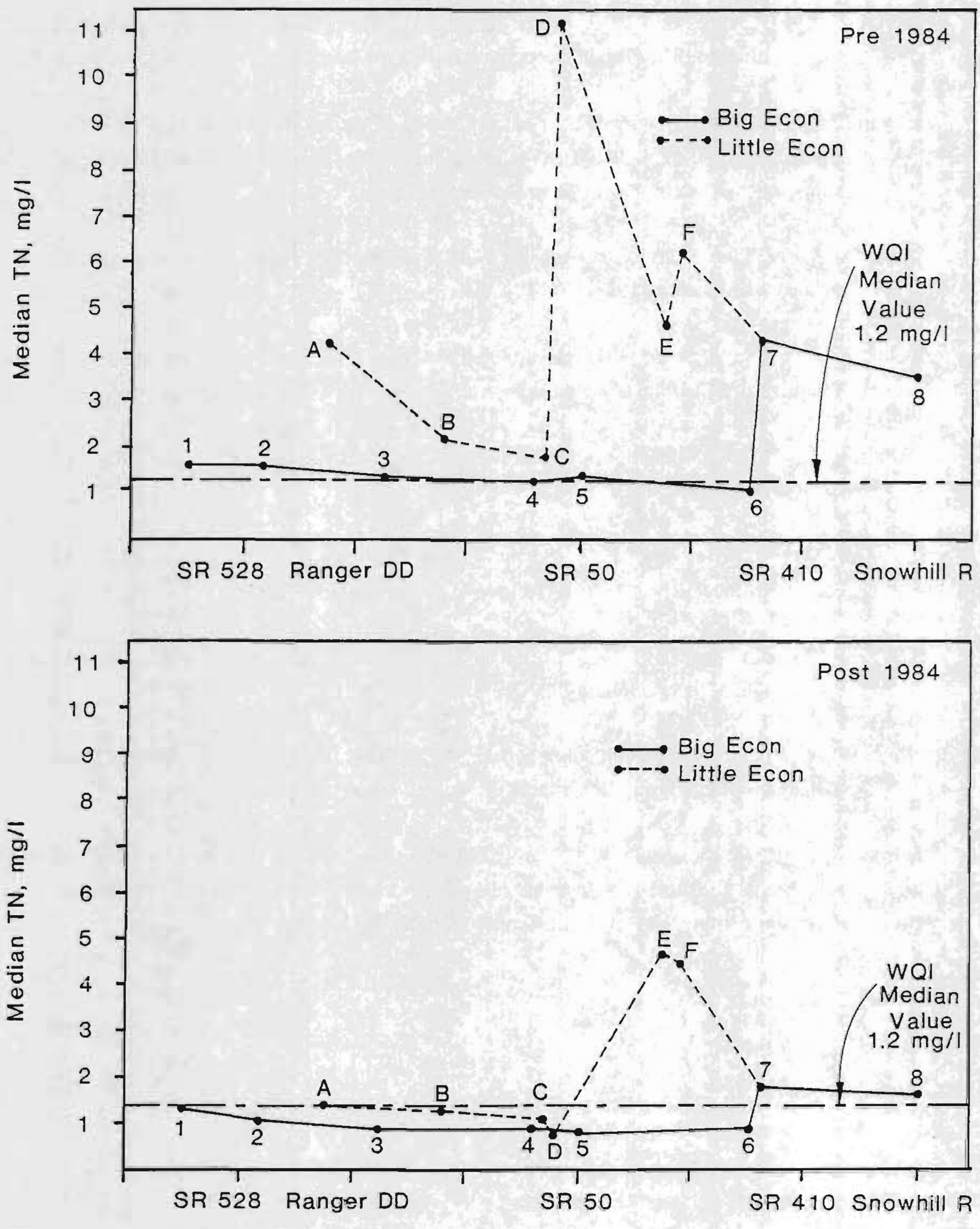


Figure 1.1 Median total nitrogen concentration in mg/l for periods 1972-1983 (PRE 1984) and 1984-1988 (POST 1984) for 14 sample sites along the Econlockhatchee River. WQI median value is from Table 1.1. Sample locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R = Snowhill Road.

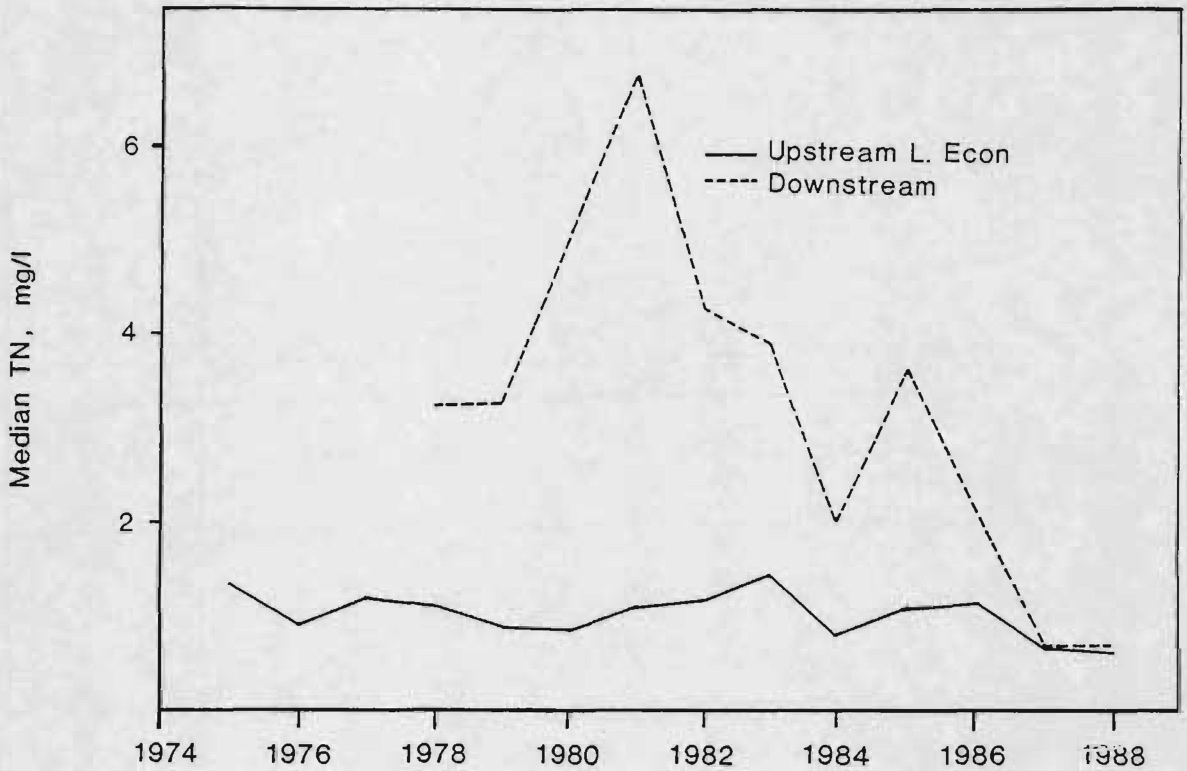


Figure 1.2 Median annual total nitrogen concentration in mg/l for Big Econlockhatchee River above and below confluence with Little Econ River for period 1975-1988.

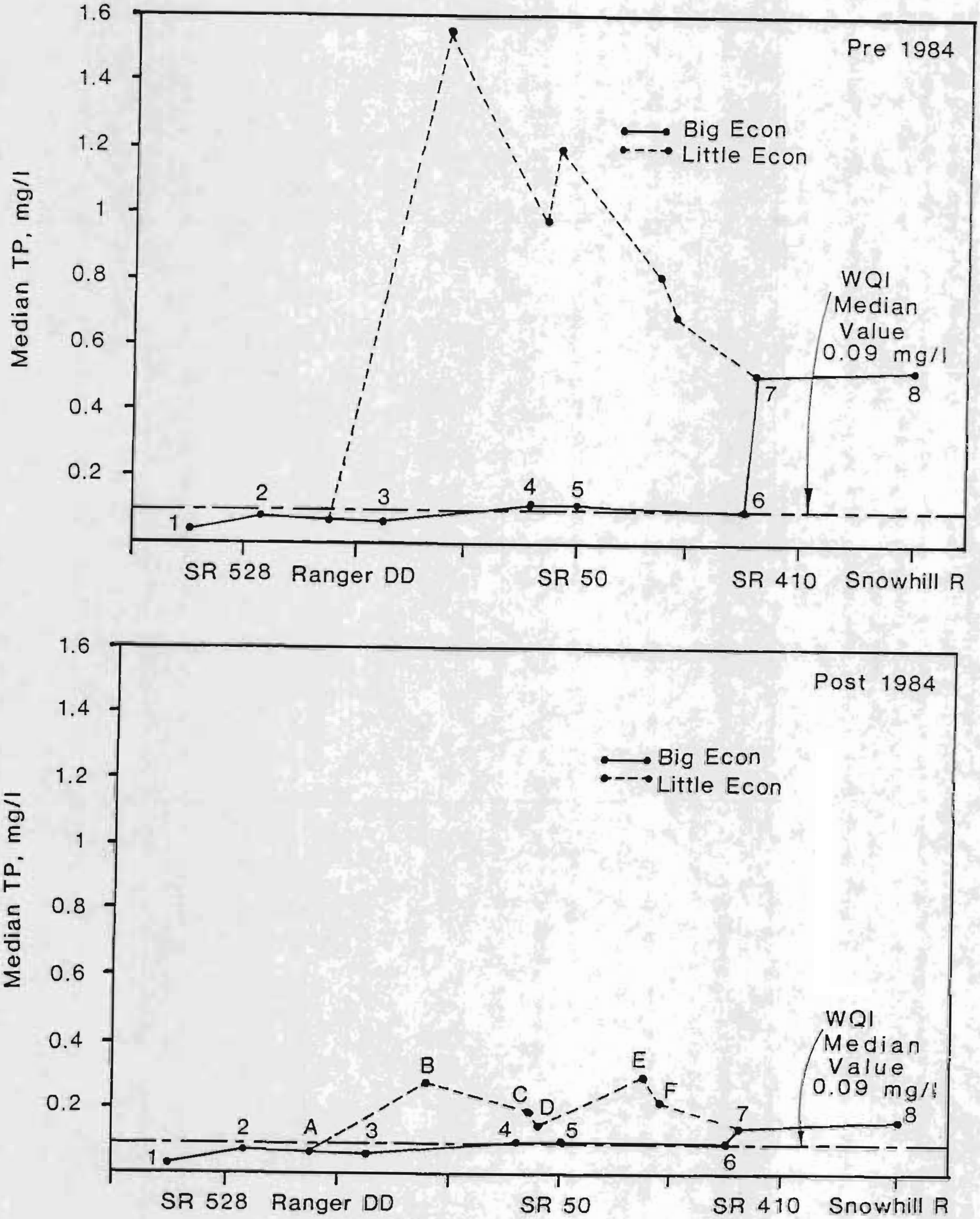


Figure 1.3 Median total phosphorous concentration in mg/l for periods 1972-1983 (PRE 1984) and 1984-1988 (POST 1984) for 14 sample sites along the Econlockhatchee River. WQI median value is from Table 1.1. Sample locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R = Snowhill Road.

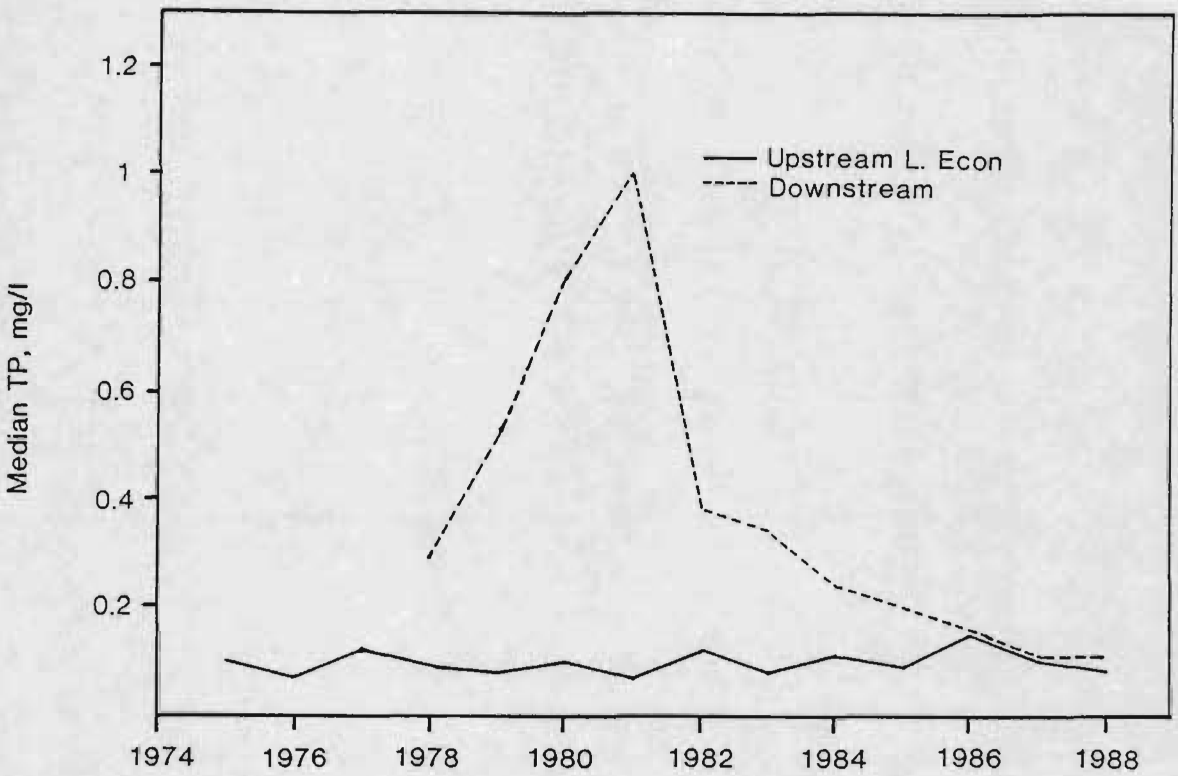


Figure 1.4 Median annual total phosphorous concentration in mg/l for Big Econlockhatchee River above and below confluence with Little Econ River for period 1975-1988.

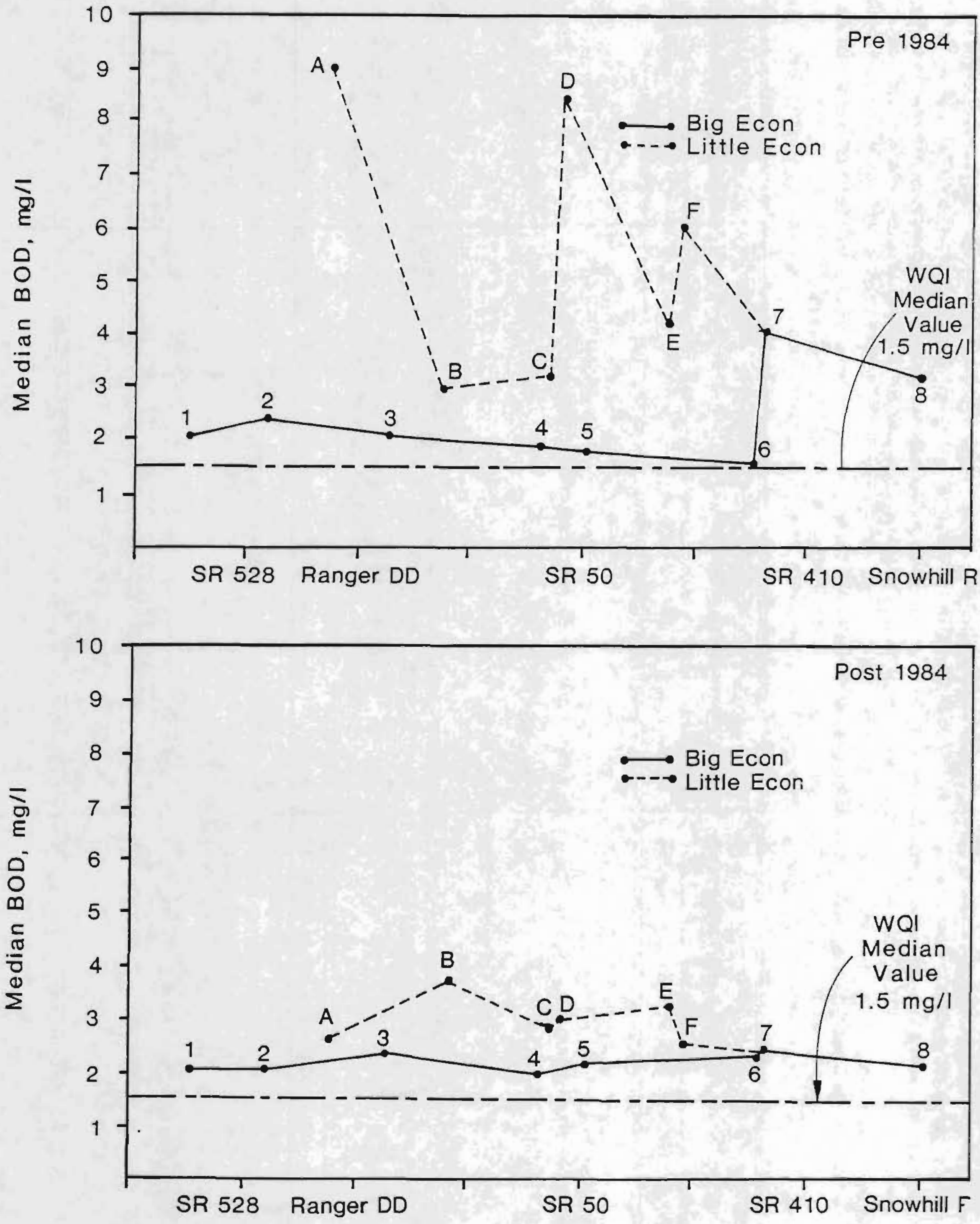


Figure 1.5 Median total BOD in mg/l for periods 1972-1983 (PRE 1984) and 1984-1988 (POST 1984) for 14 sample sites along the Econlockhatchee River. WQI median value is from Table 1.1. Sample locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R = Snowhill Road.

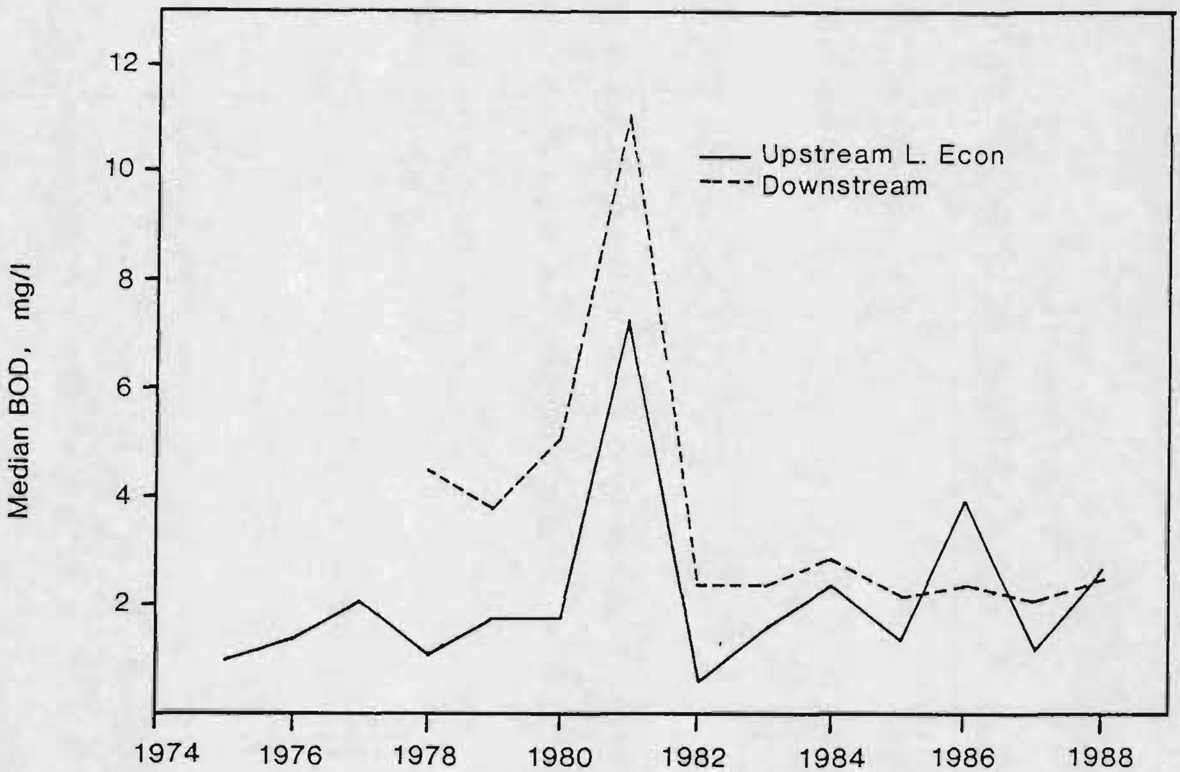


Figure 1.6 Median annual BOD concentration in mg/l for Big Econlockhatchee River above and below the confluence with Little Econ River for period 1975-1988.

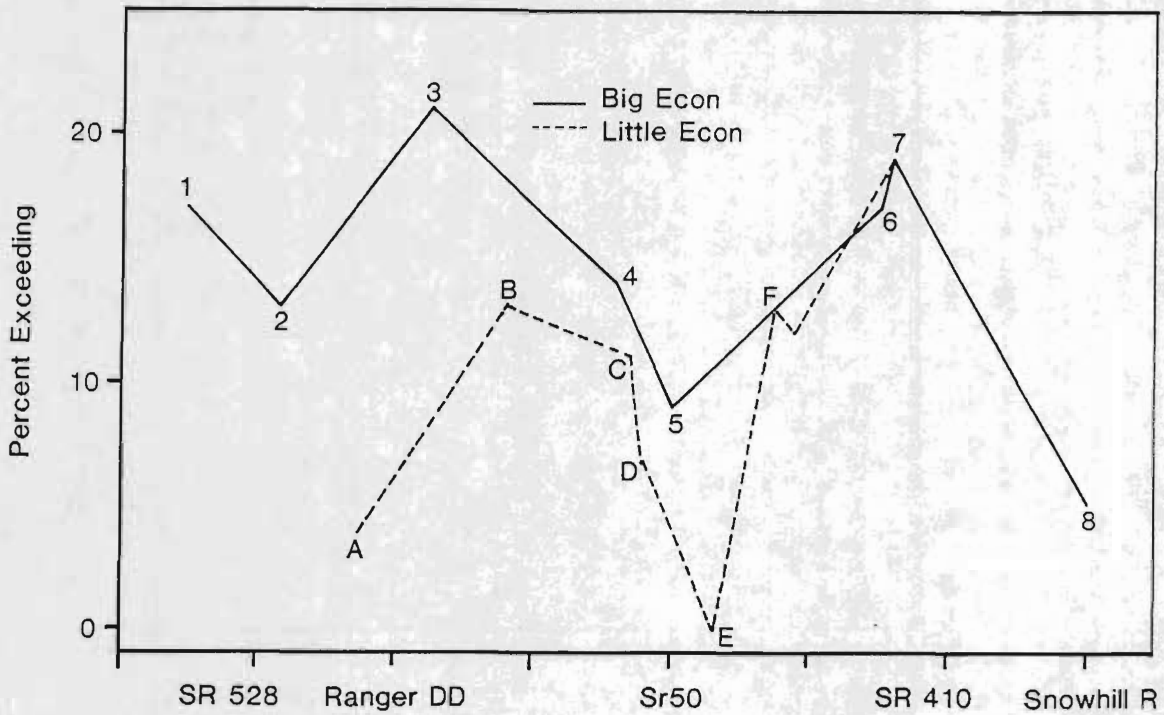


Figure 1.7 Percent of cadmium (Cd) analyses exceeding standards (0.01 mg/l) for water quality samples from Big and Little Econlockhatchee Rivers for period 1981-1988. Sample locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R = Snowhill Road.

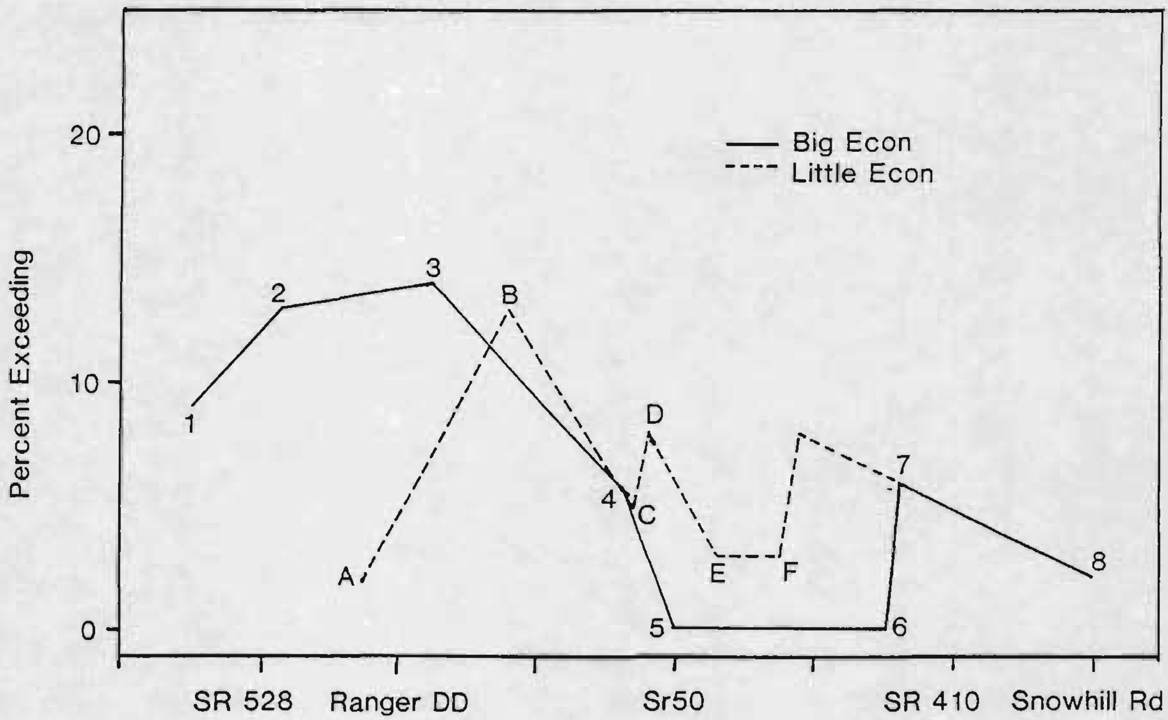


Figure 1.8 Percent of copper (Cu) analyses exceeding standard (0.03 mg/l) for water quality samples from Big and Little Econlockhatchee Rivers for period 1973-1988. Sample locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R = Snowhill Road.

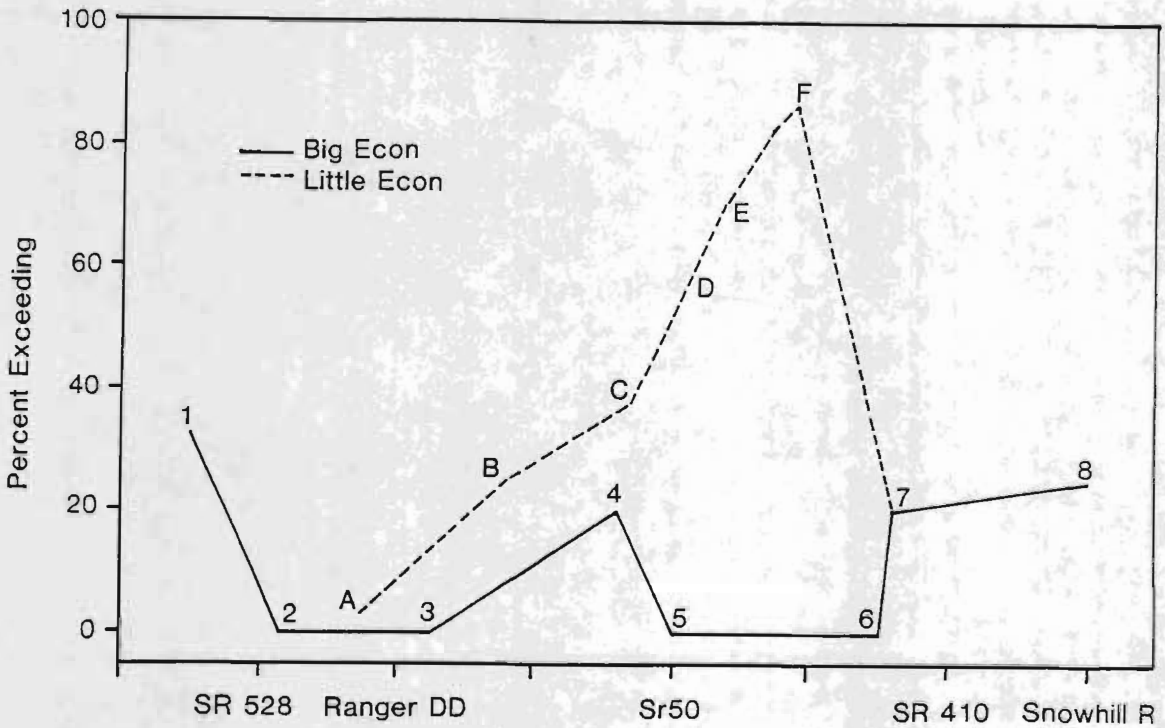
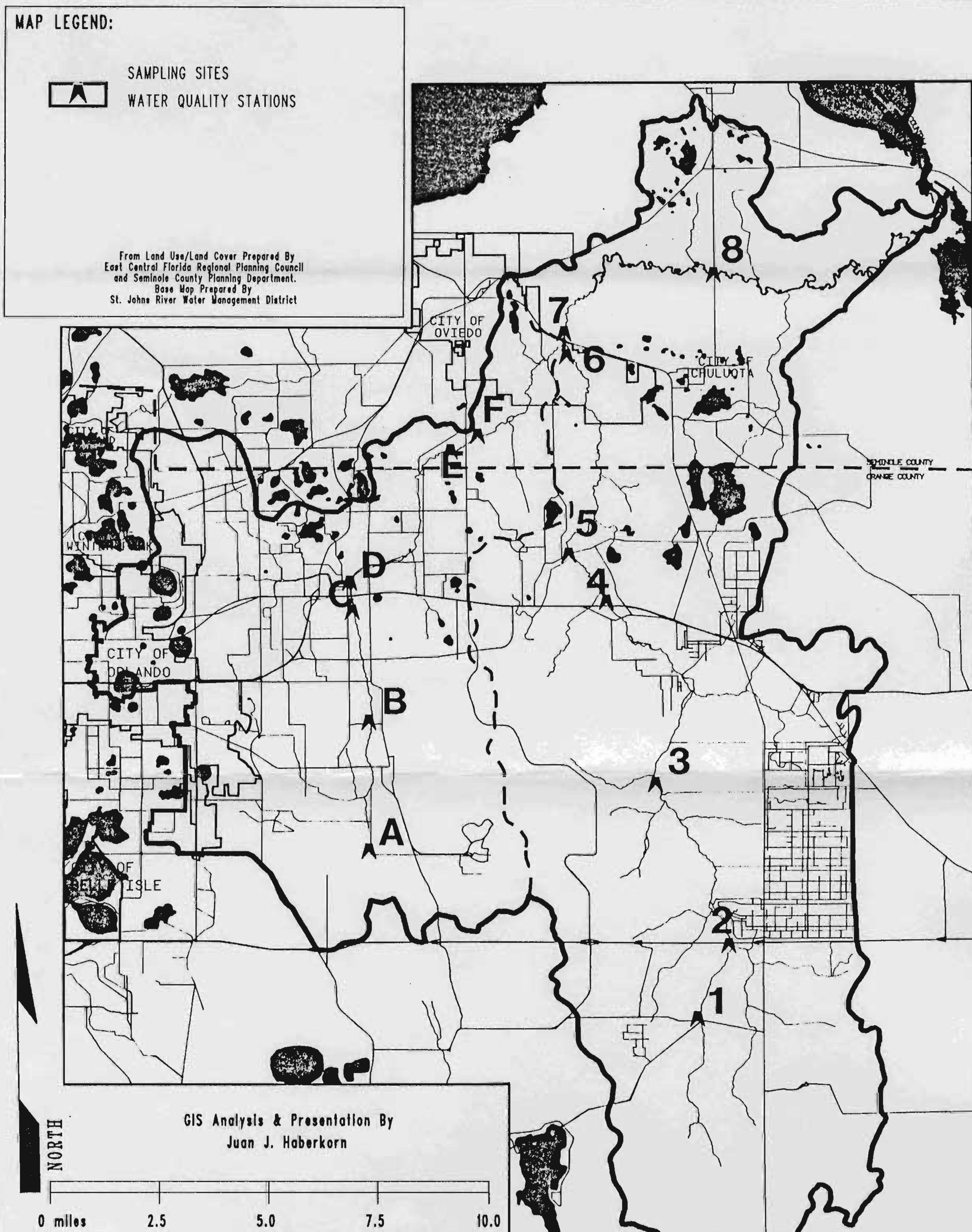


Figure 1.9 Percent of lead (Pb) analyses exceeding standard (0.03 mg/l) for water quality samples from Big and Little Econlockhatchee Rivers for period 1981-1988 (majority of data are from sample years 1987-1988). Samples locations on the X-axis are for the Big Econ River and correspond to the following: SR 526 = State Road 526, Ranger DD = Ranger Drainage District, SR 50 = State Road 50, SR 410 = State Road 410, Snowhill R =



MAP 1.1
WATER QUALITY
SAMPLING STATIONS

ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN

Prepared Under Contract
To
ST. John's River Water Managment District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990

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ECONLOCKHATCHEE RIVER BASIN NATURAL RESOURCES DEVELOPMENT AND PROTECTION PLAN

Chapter 2

TERRESTRIAL AND WETLAND RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Prepared for

St. Johns River Water Management District

October 1990

Chapter 2

TERRESTRIAL AND WETLAND RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Mark T. Brown

INTRODUCTION

The Econlockhatchee River system, its waters, wetlands, and wildlife, is more than just a slowly meandering river in central Florida. It is the manifestation of centuries of geologic processes, ecological succession, and human use. The Econ River is the ultimate expression of the physical, chemical, and biological processes of its entire watershed. It might be said (with great certainty)...as the basin goes, so goes the river. To manage a river one must manage its entire basin.

Located in central Florida and covering the eastern portions of Orange, Seminole, and Osceola counties, the Econ River Basin is composed of approximately 280 sq. mi. of nearly flat, poorly drained sands dominated by pine and palmetto flatwoods with numerous wetland sloughs, and relic beach ridges dominated by scrub communities. Until quite recently the main land uses within the basin were rangelands and some improved pasture. Within the past two decades, several development projects ranging from housing developments to regional landfills have begun to appear within the basin. Most recently, the pace of development has quickened, and with it an increased awareness of the potential for loss of resources of the basin--suggesting to many that it is time that a basinwide resource management plan be implemented.

Rationale

The landscape is composed of a mosaic of ecological communities driven and sustained by environmental forces like sunlight, winds, and rain and constantly "influenced" by the forces of humans and their development actions. Combined development within the Econ River Basin will change many characteristics including the balance between human activities and the environment. Scarce ecological communities will become even more scarce and sensitive communities will show signs of loss of ecological function. Landscape scale management of development within the basin may help to minimize those consequences of development. Management of landscapes can be broken into two elements, (1) manipulation of landscape components (resource management), and (2) regulation of developmental forces. Within both elements there are several issues that form the basis for an approach to ecological management.

Issues of Resource Management

The issues surrounding sound resource management in a developing landscape are related to how best to plan, design, and then manage to ensure viable resources and sustainable use. The overriding issue is loss of ecologic function. That is, through mismanagement, or inadequate planning or design, the resource is degraded and ecologic functions and values are lost. Such things as pollution of lakes and streams, overharvest of fish and wildlife, or overdrainage and loss of wetland hydroperiod are examples of mismanagement. The increased fragmentation of the landscape into smaller and smaller fragments of ecosystems with subsequent loss of habitat value and ecological health is an example of poor planning and design. Avoidance and regulation are the simplest solutions; avoid the practices that lead to degraded conditions, or regulate them to ensure that they are kept within acceptable limits. Both strategies require a knowledge of the resource and the activities that may cause degradation and a willingness to use that knowledge.

A subset of resource management issues that follow loss of ecologic function are threefold:

1) loss of environmental services,
2) loss of biotic diversity, and
3) loss of aesthetic qualities.

Humans interact with their environments through direct use and indirect consumption of "services." Pure water, clean air, productive soils, waste assimilation, to name a few, are the products of environmental services. Whenever the demands are higher than the supply, or wherever the environment's ability to function has been degraded, free services are replaced with purchased ones. The loss of environmental services can easily be avoided through effective management that minimizes degradation of ecologic functions and that does not overtax the environment's ability to provide these services.

Biotic diversity is landscape scale diversity of organisms of differing types. Through differences in moisture, nutrient availability, and driving energies, the landscape is fashioned into a mosaic of communities each having its own special assemblages of organisms. Taken in aggregate, small-scale community diversity generates a higher diversity at the larger landscape scale. As lands are developed and landscapes are fragmented, small-scale biodiversity may be maintained in refugia, but many components of the larger scale are lost. The best examples of loss of biodiversity are the precipitous declines in large animals (panthers and bears) as development fragments habitats and increases exposure to accidental death. Accounting for biotic diversity requires not only protection at the species level, but also habitat protection at the landscape scale.

Environmental quality (i.e., its aesthetic quality) is an important yet often neglected element of landscape management most often because a description, much less measurement of the aesthetic experience, is no simple task. It is through a juxtaposition between wilderness and civilization that the aesthetic quality of a landscape can be enhanced. An integrated landscape of developed lands and undeveloped wildlands increases total environmental quality and is the result of foresight, and effective planning and design.

In all, good resource management (that is, good planning, design, and management) should be measured through how well we achieve a balanced and functioning resource base as the landscape changes and our demands increase.

Issues of Landscape Development

The dominant issue surrounding landscape development is how best to accommodate economic development and ecologic processes within the same landscape. In other words, how do we achieve a fit of humanity and nature in a ecological setting in such a way to maximize both human-oriented potentials (most often measured in economic terms) and the normal processes and functions of the landscape that support those potentials? And how do we do it in a way that is both "cost effective" and, to some degree, aesthetically pleasing?

It is fairly well known and easily visualized that, as a landscape develops, the amount of "pristine" wilderness diminishes and, therefore, its ability to provide services. Either extreme, full development on the one hand or zero development on the other, is "limiting" since in either case one or the other potential does not exist. Thus, through relatively simple reasoning, some middle ground seems to be the most logical development scenario. However, there is a confounding aspect of landscape development that makes simple logic less than adequate. As the amount of development increases, the need for environmental services increases; thus, as an area becomes more and more developed, there is more and more of a need for an environment that will supply raw resources, absorb wastes, and provide recreational opportunities. The relationship suggests that as the amount of development increases, there is some optimum point where further development has diminishing returns.

Next, assuming that some portions of the landscape should remain undeveloped to provide these services, in what spatial configuration should these developed and undeveloped lands be arranged? It has often been suggested that large parks or reserves are sufficient to preserve vestiges of the undeveloped landscape and can serve as the required undeveloped lands. And to some extent this is true. State parks, national forests, and wildlife preserves are important components of a developed landscape. Yet, they cannot serve as the only undeveloped areas for they would soon become overtaxed, overused, and degraded. Parks by their very definition cannot be "used" or fully integrated into the developed landscape for they are preserves, designed, managed, and maintained to ensure that some vestiges of the undeveloped land are retained. Use implies consumption unless the use is strictly regulated to balance consumption with production. While parks are important parts of a developed landscape, they represent the extreme, the portion within which there is no development. What is needed is a continuum of preserves--some fully integrated into the developed landscape, others somewhat isolated and still others set aside as environmental reserves.

Finally, a third issue needs to be explored if we are to achieve a balanced landscape of developed and undeveloped lands. This third issue is related to the mix of ecological communities that should be integrated into the developed landscape. Without question, wetland communities are important resources because of their position as places of convergence of water, energy, matter, and wildlife. They are by far the most productive communities of the landscape. Yet a landscape composed entirely of developed lands and wetlands lacks the balance afforded by a heterogeneous mix of uplands and wetlands, forests and prairies. A landscape stripped of its uplands and replaced with developed lands is lopsided in its ability to function and provide the services required by a growing human population. What is needed then is an interconnected, heterogeneous mosaic of ecological communities to ensure a viable and functioning landscape.

In summary, the three issues can be distilled to the following:

How much is enough?
Where should it be?
What kind should it be?

Development of a management plan for the Econlockhatchee River Basin that protects the resources of the basin and yet fosters development offers the opportunity to test our resolve, experiment with the future, and propose a developed landscape as a balance of humanity and nature. This resource inventory is a component of the overall management plan. It is a summary of what is known about the terrestrial and wetland communities of the Econ River, a synopsis of the issues surrounding preservation on the one hand and development on the other, and a guidance mechanism with suggestions for managing the basin's resources to ensure long-term ecological viability.

Plan of Study

The process of developing a basinwide management plan for terrestrial and wetlands resources of the Econ Basin is driven by an overall set of goals and objectives, fostered by the collection of all relevant information about the current status of the resource, and organized around sound ecological planning, design, and engineering. In this study, as a consequence of the short time frame that was imposed, existing sources of information and data have been relied upon. Current comprehensive plans from the various governmental agencies that have major roles in shaping the future of the basin were consulted and relevant goals and objectives concerning natural resources were summarized.

While numerous reconnaissance field trips (both on the ground and in the air) were made, no contemporaneous field data collection was undertaken. All agency files and reports were searched, computerized library searches were acquired, and agency personnel were interviewed to collect all relevant sources of information and insights concerning the past, present, and future status of the resources of the basin. To that end, for the most part, data collection has produced a complete project file of all relevant information and data.

Finally, over the past several years, a number of studies have been undertaken by the author that have lead to recommendations for planning guidelines, model ordinances, design criteria and engineering principles that have been drawn upon to develop recommended management and development alternatives for the Econ Basin.

Definition of Terms

The following terms, some in common use, are defined to ensure meaning and help in the task of developing a clear understanding.

Biotic Diversity -- The assemblage of biotic (living) components of a landscape expressed as a measure of contrast. That is, the number of different organisms. Diversity is most often considered a desirable trait of ecological communities--the more diverse, the more valued the community.

Buffer -- A zone of transition between two different land uses that separates and protects one from another. In this report, the word "buffer" refers to the zone between a wetland and a developed or developable area.

Channelway -- That portion of a river basin that is dominated by river or stream channel and that is composed of all lands that drain into that portion of the basin that is delimited by the mouth and point where the stream channel is no longer evident.

Community, Ecological -- A natural assemblage of plants and animals that live in the same environment, are mutually sustaining and interdependent, and are constantly fixing, utilizing, and dissipating energy.

Diversity, Biological -- The composition of a particular environment or habitat as it relates to the plant and animal species present and their relative abundance.

Drawdown -- The lowering of the upper surface of a water table.

Floodplain -- Pertaining to the area of lands adjacent to a water course that are periodically inundated during flood events.

Groundwater -- See Surficial Aquifer.

Hammock -- A common named used throughout Florida in reference to uplands forested ecological communities (See Hydric, Mesic, and Xeric).

Headwaters -- The area of a watershed or river basin that is farthest from the mouth of the stream or river and that does not have a defined river or stream channel, but is dominated by isolated wetlands and overland flow.

Hydric -- Of or pertaining to wet conditions; used in this context as a description relating to forested upland ecosystems (see Hammock).

Hydroperiod -- The length of time during which there is standing water in a wetland.

Integrity, Biological -- All of the plants and animals that are characteristic of an area and all of the processes that result from interactions between these species and their environment.

Landscape -- A heterogeneous land area composed of a cluster of interacting ecological systems that are repeated in similar form throughout. Landscapes vary in size, down to a few kilometers in diameter. (Forman and Goodron 1986).

Landscape Association -- An assemblage of ecological communities with similar topography and geology which are hydrologically connected.

Landscape Dynamics -- The areal and functional relationships between different parts of the landscape, e.g., the distribution, sizes, and topographic and hydrologic connections among ecosystems in a landscape association.

Mesic -- Midway between very wet and very dry. Used in this report as a description relating to forested upland ecosystems (see Hammock).

Overstory -- The layer of foliage (leaves and branches) formed by the largest trees in a forested area.

Riparian -- Of or relating to or living or located on the bank of a flowing watercourse (as a river or stream) and also an isolated water source such as a pond or lake.

Seepage, Groundwater -- Slow, vertical or horizontal movement of groundwater in the soil.

Silviculture -- Activities of humans involving regeneration, tending, and harvesting a forest.

Slough -- A linear wetland drainage feature usually dominated by cypress (*Taxodium* spp.) lacking a perceptual water flow and open channelway.

Species Richness -- The number of different species in an area.

Strand -- A linear wetland drainage feature usually dominated by cypress (*Taxodium* spp.) having water flow, but not in an open channelway.

Succession, Vegetational -- The process of change in the types of plants occupying an area as plants mature, are replaced, and otherwise respond to the environment.

Surficial Aquifer (Groundwater) -- The unconfined aquifer that is nearest the ground surface and is open to the air.

Transfer of Development Rights (TDR) -- A practice that allows the transfer of development density from one site (usually based on sensitivity of the site) to another site so as to protect the first site from adverse development impacts or as a means of ensuring lower densities or no development.

Transfer of Mitigation Requirements (TMR) -- A practice that allows the off-site transfer of requirements for mitigation for distruction of some vegetative community. The mitigation most often required is creation of an equal of greater area of like kind community but can include fee simple purchase.

Turbidity -- The concentration in water of suspended solids (such as silts, clays, and small particles of organic matter).

Understory -- The foliage lying beneath the tallest trees consisting mainly of seedling trees, small trees, shrubs, and herbaceous plants.

Vegetation Areas, Transitional -- Areas that contain plants that are characteristic of identifiable adjacent plant communities.

Wetland -- Lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface such that the lands are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetlands, Ephemeral -- Areas temporarily or seasonally supporting wetland conditions.

Wetlands, Jurisdictional -- Wetlands that can be legally regulated by government.

Wildlands Management -- An approach to regulating the use and development of the landscape in such a way that portions of the landscape remain in a wild and scenic character. It is more regulation and control of the actions of humans than management of the wildland itself. Most wildlands are composed of self-sustaining ecological communities. However, in some situations it may be important to manage the wildlands area, or portions there of, through actions like controlled burns, tree planting, re-introduction of wildlife, controlled hunting, etc.

Wildlands Management Area (or Wildlands District) -- An area of the landscape that is designated as a wildlands. It is a management area where special attention is given to ensuring that human uses and development actions do not detract from its wild and scenic character, thus human uses are minimized and controlled. Districts that are designated as Wildlands Management Areas do not preclude human uses for development or recreation, only that human uses is a minor portion of the whole district. Wildlands areas are managed through development controls, regulatory actions, and in some cases through resource management to remain wild and scenic in character.

Xeric -- Of or relating to an extremely low amount of moisture available for the support of plant life. Used in this context as a description relating to forested upland ecosystems (see Hammock).

Review of the Pertinent Literature

Like many areas of Florida, the Econ River Basin is relatively undeveloped and contains many areas of interest from a natural resource perspective. Despite this, there is a paucity of specific literature about the terrestrial and wetland communities or landscape scale ecological organization of the basin. Be that as it may, the following is a brief review of the pertinent literature concerning the terrestrial and wetland resources of the basin. The literature review is organized in chronological order to give some temporal perspective to past scientific studies and reports.

Descriptions of the Econlockhatchee Basin

White (1970) devotes two pages to the Osceola Plain and one paragraph to the eastern portion of the plain within which the Econ Basin falls.

> ...there is nonetheless a notable distinction in the terrain east and west of a line running approximately parallel with the axis of the peninsula, following in general the route of United States Highway 441 between Fort Drum at the south through Osowaw Junction, Yeehaw Junction and Kenansville, to Cat Lake and then passing just east of the eastern edge of the Orlando Ridge to become the trend followed by the Sanford-Palatka reach of the St. Johns River Valley. This line is almost straight throughout its length and seems to mark a relict Atlantic shore. Where it traverses the Osceola Plain the terrain east of it has a drainage pattern and topography which shows it to be composed wholly of relict beach ridges and their intervening swales. But to the west of the dividing line the topography and drainage pattern are more indeterminate and randomly arranged.

The area occupied by the Big Econ and for the most part that occupied by the Little Econ lies in the Osceola Plain, and is composed of alternating relict beach ridges and swales (White 1970). These are readily apparent from aerial photography and vegetation maps that show wetland sloughs and strands occupying the lower swales and scrub communities on the "higher" ridges.

In the early 1970s a group of citizens from the Orange County area, sponsored by Orange County Audubon Society, carried out a year-long study of the Big Econ River and its floodplain (Orange County Audubon 1972). The study is remarkable in its breadth and in that it was carried out with little or no funding, involved volunteers, and extended over a period of one year. This study seems to be one of the earliest sources of data on water quality, flora, and fauna of the river. A preliminary draft of a report containing an introduction, methods, and results and discussion was published in December 1972. No further updates or drafts have been found. In general, the study focused on physical and chemical water parameters, aquatic vertebrates, terrestrial invertebrates and vertebrates and floodplain vegetation. Twelve sampling locations (four on the Little Econ, four on the upper Big Econ, one at the confluence, and three downstream of the confluence) were sampled at monthly intervals from November through

October. Sampling at some sites was not carried for the full year, presumably as a result of loss of interest by that team member.

Summarizing the floodplain botany, H. O. Whittier suggested that...

> To the biologist, the Econlockhatchee River represents, for much of its length, a relatively undisturbed sanctuary for plants and wildlife, a rather rare commodity in central Florida, where he can find the basis for useful studies on both plants and animals in relation to each other and their natural Florida environment. Botanical studies show the existence of a number of rare or unusual plants such as the Whisk fern (*Psilotum nudum*); carnivorous plants such as narrow-leaved sundew (*Drosera intermedia*), hooded pitcherplant (*Sarracenia minor*), butterwort (*Pinguicula* spp.), bladderwort (*Utricularia* spp.); orchids such as the rare leafless *Harrisella porrecta*...two other epiphytic orchids, and no less than five terrestrial orchid species....These and a number of others provide especial interest to students of natural history and nature lovers, in their own right, but in addition, many make special contributions to the diets of the various wildlife of the river region, forming essential components of an ecosystem unique in its state of preservation and continuity.

A survey report by the U.S. Army Corps of Engineers (COE) (1973), that considered the flood problems in the Econlockhatchee River Basin (apparently issued approximately five months after publication of the Audubon draft report), put to rest citizen concerns related to channelization. The District Engineer found that:

> ...construction of flood-control works are not needed in the sparsely developed floodplains of the Econlockhatchee River Basin...[and] there is a definite need to leave the environment of the Econlockhatchee River floodway undisturbed, both to preserve the vegetation balance in the natural floodway and to protect the spawning run of the American and hickory shad in the Econlockhatchee River.

Their descriptions of the basin support the findings of others of an "...essentially...wild, undeveloped stream that provides the outdoor enthusiast with recreational opportunities...[and] has remained relatively undeveloped due to poor drainage and frequent low floods which make it unsatisfactory for agricultural or residential use." The proximity of the river to the rapidly expanding Orlando urban area is suggested as the reason for gradual depredation of its natural values. In apparent disagreement with White (1970), the corps report suggests that "the topography of the area is influenced more by underground solution activity than by any other natural process." In addition the report contains strong recommendations that:

> In view of the drift of urban development into the floodprone areas, it is recommended that local agencies implement to the maximum extent possible a floodplain management program to reduce the potential for future flood-damage problems.

In a report on water quality of the Econ River, Alt et al. (1974) provide a general description of the drainage basin, its vegetation and soils. Most notable is their description of the Big Econ south of the Beeline Highway as being in a "natural state" and "one of the few remaining 'clean' aquatic habitats in the county. Water quality is good and the ecological aspects of the stream are balanced as of this time." Changes in the Big Econ Basin were noted with the most important change "...the Ranger Drainage District which will discharge to the upper reaches of the Big Econ....[and] drain approximately 6,000 acres of what is presently pine flatwoods..."

The East Central Florida Regional Planning Council (1978) in a report on the 208 Area Wide Water Quality Management Plan give a brief description of the Big and Little Econ watersheds with some comparisons. Generally, they conclude that the majority of the Big Econ is dominated by pine and palmetto flatwoods with mixed hardwood swamp forests along water courses. There are several very gently sloping, low ridges but changes in elevation for the most part are so gradual as to be barely perceptible. In many respects they suggest the physical characteristics of the Little Econ are similar to those of the Big Econ, except in the extreme western portion of the basin where elevations are in excess of 90 feet and are occupied by xeric communities with a majority of the lakes of the basin.

Describing the Osceola Plain from a "soils" perspective, Readle (1979) wrote that....

> Elevations range between 25 and 80 feet above sea level. The vegetation consists mostly of pine and palmetto flatwoods with numerous large to small lakes and fewer areas of broad, grassy sloughs and depressions and poorly defined drainageways. The soils are predominately nearly level, wet, and sandy. The sandy subsoil is weakly cemented with organic matter. Some of the soils have a loamy subsoil, and some are organic. Large areas of this region are used for range and improved pasture.

In a study initiated for the purposes of determining existing water quality problems within the Little Econ watershed, identifying the sources of pollutants, and recommending methods of restoring the river system to a more ecologically diverse and aesthetically pleasing water body, Miller and Miller (1984) described that portion of the river within Orange County as a river that has experienced severe water quality problems. Their description of the basin is one of low topographic relief with numerous swamps and sloughs, and several gently sloping, low ridges. The natural setting is described as dominated by pine palmetto flatwoods, with lesser areas of longleaf pine and xerophytic oak forests occurring on the higher lands in the western portions of the basin. The mixed hardwood swamp forest is common along water courses and in sloughs and swamps. They suggest that prior to development the Little Econ Basin's land cover was composed of 58% flatwoods, 25% swamp, 15% well drained, and 2% open water.

Wilson et al. (1987) concluded in a study that analyzed the causative factors related to sinkhole development in the Orlando area that the Osceola Plain in eastern Orange, Osceola, and Seminole counties exhibits conditions that are not suitable for sinkhole development. Much of the Big Econ Basin is within areas where conditions are unsuitable for sinkhole development, while most of the Little Econ Basin is within an area that is marginally suitable, but where none have been reported. They suggest that "ancient sinkhole lakes occur in scattered localities, but are not common overall." Recharge rates seem to be a positive indicator of potential sinkhole development. Most of the Econ Basin is situated within an area of very poor recharge potential (less than 3 inches per year) while portions of the upper Little Econ occupy areas having moderate recharge potential (3 to 10 inches per year).

The Conservation Element of Seminole County (Seminole County 1988) describes the portion of the Econ River within Seminole County as "...one of the most natural settings in central Florida. This pristine bottomland hardwood forest is surrounded by a watershed of undisturbed ranchlands." The conservation element proposed that the county pass a resolution in favor of acquisition of the proposed lower Econ River parcel under the state CARL program.

Descriptions of Ecologic Communities

Some of the most useful information concerning the terrestrial and wetland community resources of the Econ Basin are contained in numerous Applications for Development Approval (residential developments) and environmental evaluations related to utility siting studies. While these studies were conducted for specific tracts of land scattered throughout the basin (see Map 2.1), they serve as an important resource in developing an overview of the vegetation and characteristics of ecological communities.

In its Site Certification Application, the Orlando Utilities Commission (ca. 1981) described eight plant communities occupying the approximately 5 sq. mi area of the Stanton Energy Center. They included: pine flatwoods, xeric oak scrub, pond cypress, pond pine, bay hardwood, oak hardwood, mixed forested wetlands, and wet prairie. In addition to species lists, the studies provide quantitative data on community composition, aerial extent of communities, discussion of importance of fire in succession, and soil moisture control of plant community composition.

Best et al. (1982) described the site of the Easterly Regional Waste Treatment Plant finding seven communities including: sand pine scrub, xeric oak scrub, mixed hardwood swamp, longleaf pine-palmetto flatwood, pond pine flatwood, wet prairie, and cypress dome. Community surveys were conducted in each community and species composition determined. They discussed the importance of both wetland communities and, in particular, the scrub communities which they felt were endangered ecosystems. Their closing remarks include:

> Large areas of sand pine scrub are preserved in the Big Scrub of the Ocala National Forest, but outside the national forest the scrub is one of the endangered ecosystems of the state. There are currently no regulatory restrictions to development of upland habitats, and subsequently the development pressures in the central Florida region represent chronic threat to what little scrub habitat remains.

The Andean Group of Florida (1985) identified six "vegetation associations" in their ADA for the Riverwood development project including: pine flatwoods, xeric oak, other hardwoods, pond pine, wetland hardwood forest, and freshwater marsh. Some species lists for wetland communities were given, but relatively little information on other ecological communities was included.

In the Application for Development Approval for the International Corporate Park, Inc. Canin and Associates (1985) classified vegetation uses into three classes of Rangeland, Upland Forest, and Wetlands. Rangeland included pastureland, palmetto prairie, and shrub and bushland. There were six upland forest types, including pine flatwoods, longleaf pine, xeric oak, other hardwood mixed forest, and clear-cut. The wetlands class included cypress, pond pine, freshwater swamp, mixed forest, and freshwater marsh. In an apparent contradiction, pond pine communities are classified as wetlands for the purposes of mapping, but considered uplands and included in developable portions of the tract. In later submittals (Canin Associates September 1985), the contradiction is explained as differences in classification between the FLUCC system and jurisdictional determination because of understory vegetation.

Level IV classification (FL Dept. of Administration 1976) was used by Orange County Research and Development Authority (1987) to classify more than 26 different community types in one of the most detailed vegetation classifications found in any ADA. The comuunity types are too numerous to list here, but of particular interest is their splitting of pond pine communities between a wetland variety and an upland variety.

Defining wetlands as stressed and healthy, on a site near the Orange County Landfill, Glatting, Lopez, Kercher, Anglin (1988) in the ADA for Young Pine showed very graphically the impact of drainage canals on wetlands. The East Orlando Canal bisects the Young Pine site dewatering the majority of wetlands (about 73%). They attributed the stress to interruption of surface-water flows in the wetland strands and general lowering of the groundwater. The effects of the canal appear to extend as far away as 2700 feet, where stressed wetlands extend off-site on the southside of the canal. They suggest that:

> Evidence of stress attributed to the artificial dewatering caused by the canal system primarily takes the form of vegetative succession favoring upland species within the historic strand. Pine, myrtles, wild grape, and fennels have become established within this wetland system, extending several hundred feet in each direction from the drainage canal.

Further, they state that one isolated wetland near the canal was particularly stressed due to long-term dewatering as a result of its close proximity to the canal.

Several other ADAs (Canin Associates 1982, 1984, 1987) provide further documentation of ecological communities found throughout the Econ Basin. For the most part, their community analysis shows the same basic array of communities.

THE TERRESTRIAL AND WETLAND RESOURCES

The terrestrial and wetland resources of the Econlockhatchee River Basin are as varied as the river itself. Beginning as a broad expanse of wetland slough dominated by forested areas of cypress and bays with extensive areas of marsh, the Big Econlockhatchee River flows northward from northeast Osceola County through eastern Orange and Seminole counties and takes an abrupt right turn to exit eastward to the St. Johns River. Abundant rainfall, relatively flat terrain, and the poorly drained character of the soils are the main factors that have produced a basin dominated by pine flatwoods interspersed with significant areas of cypress domes, strands and sloughs. The biggest recent changes in the vegetative communities of the basin have resulted from improved drainage and conversion of flatwoods to pasture and rangeland. Serious loss of wetland and pineland habitat have occurred recently as the result of fire and conversions to other uses. For example, the area immediately south of the Orange County Landfill know as Wide Cypress Swamp, experienced a disasterous fire after the construction of a 10-mile drainage canal that significantly lowered water tables in the area. The fire reduced what was once a 1200-acre cypress slough to a shrub wetland composed of young big trees and large expanses of cattail (*Typha* spp.) in impounded areas to the north of the canal. Areas south of the canal are still overdrained and dominated by bay trees and wax myrtle (*M. cerifera*).

The river has a second major tributary, the Little Econlockhatchee River which joins the Big Econ approximately two-thirds of the distance from headwaters to the mouth. The Little Econ drains higher lands in the extreme western portions of its basin that were dominated by gently rolling hammocks and sandhill communities, but most of the basin was relatively flat, poorly drained and dominated by pine flatwoods. In the early 1980s, the basin had more than 50% of its land area in urban, agricultural or other uses (Miller and Miller 1984).

Map 2.2 shows urban and agricultural land uses within the basin. Table 2.1 gives total area in urban and agricultural uses and their percent of the total land area. Obvious is the extent of urban uses in the Little Econ Basin when compared to the Big Econ. Most agricultural uses are confined to the Big Econ Basin.

As a means of simplifying the complexity of the basin into larger scale classes of ecological systems, the basin was classified and mapped in what might be called a FLUCC Level 0 classification by "lumping" or aggregating ecological communities into landscape associations. Map 2.3 shows the landscape associations of the basin. The following section describes associations and their topographic and hydrologic characteristics.

Table 2.1 Land use in the Econlockhatchee River Basin.

Region	Area (acres)	Percent of Region
Seminole County		
Urban	2563	8.2%
Agriculture	3475	11.1%
Wooded	17142	54.7%
Wetlands	6787	21.6%
Lakes	1387	4.4%
Total	31354	
Orange County		
Urban	39734	31.2%
Agriculture	11790	9.3%
Forested (300,400)	43601	34.2%
Wetlands (600)	28934	22.7%
Lakes	3256	2.6%
Total	127315	
Osceola County		
Urban	0	0.0%
Agriculture	180	1.1%
Range	8550	52.8%
Wetlands	7473	46.1%
Total	16203	
Total Basin	174872	

Landscape Associations

From previous studies (Brown and Best 1985; Brown, Schaefer and Brandt 1989) a technique of landscape scale classification has been developed that generalizes somewhat characteristics of ecological organization with topographical and hydrological gradients. Called landscape associations, they are an assemblage of ecological communities classified on the basis of similarity of topographic, geologic, and hydrologic conditions as well as landscape position. Using this system of classification, the central Florida region within which the Econ Basin is found is composed of eight associations. Three landscape associations are characteristic of the Econ Basin and they are

1) pine flatwoods with isolated wetlands,
2) pine flatwoods with flowing water wetlands, and
3) pine flatwoods and/or hammocks with hardwood swamps wetlands.

The following paragraphs describe the associations. For complete descriptions of the communities that comprise these associations see Brown (1980) and Brown and Starnes (1982).

Landscape Classification 1. Flatwoods/Isolated Wetlands

This association is characterized by very low topographic relief and very minor surface drainage features. As a result, overland flow during the wet season and significant storm events is quite common. During normal years, water tables are at or near the ground surface for about six months of the year.

Pine flatwoods are so named because of the flat topography on which this association is typically found. The lack of gradient results in frequent flooding during the summer rainy season (Brown 1980). Often underlain by a "hardpan" of organic materials, clays or accreted oxides, that retard downward migration of groundwaters, flatwood soils are often poorly drained and flood easily. Many grassy scrub areas and palmetto prairies were probably once pine flatwoods that have been converted to grassy scrub by tree harvest, increased drainage, and/or greater fire frequency (Brown 1980).

Interspersed throughout the flatwoods are topographic low areas, which are occupied by patches of wetlands of various types. Wetlands are typically circular in shape and vary from quite small (less than one-half acre) to large (tens of acres). Depth of standing water in isolated wetlands during the rainy season is typically 18 to 24 inches. Wetland types include cypress domes, bayheads, wet prairie, and shallow marshes (Brown and Schaefer 1987). Occasionally deep freshwater marshes (Brown 1980) are found although they most often are associated with areas of higher relief and greater surface water drainage. The wetlands in this association are relatively oligotrophic whose main source of nutrients is rainfall and a minor surface drainage from small surrounding watersheds.

Cypress domes are dominated by pond cypress (*Taxodium ascendens*). Dominant tree species in bayheads include red bay (*Persea borbonia*), sweet bay (*Magnolia virginiana*), loblolly bay (*Gordonia lasianthus*), black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), pond pine (*Pinus serotina*), and slash pine (*Pinus elliottii*). Typical wet prairie plants include St. John's wort (*Hypericum fasciculatum*), primrose willow (*Ludwigia* spp.), elderberry (*Sambucus simpsonii*), panicum grasses (*Panicum* spp.), soft rush (*Juncus effusus*), spike rush (*Eleocharis cellulosa*), and pickerelweed (*Pontederia cordata*).

Deepwater marshes are usually dominated by free-floating plants such as water hyacinth (*Eichhornia crasspipes*) and water lettuce (*Pistia stratiodes*) or rooted aquatic plants such as water lily (*Nymphaea odorata*) and spatterdock (*Nuphar luteum*). Shallow marshes may be dominated by one of the following species: pickerelweed (*P. cordata*), sawgrass (*Cladium jamaicense*), arrowhead (*Sagittaria* spp.), fire flag (*Thalia geniculata*), cattail (*Typha* spp.), spikerush (*E. cellulosa*), bulrush (*Scirpus* spp.), or maidencane (*Panicum hemitomon*); some marshes contain patches or mixtures of some or all of these species (Brown and Starnes 1983).

The flatwoods/isolated wetland association is found throughout the Econ Basin occupying the flat table lands between drainage features and as the headwaters areas of many first order streams.

Landscape Classification 2. Flatwoods/Flowing Water Wetlands

The soils in this category are poorly drained and have higher percentages of clay and organic matter than do those of the flatwoods/isolated wetland association. Unlike the table lands of the first association, the topography of this association is more variable. Having somewhat greater relief, the flatwoods of this association have surface drainage features that resemble elongated swales dominated by wetland vegetation. Both surface and groundwaters contribute water flows to the wetland drainage features.

Sloughs or strands are elongated wetlands with no open water channels; however, water flows imperceptibly slow as sheet flow during the wet season and through small, braided channels during drier times.

Flowing water wetlands include both bald cypress (*Taxodium distichum*) and southern mixed hardwood forests growing throughout sloughs and strands. Common hardwood species include red maple (*A. rubrum*), water tupelo (*Nyssa aquatica*), swamp black gum (*Nyssa sylvatica* var. *biflora*), sweet gum (*Liquidambar styraciflua*), pop ash (*Fraxinus caroliniana*), Florida elm (*Ulmus floridana*), and cabbage palm (*Sabal palmetto*) (Brown 1980).

The seasonal flooding that is characteristic of flowing water wetlands provides the nutrients needed for plant growth. Water levels can fluctuate about 2.5 feet between the wet and dry season in an average year. The normal depths of inundation are about 24 to 30 inches. Often deeper pools in a slough may be as deep as 5 feet (Brown and Starnes 1983). Flooding is also important for seed distribution, seed scarification, and elimination of upland plant species (Brandt and Ewel 1989).

The flatwoods/flowing water wetlands association is the most common association of the Econ Basin. The southern and central portions of the basin where alternating relic beach ridges and sloughs are characteristic (Osceola and Orange counties) are dominated by this association type. The linear drainage features of this portion of the basin are an easy means of identification.

Landscape Classification 3. Flatwoods/mesic hammocks/hydric hammocks/hardwood swamps

More moderate to moderately well drained sandy soils and level to sloping topography characterize the uplands of this association. Between the upland communities of flatwoods and mesic hammock and the lower zone communities of hardwood swamp or marsh, hydric hammocks often occur where moisture conditions maintain soils in constant saturation but rarely, if ever, flood.

The excellent growing conditions and good soils foster the development of quite diverse and robust pine flatwoods. If fire is excluded, the mesic hammocks that follow are the most diverse of the upland communities in the central Florida region and may contain between 8 and 35 tree species. Overstory species in mesic hammocks include Southern magnolia (*Magnolia grandiflora*), laurel oak (*Quercus laurifolia*), red bay (*P. borbonia*), pignut (*Carya glabra*), American holly (*Ilex opaca*), water oak (*Quercus nigra*), black cherry (*Prunus serotina*), and live oak (*Quercus virginiana*). The canopy is so dense that little sunlight reaches the forest floor. Soils are moderately well drained to somewhat poorly drained. Rainfall is the major water source for mesic hammocks, although seepage and runoff may provide water to some stands (Brown 1980).

Soils in hydric hammocks are generally shallow and sandy, and limestone (either in bedrock or in nodules in the soil) is most often present (Vince et al. in press). Hardpans (weakly cemented Bh horizons) do not occur in hydric hammocks, but clay layers that support surficial water tables occur in some hammocks (Vince et al. in press).

Where high water tables are characteristic hydric hammock soils are saturated most of the year (Brown and Schaefer 1987). Sources of water to hydric hammocks include groundwater seepage, rainfall, stream overflows, and aquifer discharge (Simons et al. in press); groundwater seepage from uplands is the major source of water for many hydric hammocks found bordering floodplain swamps. Hydric hammocks have the most diverse flora of any wetland in central Florida. Species include pop ash (*F. caroliniana*), live oak (*Q. virginiana*), laurel oak (*Q. laurifolia*), water oak (*Q. nigra*), Southern magnolia (*M. grandiflora*), red bay (*P. borbonia*), sweet bay (*M. virginiana*), tulip poplar (*Liriodendron tulipifera*), red maple (*A. rubrum*), red cedar (*Juniperus silicicola*), cabbage palm (*S. palmetto*), slash pine (*P. elliottii*), and blue beech (*Carpinus caroliniana*) (Brown and Starnes 1983).

Hardwood swamps are characterized by seasonal flooding of the flowing waters along which they are found. Species composition depends upon the flow rate, water quality, and turbidity of the adjacent waterway. The most common species are red maple (*A. rubrum*), water tupelo (*N. aquatica*), swamp black gum (*N. sylvatica* var. *biflora*), sweet gum (*L. styriciflua*), bald cypress (*T. distichum*), pop ash (*F. caroliniana*), Florida elm (*U. floridana*), and cabbage palm (*S. palmetto*) (Brown 1980). Soils associated with this community are nearly level, very poorly drained, and dark in color. They are either organic or have coarse- to medium-textured surfaces underlain by finer textured material (Brown and Starnes 1983).

The higher relief and better drained topography of the lower Econ near and below the confluence of Little and Big Econ rivers are dominated by this landscape association.

Ecological Communities

Generalized land cover for the Econ Basin are shown in Maps 2.4, 2.5, and 2.6. Because of the limited size of maps that may be included within the report, land cover categories have been greatly simplified. Larger detailed maps at a FLUCC Level 3 classification are available from either the Center for Wetlands, University of Florida, or the St. Johns River Water Management District, Palatka, FL. Land use and land cover have been generalized and are shown on separate maps for clarity. Urban and agricultural uses are shown on Map 2.3; xeric forests are shown on Map 2.4; pine flatwoods and mesic hammocks on Map 2.5; and wetlands are shown on Map 2.5. Quite obvious is the difference between the Little Econ Basin and the Big Econ Basin in the extent of ecological communities in both basins reflecting the greater urbanization of the Little Econ.

Xeric Communities

Xeric communities in the Big Econ Basin are given in Map 2.4. They have been mapped separately because of their limited distribution and status as communities of special concern. As a result of their limited distribution and integral relationship within the ridge and swale system of the basin, they are of special significance. The best remaining examples can be found in the western portions of the Big Econ Basin along the "ridge" between the Big and Little Econ watersheds. This ridge occupies a line that runs through the Stanton Energy Center and the Easterly Waste Treatment Plant, and east of Lake Mary Jane in Orange County. Unfortunately both the Stanton Energy Center and the Easterly Waste Treatment Rapid Infiltration Basins (RIBs) were constructed on relatively intact xeric communities, reducing the total area of these communities significantly. The International Corporate Park ADA lists a total of 225.3 acres of xeric oak community on their site now approved for development, of which all are subject to development. Some relatively intact scrub exist on the UCF Campus, but recently portions were developed.

Xeric communities occupy topographic ridges, in some locations the ridges can be many meters in height, but in the Big Econ Basin they are often less than a meter higher than the surrounding landscape. Often called xeric oak scrub, xeric scrub, or scrub oak communities, they are characterized by soils that are well drained (droughty), often white and well washed, with little herbaceous cover. When fire has been withheld, the shrub layer can become extremely dense. Most often the sole canopy species is sand live oak (*Quercus geminata*) growing in a relatively open and discontinuous canopy of individuals that are low, arching and mostly less than 10 meters in height. The shrub layer is composed of saw palmetto (*Serenoa repens*), live oak (*Q. virginiana*), myrtle oak (*Quercus myrtifolia*), staggerbush (*Lyonia fruticosa*), Chapman's oak (*Quercus chapmanii*), and fetterbush (*Lyonia lucida*). Rosemary (*Ceratiola ericoides*), tarflower (*Befaria racemosa*), and gopher apple (*Licania michauxii*) are also encountered in the shrub layer. Herbaceous species are relatively uncommon and, when encountered, they occupy open patches of bleached white sand. Most frequently encountered herbaceous species include: wire grass (*Aristida stricta*), roserush (*Lygodesmia aphylla*), reindeermoss (*Cladonia* spp.), beak sedge (*Rhynchospora dodecandra*) and others.

The sand pine scrub, a variation of the xeric scrub community, is apparently even less common than the xeric oak scrub in the Econ Basin (the only mention of sand pine scrub is by Best et al. 1982), and the RIBs of the Easterly Waste Treatment Plant now occupy the site where they were documented). Like the xeric oak scrub, the sand pine scrub canopy is composed of a single species; sand pine (*Pinus clausa*), whose spacing is quite variable such that the canopy is not fully closed in most places. While there is no woody subcanopy, the shrub layer is well developed and often extremely dense, impenetrable thickets are formed. In general, the shrubs are the same as are found in the xeric oak scrub, as are the herbaceous species.

Pine Flatwoods

The pine flatwoods ecosystem is the most common and widespread in Florida. Given its extensive coverage, the pine flatwoods exhibits a broad variety of growth forms from communities resembling prairies with widely scattered longleaf pines (*Pinus palustris*) to extremely dense communities of longleaf pine (*P. palustris*) and slash pine (*P. elliottii*) on moderately drained soils, to dense communities of pond pine (*P. serotina*) often growing in poorly drained sloughs. Most frequently, pine flatwoods occupy nearly level, poorly drained soils that are strongly acidic, and have a "hardpan" several feet below the ground surface. These conditions lead to frequent flooding during the wet season, and often flatwoods are flooded from June through September. However, just as they are prone to flooding during the wet season, they are also prone to drought conditions during the dry season (October to May). With the dry season drought and the flammable nature of the litter layer, fire is a common occurrence in the pine flatwoods. The community is adapted to fire and often referred to as a "fire climax" community; if fire is withheld, the community often succeeds to a hardwood forest or hammock.

Throughout the Big Econ Basin, the flatwoods are dominated by longleaf pine (*P. palustris*). In many locations, as the result of logging and killing fires, the canopy of longleaf pine (*P. palustris*) has been almost eliminated. Where the canopy is open and much sunlight can reach the understory vegetation, a dense layer of saw palmetto (*S. repens*) often becomes the dominant species in the shrub layer. Other species in the shrub layer include: fetterbush (*L. lucida*), staggerbush (*L. fruticosa*), pawpaw (*Asimina reticulatus*), shiny blueberry (*Vaccinium myrsinites*), sparkleberry (*Vaccinium arboreum*), tarflower (*B. racemosa*), wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*), and dwarf huckleberry (*Gaylussacia dumosa*).

While quite common, "healthy" examples of robust flatwoods are increasingly hard to come by. The majority of the drier longleaf communities seem to occupy an area along a line through the Easterly Waste Treatment Plant, Stanton Energy Center southward, east of Lake Mary Jane. The headwaters area of the Big Econ south of the Beeline Highway is dominated by relatively open canopied flatwoods and palmetto prairies. The palmetto prairies may have once been pine flatwoods, but due to fire, logging, and cattle grazing the canopy has been much reduced.

Mesic Hammock

The mesic hammock community is a hardwood forest ecosystem also called a southern mixed forest. The term "hammock" seems to be an old colloquial term meaning grove or stand of trees. Over the years it has come into common usage and is often used to describe forested communities in conjunction with the terms xeric, mesic and hydric, to differentiate between dry, moist, and wet hammocks, respectively.

The mesic hammock occupies moderately well-drained, neutral soils and is believed to be the latter successional stage resulting from the absence of fire in pine flatwoods. The canopy is quite diverse and dominated by any of the following: Southern magnolia (*M. grandiflora*), laurel oak (*Q. laurifolia*), red bay (*P. borbonia*), pignut (*C. glabra*), American holly (*I. opaca*), water oak (*Q. nigra*), black cherry (*P. serotina*), live oak (*Q. virginiana*), sweet gum (*L. styriciflua*), and cabbage palm (*S. palmetto*). The understory is often composed of seedlings of the overstory as well as saw palmetto (*S. repens*), wax myrtle (*M. cerifera*), persimmon (*Dispyros virginana*), fetterbush (*L. lucida*), and various grasses and sedges.

The most extensive areas of this community type occur in the Lower Econ Basin and along the Big Econ, south of the confluence, mostly within Seminole County.

Wetland communities

There are several types of wetlands occurring within the Econ Basin. In general, community structure of wetlands is controlled primarily by hydrologic parameters (hydroperiod and depth of inundation) and then by other factors such as soils, recent fire history, and logging activities. The types of wetlands occurring within the basin are as follows: Pond pine communities (sometimes considered an upland or transitional community), bayheads, cypress domes/strands/sloughs, mixed hardwood swamps, hydric hammocks, wet prairies, shallow marshes, and deepwater marshes. Each is discussed in some detail below.

Pond pine community - The pond pine community is found on poorly drained soils downslope from flatwoods, often in transitional areas between flatwoods and cypress or mixed hardwoods swamps. The soils of the pond pine community remain wet to flooded throughout much of the year. As a result, the community, while adapted to fire, does not burn as frequently as the drier flatwoods. When the community does burn, fire is often disastrous, killing canopy trees, but releasing new seedlings from serotinous (meaning fire loving) cones that are held on branches unopened for several years at a time.

The canopy is principally composed of pond pine (*P. serotina*) but intergrades on the upland edges with longleaf pine (*P. palustris*) and along the wetland edge with cypress and several of the bay species. Distributions of the shrub species varies along the soil moisture gradient. On the drier soils, saw palmetto (*S. repens*) and gallberry (*I. glabra*) predominate, while on the wetter soils, fetterbush (*L. lucida*) and St. John's wort (*H. fasciculatum*) are quite common.

Most all wetland sloughs of the Big Econ Basin have adjacent pond pine communities; some of the best examples are along the line running from the Easterly Waste Treatment Plant southeast through the Stanton Energy Site into southern Orange County east of Lake Mary Jane, and along the Big Econ and its tributaries between the Beeline Highway and Highway 50.

Bay swamp communities - The bay communities of the Big Econ Basin are, for the most part, quite young, suggesting recent changes in wetland community structure and ecological organization. Often, wetland community structure can be radically reorganized as the result of changing groundwater conditions (drier or wetter). This may be the case throughout the basin. Many observations by ecologists documenting community structure allude to increased fire, drier conditions, drained and burned wetlands, and so forth; suggesting that the overall trend throughout the basin has been one of decreasing water table levels. Young bay communities suggest that recently some change has occurred that is more conducive to bay trees (shorter hydroperiods, with minimal inundation) than for other forested wetland community types.

Bay swamps naturally occur where ground surfaces are rarely inundated to any degree for long periods of time, but saturation is quite common for most of the year. Seepage areas at the base of sandy ridges are often dominated by bay communities. Experience has shown community shifts from cypress wetlands to bay swamps in response to lowered groundwater tables and fire.

Bay swamps are dominated by sweet bay (*M. virginiana*), loblolly bay (*G. lasianthus*), and, to a lesser extent, swamp red bay (*Persea palustria*). Other species sometimes reaching canopy stature include: wax myrtle (*M. cerifera*) and dahoon holly (*Ilex cassine*). The understory often resembles a thicket dominated by wax myrtle (*M. cerifera*), fetterbush (*L. lucida*), and vines like wild grape (*Vitisis rotundifolia*) and catbrier (*Smilax laurifolia*).

Numerous throughout the Big Econ Basin some of the areas within and adjacent to the Econlockhatchee River Swamp in northern Osceola County are dominated by bay swamps, interdigitated with marshes, cypress and wet prairies. Many of the cypress domes and swamps of the central portions of the Big Econ are increasingly becoming dominated by bays, presumably resulting from lowered groundwater tables and increased fires.

Cypress Swamps - Cypress swamps are probably one of the most common forested wetlands in Florida. When circular in shape and isolated they are called cypress domes. When elongated and exhibiting sluggish surface-water flow in nondistinct channels, they are called cypress sloughs; and when surface flows are evident but still without distinct channels, they are referred to as cypress strands. Riverine cypress occupy the margins of channelways of streams and rivers. Lake border swamps are often dominated by cypress along the lake margins. Growth rates, density of trees and basal area all seem to increase with increasing hydrologic function and access to nutrients from cypress domes (smallest trees and lowest growth rates) to riverine cypress swamps (largest trees and highest growth rates).

Cypress domes, sloughs, and sometimes strands are dominated by pond cypress (*T. ascendens*) while riverine swamps and lake border swamps are more characteristically dominated by bald cypress (*T. distichum*). Other trees sharing the canopy include black gum (*N. sylvatica*), pond pine (*P.*

serotina), slash pine (*P. elliottii*), red maple (*A. rubrum*), and one or more of the bay species. The understory can be relatively diverse having fetterbush (*L. lucida*), wax myrtle (*M. cerifera*), dahoon holly (*I. cassine*), buttonbush (*Cephalanthus occidentalis*), Virginia willow (*Itea virginica*) and numerous others.

Cypress domes, sloughs and strands are quite common throughout the Big Econ Basin. Although many show successional trends and the effects of earlier logging to the extent that they are now co-dominated with other tree species, some have only remanent cypress trees. The large headwater swamp called the Econlockhatchee River Swamp in northern Osceola County has extensive stands of cypress, although a recent over flight revealed significant logging in some portions of the swamp.

When the dominance of cypress gives way to other species, especially in the riverine floodplain swamps of the river, the community is classified as a mixed hardwood swamp.

<u>Mixed hardwood swamp</u> - When hydroperiods are short, inundation is moderate, and ground topography is relatively rough, the diversity of plant species that can colonize, survive and grow is richer. Mixed hardwood swamps have the highest diversity of the forested wetland communities, primarily as a result of the variation in hydrologic regimes of "micro-sites" within the wetland.

The canopy in these wetlands is a rich assemblage of hardwood species and cypress such that no single species dominates. Canopy species include: red maple (*A. rubrum*), water tupelo (*N. aquatica*), swamp black gum (*N. sylvatica* var. *biflora*), sweet gum (*L. styriciflua*), bald cypress (*T. distichum*), pond cypress (*T. ascendens*), pop ash (*F. caroliniana*), Florida elm (*U. floridana*), cabbage palm (*S. palmetto*), sweet bay (*M. virginiana*), and loblolly bay (*G. lasianthus*). The understory is similar to cypress swamps.

The preponderance of mixed hardwood swamps are associated with the riverine swamps of the floodplain of the Big and Little Econ rivers, although there are numerous isolated wetlands that resemble cypress domes or strands but, because of hydrologic conditions, have mixed canopies.

<u>Wet prairies</u> - Surrounding many forested wetlands in a transitional zone from several meters to as much as 50 meters wide, and in isolated depressions, wet prairies are found. Wet prairies are essentially treeless wetlands inundated for short periods of time, and often ravaged by fire. Wet prairies often occur on mineral soils and do not exhibit accumulations of organic matter; however, when fire is not a recurrent element, minor organic accumulations may occur. Wet prairies are maintained by high water tables, infrequent inundation, frequent fires, and most recently, heavy grazing. Changes in groundwater table elevations as a result of "improved drainage" is practically disasterous to wet prairies, often eliminating them entirely from the landscape after only two dry years.

St. John's wort is often the only woody species present. Sometimes on the drier margins dense stands of wax myrtle (*M. cerifera*) may grow to heights of 4 meters or more. There is a wide variety of herbaceous species associated with wet prairies including: grassy arrowhead (*Sagittaria graminea*), pipewort (*Eriocaulon decangulare*), capitate beaked-rush (*Rhynchospora microcephala*), mermaid-weed (*Proserpinaca pectinata*), yellow-eyed grass (*Xyris caroliniana*), bloodroot (*Lachnanthes caroliniana*), red ludwigia (*Ludwigia repens*), Virginia chain-fern (*Woodwardia virginica*), Baldwin's spikerush

(*Eleocharis baldwinnii*), maidencane (*P. hemitomon*), water smartweed (*Polygonum punctatum*), (*Pluchea rosea*), (*Cyperus* spp.), and water pennywort (*Hydrocotyle umbellata*).

Wet prairie communities are common throughout the headwater and channelway of the Big Econ River Basin, but are not as common throughout the Little Econ Basin and below the confluence in eastern Seminole County.

Shallow marshes - Where inundation is more frequent, depths of inundation are around 0.5 meters, and fire is somewhat less frequent than wet prairies, shallow marshes are common. With deeper inundation, longer hydroperiods and accumulations of organic matter, broad-leaved marshes occur (sometimes called flag ponds) dominated by the following species: pickerelweed (*P. cordata*), arrowhead (*Sagittaria* spp.), fire flag (*T. geniculata*), and cattail (*Typha*, spp.). Dominant in the grassy shallow marshes are sawgrass (*C. jamaicense*), spikerush (*E. cellulosa*), soft rush (*J. effusus*), bulrush (*Scirpus* spp.), maidencane (*P. hemitomon*), to name but a few.

Shallow marshes are common throughout the Big Econ Basin, where they appear as isolated flatwoods marshes and sometimes as fringing forested swamps. The magnificent headwaters swamp of the Big Econ River is an extensive, shallow marsh intermixed with cypress wetlands, bays, and shrubby swamps. Like wet prairies, shallow marshes are particularly susceptible to lowered groundwater tables.

Deepwater marshes - Where hydroperiods are long, and depths of inundation greater than 0.5 meters to a much as 1 m., deepwater marshes prevail. Often found as deeper pools within other wetland systems (including forested wetlands) they are usually dominated by free-floating plants such as water hyacinth and water lettuce if nutrients are high, or rooted aquatic plants such as water lily and spatterdock in lower nutrient conditions.

The extent of deepwater marshes is usually small and relatively local in occurrence. Their spatial distribution within the basin is unknown at this time.

MANAGEMENT ALTERNATIVES

Landscape management in developing regions must be approached from two perspectives. First, from the perspective of resource management, that is, manipulating ecological communities directly as a means of controlling growth, productivity, or species composition. Silviculture is one of the most common landscape management techniques, native range cattle grazing is another. In both of these schemes, the ecological communities of the landscape are manipulated (burned, planted, harvested, ditched, etc.) to increase yields and direct ecological succession in "desirable" directions. Examples of resource management are creating ecological communities, recycling treated sewage effluent through wetlands, controlling burns, manipulating of groundwater levels, and enhancing natural succession.

The second approach is controlling or managing development actions. How much development and how it is placed on the landscape are probably the most important factors affecting overall landscape "health." Management of development includes such things as wetlands protection, zoning, habitat set-asides, floodplain ordinances, and wetland buffers.

Management suggestions for maintenance of a vital and sustainable landscape for the Econ River Basin are included in this chapter. First are resource management alternatives followed by suggestions for managing development impacts.

Managing the Terrestrial and Wetland Resources of the Econlockhatchee River Basin

Principles

The ecological communities of the Econ Basin are self-organizing systems driven by natural forces of sunlight, wind and rains and reorganized through the actions of pulses of flood, drought and fire. The development actions of humans often create conditions that increase the frequency and severity of pulses. Good landscape management does not interrupt natural cycles or alter driving forces. It fits development into the landscape instead of upon it. Effective landscape management balances a symbiotic relationship between ecological communities and human uses for a long-term sustainable yield rather than short-term gain.

Management Suggestions

Managing Fire - The ecological communities of the basin suffer from overexposure to fire. Throughout the Econ Basin fire has increased in severity and frequency as a result of increased presence of humans and lowered water tables. Increased frequency has the net effect of decreasing ecological potential because vegetation is killed and survival of many seedlings is greatly reduced by recurrent fires. Severity of fire is from two sources: first, when fire is suppressed, the buildup of understory vegetation and litter causes fires to burn hotter; and second, many fires result from the actions of humans and occur during the driest portions of the year increasing the likelihood of a hot, killing fire. The drier conditions resulting from combinations of natural drought cycles and drainage activities by humans has dried many ecological communities (especially wetlands) that now burn on a regular basis, killing indigenous species and opening the system to invasion.

To minimize the impacts of fire several management strategies are important:

1) Control burn all terrestrial communities on proper frequency and during wet season when fires are better controlled.
2) Maintain a strong fire control presence in the basin to extinguish fires quickly prior to their getting out of control.
3) Re-establish historic groundwater levels to minimize burning of wetland ecological communities.

Managing Silviculture - Often silvicultural operations are managed for short-term gain with little attention to long-term sustainability or to concepts of multiple use. Cutting practices that cut all timber including wetland timber, site preparation practices that ditch and drain wetter sites, and clear-cutting in general should be discouraged. Sustainable yields can easily be achieved through selective harvesting, and/or rotating clear-cutting in smaller strips leaving uncut trees in alternating rows. Sustainable management alternatives are as follows:

1) Observe best management practices throughout all logging operations.
2) Suspend large clear-cutting in favor of harvesting in small clear-cuts in alternating strips of cut and uncut lands.
3) Suspend clear-cutting in wetlands and wetland buffers in favor of selective logging on a long-term saw timber rotation.
4) Suspend all cutting in wildlands management areas.

Establish Wildlands Management Areas - Fragmentation of landscapes into ever smaller parcels has the net effect of reducing biotic diversity by elimination of wildlife habitat. To ensure that there are some wild landscapes, especially around fast urbanizing metropolitan areas, wildlands management districts need to be established. Through purchase, transfer of development rights (TDR), and transfer of mitigation requirements (TMR), portions of the developing landscape that are wild in character, large enough in size, and a network in design should be set aside.

Wildlands greenbelts that contain and give definition to urban areas and that provide close proximity to a wild and scenic landscape for urban dwellers need to be planned far in advance of their actual need. Once the landscape is developed, reversing urbanization and retrieving a wild landscape, while desirable, becomes impossible. The great greenbelts of Europe were not afterthoughts, but planned well in advance.

Establish Wetlands Buffer Requirements - The purpose of setting aside buffer zones between a wetland and a developed upland area is to protect the integrity of the wetland's water supply, it's water quality, and associated wetland dependent wildlife. A buffer can be thought of as a zone of transition between two different land uses that separates and protects one from the other. Based on previous studies (Brown and Schaefer et al. 1987; Brandt and Brown 1988; and Brown, Schaefer, and Brandt 1989) it is recommended that a wetlands buffer be established that protects wetland integrity and wildlife habitat.

In general, a buffer is necessary to ensure against the degradation of adequate quantity of water (i.e., hydroperiods and depths of inundation are not negatively effected by drainage activities in surrounding lands), adequate quality of water (protection from erosion and sediment) and wildlife habitat value for wetland and aquatic-dependent species. Methods for determining appropriate buffers for landscapes typical of the Econ Basin are provided in Brown, Schaefer, and Brandt (1989).

Dechannalize Streams and Rivers - Natural drainage patterns are organized to minimize slope and water velocities, and to maximize potential use of surface waters. Engineering that reverses these basic organizational principles is destructive to ecological processes landscape wide. Deep drainage canals and ditches lower water tables and cause increased drought in wetlands and uplands alike. Straight ditches increase velocity and allow waters with suspended nutrients and pollutants to quickly exit the upper reaches of a watershed and carry materials far downstream where they contribute to water quality problems. Meandering wetland drainage structures retard runoff during low flows, filter runoff, act as wildlife habitat corridors, and provide aesthetic buffers between lands uses.

Manage for both eutrophy and oligotrophy conditions - Much of the Florida landscape is naturally high in nutrients, while other areas have become nutrient rich as a result of runoff from urban and agriculture lands. Policies trying to maintain nutrient-rich areas (eutrophic areas) as if they were nutrient poor (oligotrophic) run counter to good ecological management. Vegetation should be encouraged to grow, wetlands planted, and surface waters routed so as to maximize the filtration capacity and uptake capacity of ecological communities. Where sunlight and nutrients are abundant, vegetation will invade, taking advantage of these conditions. Herbiciding invading vegetation only allows nutrients and other pollutants to move farther downstream spreading the eutrophic conditions across a wider portion of the landscape.

Managing Development Impacts on Terrestrial and Wetland Ecological Communities

The key to minimizing developmental impacts on the Econlockhatchee River is managing development throughout the basin. Water quality and quantity are fundamental to maintaining a high quality environment and are dealt with in detail in the first chapter of this volume. However, to maintain good water quality, adequate water quantity, and productive wildlife habitat, development of ecological communities throughout the basin needs to be controlled. How much development, where it is located, and how it is designed are important factors that will determine the fate of the Econlockhatchee River.

Principles

Those managing development to minimize impacts to ecological communities should be cognizant of two basic postulates: (1) There are few abrupt changes in nature, and (2) increased economies of scale may apply to economic systems but are often detrimental to ecologic systems. In the first postulate the concern is related to transition. In the second postulate the concern is with "bigness" and the ability of the environment to assimilate wastes. These two postulates lead to the following management suggestions.

Management Suggestions

Confine intense land uses to least sensitive lands - As the intensity of use increases, so do the impacts to the environment. A general environmental planning principle that makes good ecological sense is to confine intense uses (industry, landfills, and commercial uses that have significant impacts on ecological communities) to locations where there is sufficient distance to mitigate negative effects prior to impacting sensitive communities. Intense uses should be confined to areas at the greatest distance from surface-water bodies; and stormwater runoff should be routed through wetlands and other ecologically engineered ecosystems to filter nutrients and pollutants.

Confine development to 50% of land - As a general rule, at least 50% of lands should be left intact as integral urban/ecological communities. These wildlands can be so designed and located as to form an ecological system of corridors and habitats of connected uplands and wetlands that will provide open space and enhance property values. They are necessary components of a landscape and, as such, landowners should be given tax incentives to ensure they are justly compensated for their contribution of these environmental values to society.

Preserve landscape associations instead of communities - It is well known that no ecological community can be isolated from the landscape within which it is imbedded and hope to maintain ecologic functions. Once a community becomes isolated and is driven by a different suite of environmental conditions, it becomes host to a different suite of wildlife. Recent trends in wetlands preservation have left numerous wetlands isolated within large expanses of developed lands. Wetlands found in these situations often have degraded ecologic function and have lost much of their habitat value by virtue of the fact that they are isolated from other interdependent communities. Where trade-offs are appropriate, healthy "mosiacs" of landscape associations of uplands and wetlands should be preserved within developed areas to ensure viable and effective ecological communities. These mosaics should be connected to local and regional wildland corridors in a effort to achieve an integrated wildlands network.

Design stormwater systems as forested ecosystems - There are numerous reasons why stormwater conveyance systems should resemble natural watersheds, the most important are:

1) Natural systems are self maintaining. Wetlands and first-order stream floodplains need no maintenance once they have become established.
2) Constructed wetland retention ponds and first-order stream floodplains provide wildlife habitat.
3) Constructed wetland retention ponds and floodplain ecosystems retard the flow of water.
4) Constructed wetland ecosystems conserve water over open water ponds.
5) Constructed wetland ecosystems provide visual buffers.

Maximize use of native vegetation in landscaping - Maintain existing vegetation, both overstory and understory plants, as elements in developed landscape design wherever possible. They provide food and shelter for native wildlife species and are self maintaining. The use of sod as a ground cover should be minimized because of its lack of wildlife value, its requirements for fertilizer and watering, and the fact that it increases stormwater runoff.

Minimize use of pavement - Use permeable materials for paved surfaces so as to minimize stormwater runoff wherever possible. The design of all paved areas should be such that surface water runoff is routed through constructed wetland filters for sufficient distance and time to remove 99% of sediments, nutrients, oils and greases, and other pollutants.

Minimize groundwater drawdown - When groundwater tables are lowered, soils are drier, hydroperiods shorter and depths of inundation shallower in all communities of the affected area. Soil moisture conditions in upland ecological communities and hydroperiods and depths of inundation in wetland communities are important parameters that control species distributions, productivity, and overall community organization.

Groundwater tables are often manipulated within developments as part of stormwater management. Surrounding ecological communities, preservation areas, and wetlands within the development are adversely affected by the loss of soil moisture and flooding. The overall ecological health declines and their habitat value deteriorates as the landscape becomes more desiccated.

SUMMARY AND RECOMMENDATIONS

Probably the single most important factor to consider in managing the Econlockhatchee River Basin, is the interconnections between elements of the landscape mosaic. Vital and sustainable economic development should not be separated from sound environmental and resource management. River water quality should not be separated from wetlands protection and sound development planning. Healthy wetland ecosystems cannot be separated from the landscape within which they are embedded. Effective management of the water resources of the basin requires effective management of the land resources of the basin. Basin management must recognize the inseparability of good water quality from sound environmental and land use planning. To achieve basinwide management, it is recommended that a special planning district be formed to encompass the Econ Basin and that basin-specific planning criteria be developed to protect the resources of the basin.

It is strongly recommended that in order to achieve some measure of control over the way in which the basin develops, detailed planning studies be conducted to evaluate the resources and condition of the basin in great detail, and then a detailed basin development plan be generated. The plan should be driven by the natural resources of the basin and how best to protect and enhance them. It should be basinwide in scope and include an overall evaluation of the developmental carrying capacity based on maintenance of environmental quality and good water quality in the Econlockhatchee River.

The Econ River Basin is not remarkable in its flora. There are numerous areas throughout central Florida where these same communities can be found. What makes the Econ unique is the fact that much of the basin (Big Econ) is still relatively intact. What is worrisome is the number of new developments and DRI proposals that have recently been made known. Development of a basinwide, cohesive planning initiative offers the opportunity to plan ahead of time how the basin will look and how it will function ecologically and hydrologically.

The Econ River Basin unlike other basins that have greater relief is dominated by slow runoff, high surface storage of stormwaters in wetlands, and high groundwater tables. Development actions within this landscape and studies (Brown, Schaefer, and Brandt 1989) have shown that the flatter a landscape the greater the spatial impacts of drainage structures. Greater care is required in developing the poorly drained lands of the Econ Basin, for the potential negative impacts are larger.

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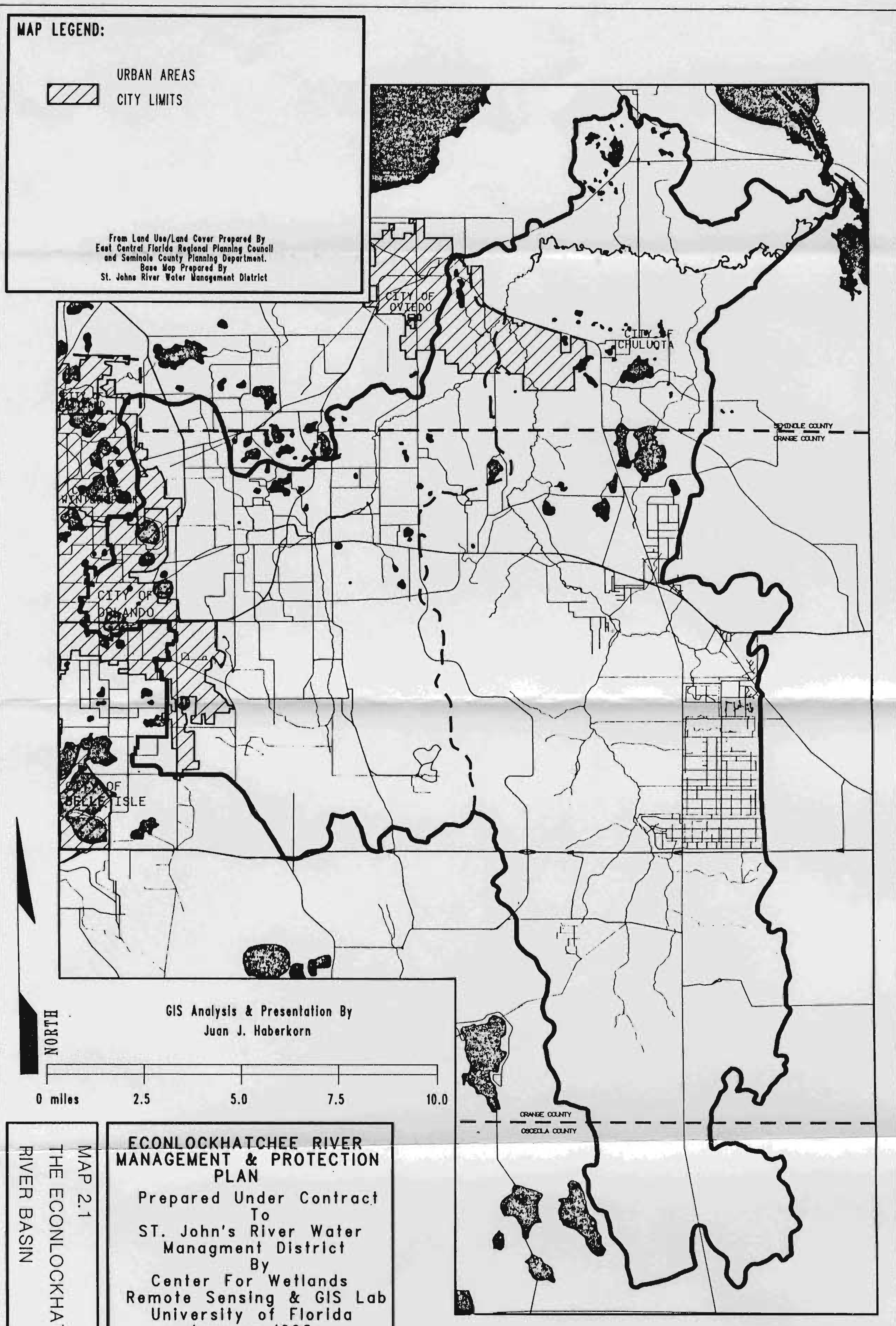

MAP 2.1
THE ECONLOCKHATCHEE RIVER BASIN

ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN

Prepared Under Contract
To
ST. John's River Water Managment District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990

MARK T. BROWN
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UNIVERSITY OF FLORIDA

RICHARD HAMANN/JOHN TUCKER
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UNIVERSITY OF FLORIDA

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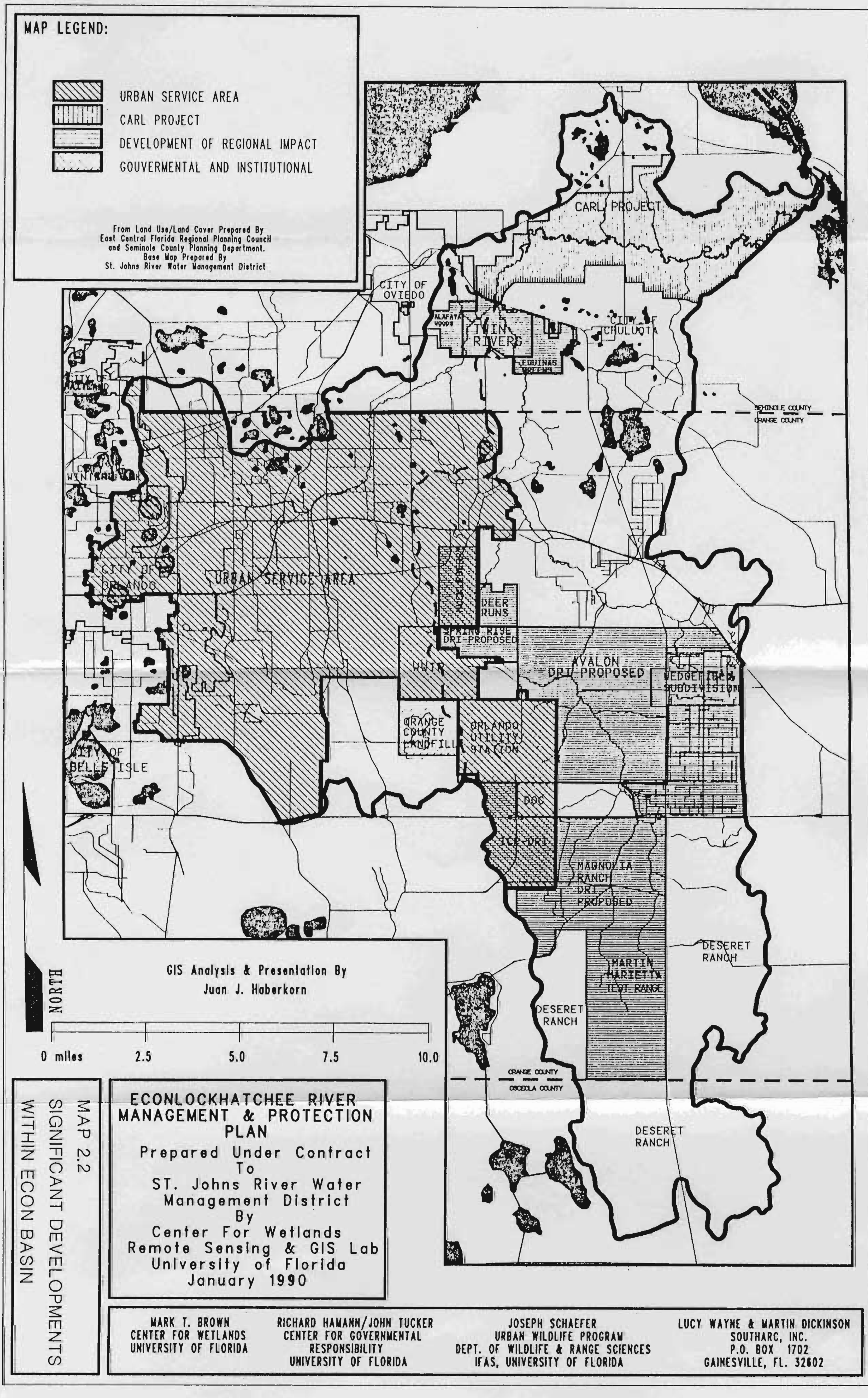
MAP LEGEND:
URBAN SERVICE AREA
CARL PROJECT
DEVELOPMENT OF REGIONAL IMPACT
GOUVERMENTAL AND INSTITUTIONAL
From Land Use/Land Cover Prepared By East Central Florida Regional Planning Council and Seminole County Planning Department. Base Map Prepared By St. Johns River Water Management District
CARL PROJECT
CITY OF OVIEDO
TWIN RIVERS
CITY OF CHULUOTA
SEMINOLE COUNTY
ORANGE COUNTY
CITY OF ORLANDO
URBAN SERVICE AREA
DEER RUNS
SPRING RISE DRI-PROPOSED
AVALON DRI-PROPOSED
WEDGEFIELD SUBDIVISION
ORANGE COUNTY LANDFILL
ORLANDO UTILITY STATION
CITY OF BELLE ISLE
DOC
ICP-DRI
MAGNOLIA RANCH DRI PROPOSED
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DESERET RANCH
NORTH
GIS Analysis & Presentation By Juan J. Haberkorn
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OSCEOLA COUNTY
DESERET RANCH
MAP 2.2 SIGNIFICANT DEVELOPMENTS WITHIN ECON BASIN
ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN
Prepared Under Contract To St. Johns River Water Management District By Center For Wetlands Remote Sensing & GIS Lab University of Florida January 1990
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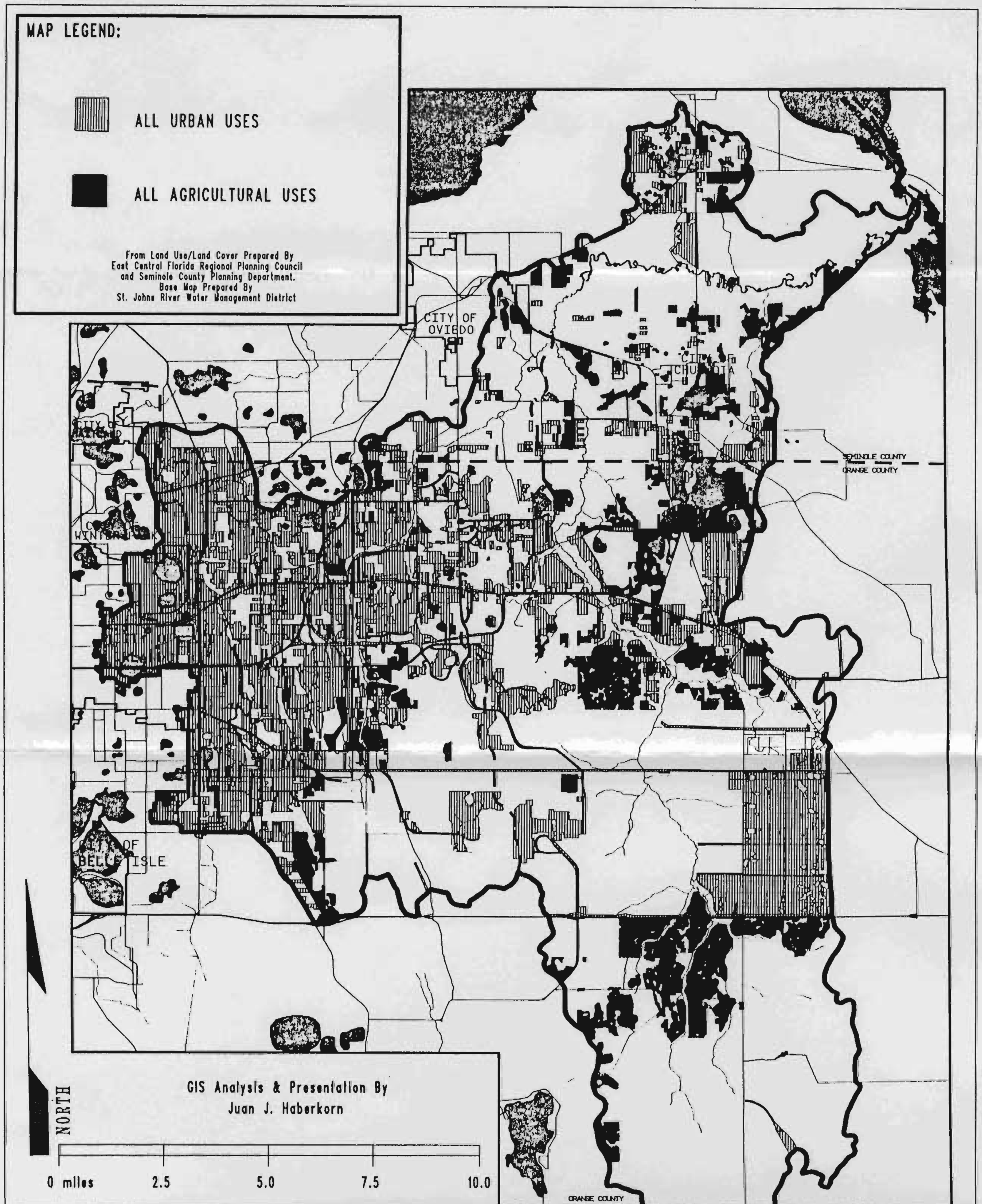
LUCY WAYNE & MARTIN DICKINSON SOUTHARC, INC. P.O. BOX 1702 GAINESVILLE, FL. 32602



MAP LEGEND:
ALL URBAN USES
ALL AGRICULTURAL USES
From Land Use/Land Cover Prepared By East Central Florida Regional Planning Council and Seminole County Planning Department. Base Map Prepared By St. Johns River Water Management District
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SEMINOLE COUNTY
ORANGE COUNTY
ISLE
OSCEOLA COUNTY
NORTH
GIS Analysis & Presentation By Juan J. Haberkorn
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MAP 2.3
URBAN AND AGRICULTURAL LAND USES
ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN
Prepared Under Contract To ST. John's River Water Managment District By Center For Wetlands Remote Sensing & GIS Lab University of Florida January 1990
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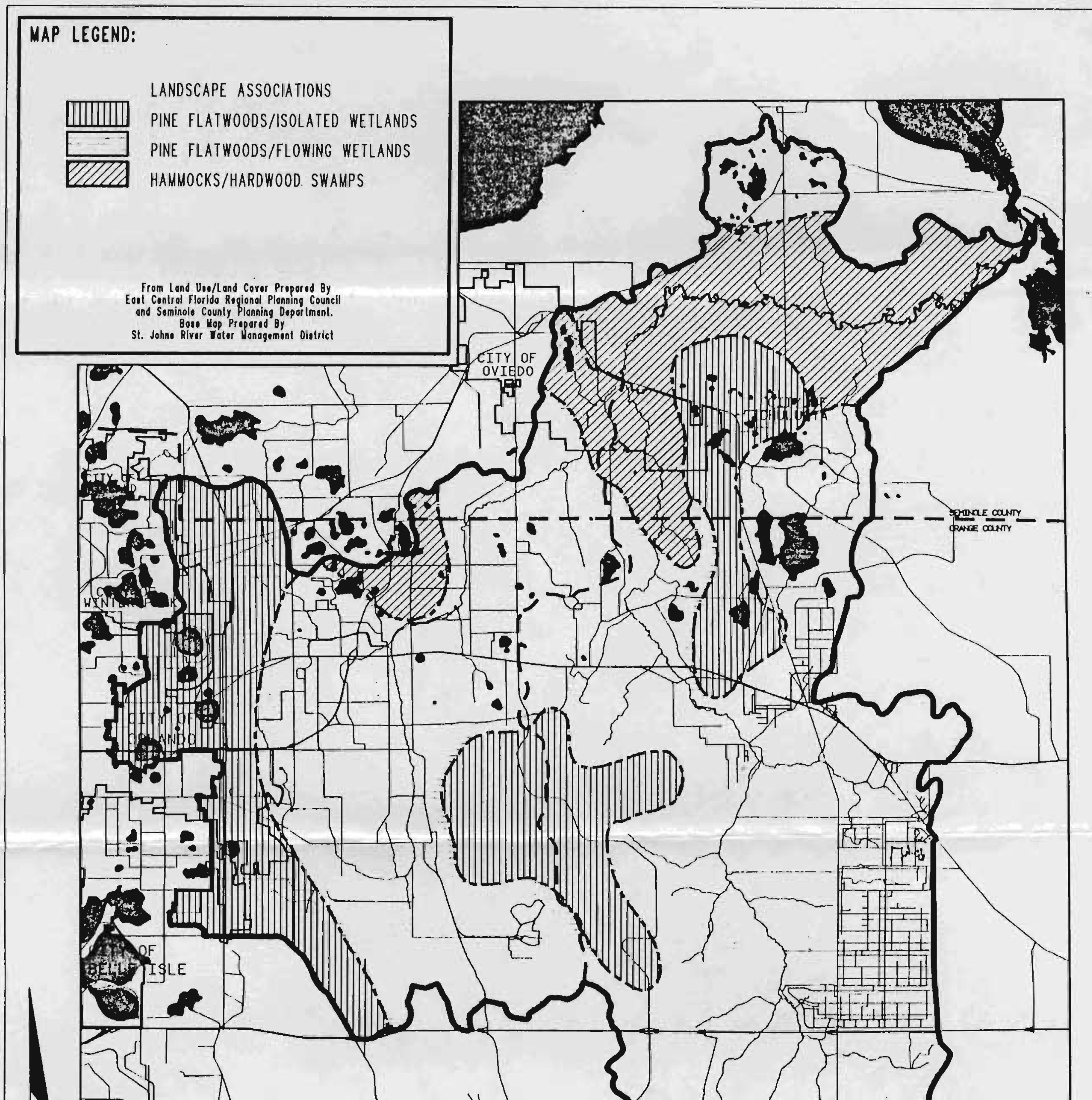
MAP LEGEND:
LANDSCAPE ASSOCIATIONS
PINE FLATWOODS/ISOLATED WETLANDS
PINE FLATWOODS/FLOWING WETLANDS
HAMMOCKS/HARDWOOD SWAMPS
From Land Use/Land Cover Prepared By
East Central Florida Regional Planning Council
and Seminole County Planning Department.
Base Map Prepared By
St. Johns River Water Management District
CITY OF OVIEDO
SEMINOLE COUNTY
ORANGE COUNTY
CITY OF ORLANDO
ISLE
ORANGE COUNTY
OSCEOLA COUNTY
NORTH
GIS Analysis & Presentation By
Juan J. Haberkorn
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MAP 2.4
ECON LANDSCAPE
ASSOCIATIONS
ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION
PLAN
Prepared Under Contract
To
ST. John's River Water
Managment District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990
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UNIVERSITY OF FLORIDA
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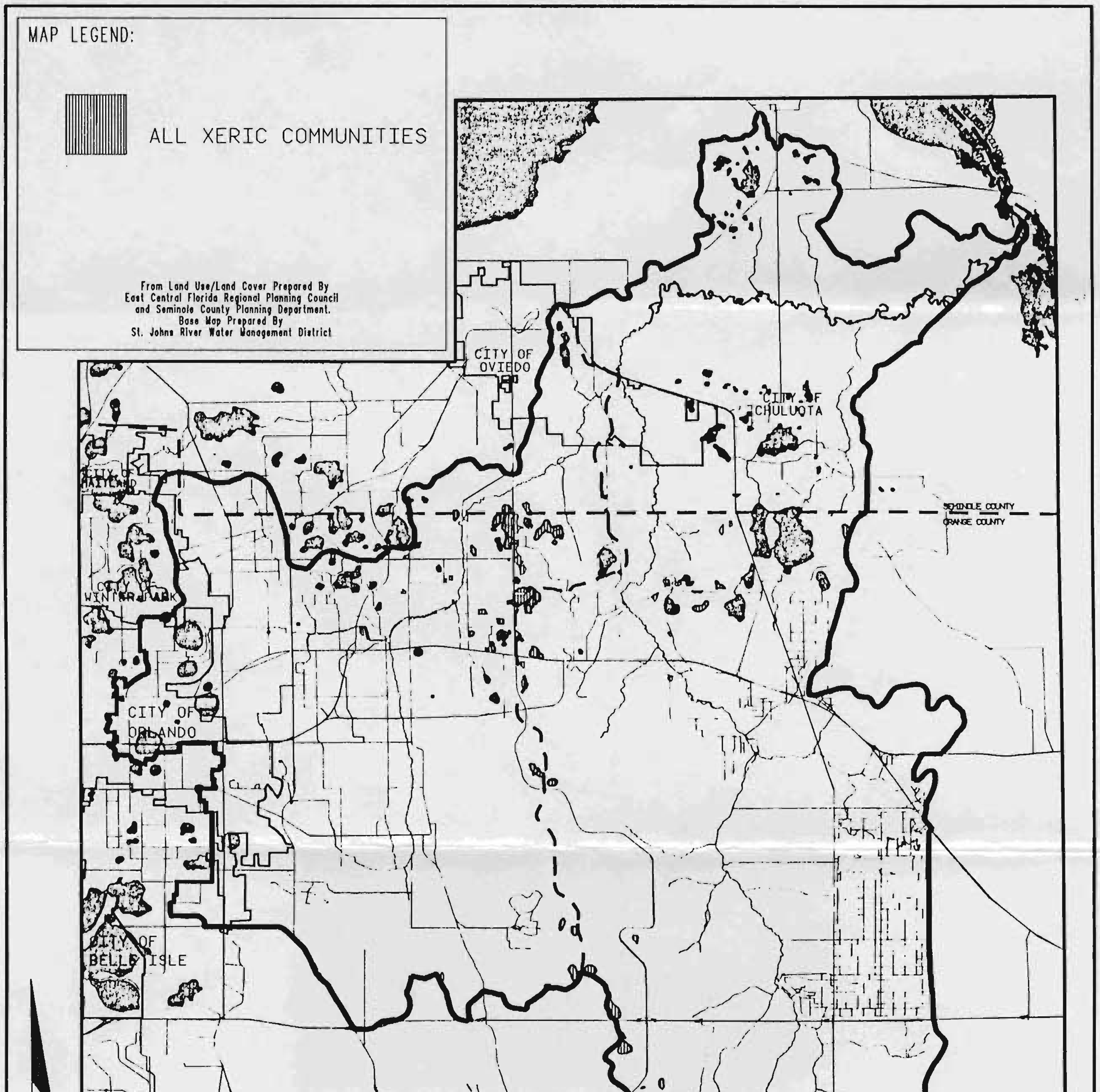
MAP LEGEND:
ALL XERIC COMMUNITIES
From Land Use/Land Cover Prepared By East Central Florida Regional Planning Council and Seminole County Planning Department. Base Map Prepared By St. Johns River Water Management District
CITY OF OVIEDO
CITY OF CHULUOTA
CITY OF MAITLAND
CITY OF WINTER PARK
CITY OF ORLANDO
CITY OF BELLE ISLE
SEMINOLE COUNTY
ORANGE COUNTY
OSCEOLA COUNTY
NORTH
GIS Analysis & Presentation By Juan J. Haberkorn
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MAP 2.5
XERIC COMMUNITY LOCATIONS
ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN
Prepared Under Contract To ST. Johns River Water Management District By Center For Wetlands Remote Sensing & GIS Lab University of Florida January 1990
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RICHARD HAMANN/JOHN TUCKER CENTER FOR GOVERNMENTAL RESPONSIBILITY UNIVERSITY OF FLORIDA
JOSEPH SCHAEFER URBAN WILDLIFE PROGRAM DEPT. OF WILDLIFE & RANGE SCIENCES IFAS, UNIVERSITY OF FLORIDA
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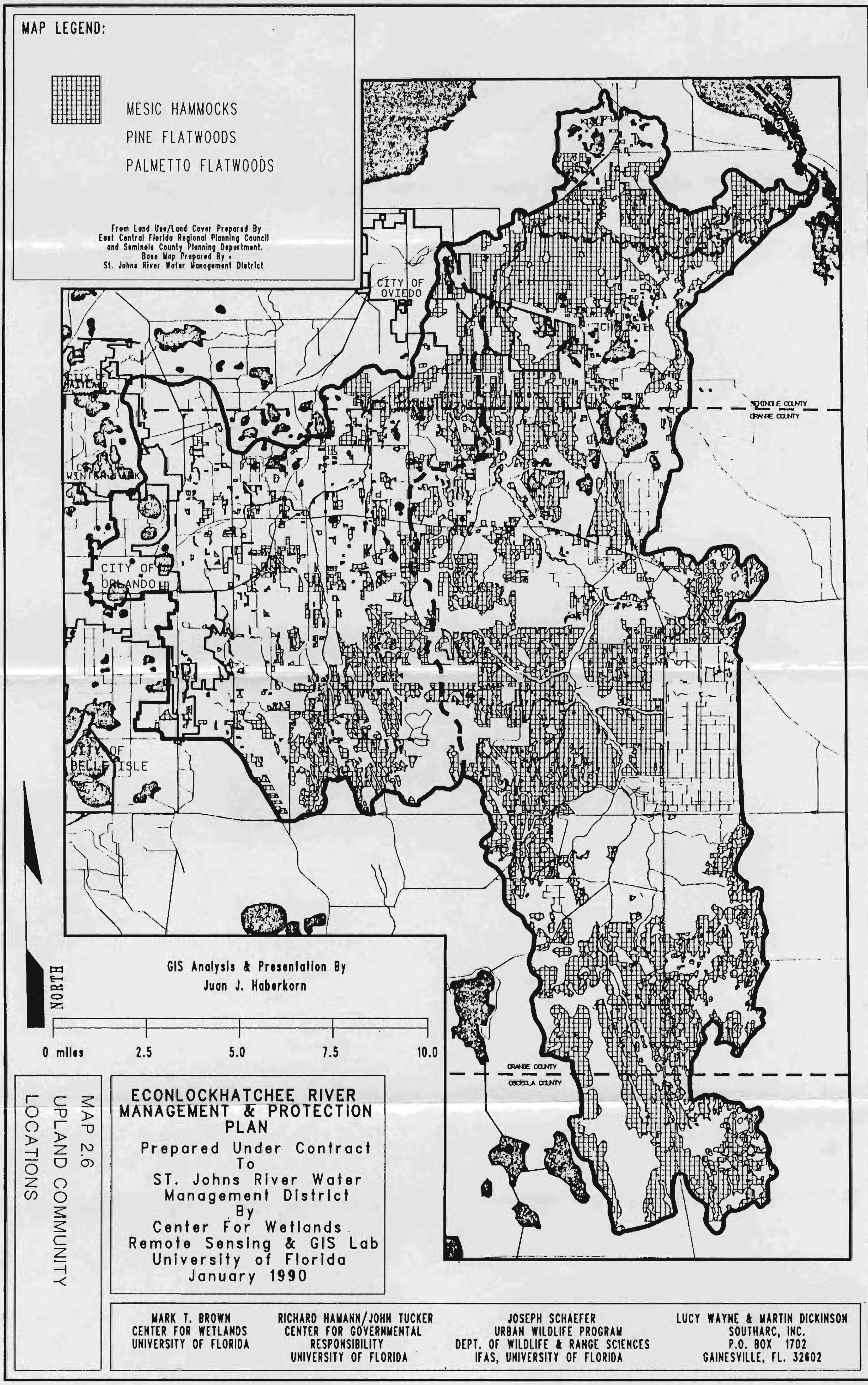
MAP LEGEND:
MESIC HAMMOCKS
PINE FLATWOODS
PALMETTO FLATWOODS
From Land Use/Land Cover Prepared By
East Central Florida Regional Planning Council
and Seminole County Planning Department.
Base Map Prepared By
St. Johns River Water Management District
CITY OF OVIEDO
CITY OF ORLANDO
CITY OF BELLE ISLE
SEMINOLE COUNTY
ORANGE COUNTY
OSCEOLA COUNTY
NORTH
GIS Analysis & Presentation By
Juan J. Haberkorn
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MAP 2.6
UPLAND COMMUNITY LOCATIONS
ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION PLAN
Prepared Under Contract To
ST. Johns River Water Management District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990
MARK T. BROWN
CENTER FOR WETLANDS
UNIVERSITY OF FLORIDA
RICHARD HAMANN/JOHN TUCKER
CENTER FOR GOVERNMENTAL RESPONSIBILITY
UNIVERSITY OF FLORIDA
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URBAN WILDLIFE PROGRAM
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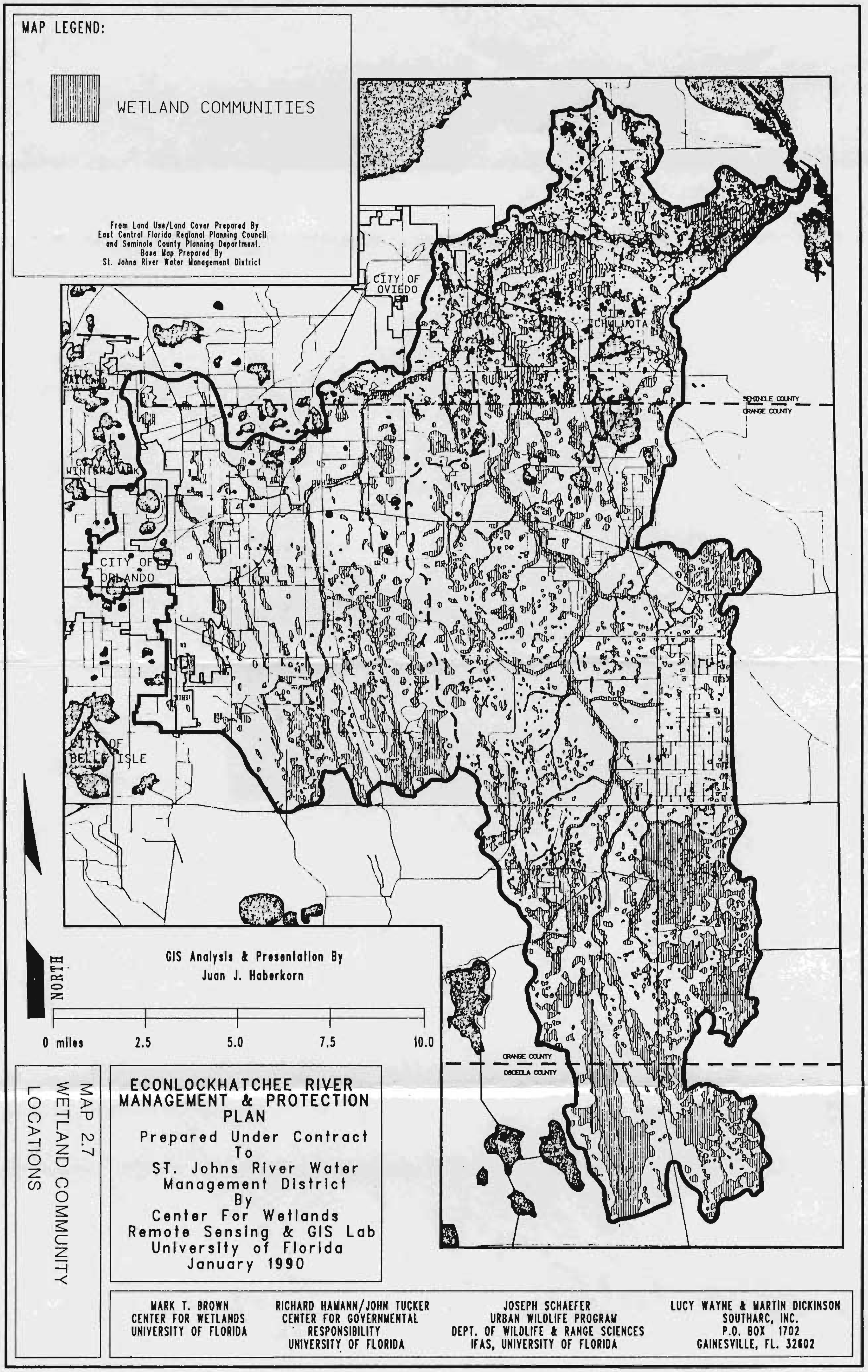
MAP LEGEND:
WETLAND COMMUNITIES
From Land Use/Land Cover Prepared By
East Central Florida Regional Planning Council
and Seminole County Planning Department.
Base Map Prepared By
St. Johns River Water Management District
CITY OF OVIEDO
CITY OF CHULUOTA
CITY OF MAITLAND
WINTER PARK
CITY OF ORLANDO
CITY OF BELLE ISLE
SEMINOLE COUNTY
ORANGE COUNTY
OSCEOLA COUNTY
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WETLAND COMMUNITY
LOCATIONS
ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION
PLAN
Prepared Under Contract
To
ST. Johns River Water
Management District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990
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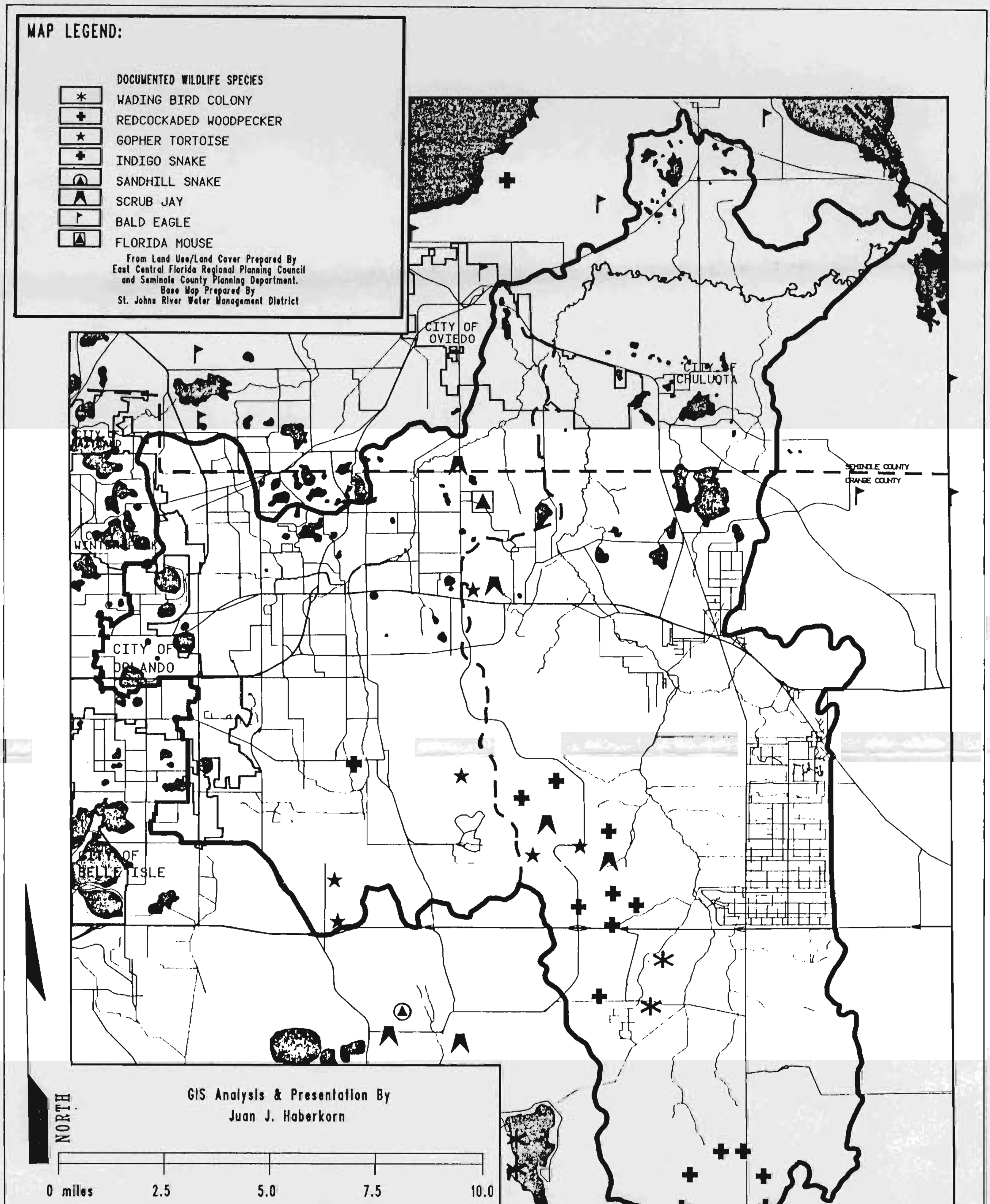

MAP 3.1 DOCUMENTED OCCURRENCES OF LISTED WILDLIFE SPECIES

ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN

Prepared Under Contract To ST. John's River Water Managment District By Center For Wetlands Remote Sensing & GIS Lab University of Florida January 1990

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ECONLOCKHATCHEE RIVER BASIN NATURAL RESOURCES DEVELOPMENT AND PROTECTION PLAN

Chapter 3

WILDLIFE RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Prepared for

St. Johns River Water Management District

October 1990

Chapter 3

WILDLIFE RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Joseph M. Schaefer

INTRODUCTION

The annual projected population growth rate for the Orlando area through 1992 is 38,670 (West 1989). This is more than one-tenth of the total state growth and second only to Tampa. The real income growth will be more than three-quarters of a billion dollars and about 25,000 new jobs will be created. This growth will also bring more crimes, greater and the clearing of approximately 20 square miles of natural habitat each year to meet the demands for housing, roads, shopping centers, schools and other development-related uses (calculated from data presented by Bethea 1974, Edwards 1988).

From 1980 to 1987, urban development caused the deforestation of almost 5% of the total Florida timberland surveyed in 1980 (Brown 1987). Florida has the second largest number of federally listed threatened and endangered species in the nation. The ecological and recreational values (about $5.2 billion annually) of Florida's wildlife resources are becoming more and more jeopardized by urbanization.

As development continues to spread across the landscape toward the Econlockhatchee River, protecting wildlife from extinction within the basin becomes increasingly difficult. Cumulative effects of sub-DRI developments are often overlooked, resulting in the slow degradation of habitats. Land use decisions made without full knowledge of their potential consequences have altered and fragmented wildlife habitats, destroyed critical nesting and feeding areas, and polluted aquatic and terrestrial environments. Growth management objectives and policies that generally state the obvious need to protect habitat are not measurable and do not adequately address the ultimate problem of species' extinctions.

Every time the ground, understory or canopy layers in a natural vegetation community are altered, food and cover requirements for certain wildlife are removed. When an essential habitat component is diminished to a level that is not enough for a species to survive, that species can no longer live there. In other words, it becomes extinct in that area.

Of course, there are different levels of extinction. Species first become extinct on individual sites. When enough sites are altered, the extinction spreads to a township level. County, region, state, nation, and world are other levels of extinction.

Legally classified endangered species already have become extinct in much of their former range and are found only where their essential requirements remain. Land use around these critical habitat areas is restricted. The rationale for these mandates is to prevent endangered species from becoming extinct at the state level. Very few species that have reached this stage in the extinction process have been recovered to the point where they no longer need special protection. The best endangered species recovery plan will only help to keep the status quo and places the burden of habitat protection on the few landowners with critical habitat on their properties. This method is also species specific and does not address the needs of other wildlife that are rapidly approaching statewide endangerment or extinction.

A proactive, holistic wildlife protection strategy designed to preserve enough habitat for viable populations of wildlife would be more ecologically sound and equitable for landowners. Growth management standards that protect existing species from extinctions within various jurisdictions need to be developed. Then implementation of conservation plans will be based on scientific data and can be evaluated easily through periodic wildlife surveys.

The small "conservation areas" and "wildlife corridors" that are included in individual DRIs are usually not adequate to protect species that are most adversely affected by development activities. These token habitats only provide enough area for common species such as cardinals, mockingbirds, mourning doves, blue jays, and others that merely need a well-landscaped yard to survive. Large, connecting systems that include several wetland and upland vegetation community types are needed to preserve viable populations of all wildlife species within the Econ Basin.

Of the state's 111 endangered, threatened, or special concern species, 22 are found in various habitats within the Econ Basin. Three of these occur only in Florida. Unless something is done to reverse present trends, these unique components of our natural heritage will be gone forever.

The need for managing growth in a manner that is compatible with wildlife preservation efforts is addressed in the State and Regional Planning Act of 1984 (Chapter 186 of Florida Statutes) and the Local Government Comprehensive Planning and Land Development Regulation Act of 1985 (Chapter 163 of Florida Statutes). Within the State, Regional, and Local Comprehensive Plans mandated by these Acts, Conservation Elements were established "to promote the conservation, use and protection of natural resources." An important aspect of this planned attempt to manage growth in an environmentally acceptable manner involves generating the necessary information base to carry out specific requirements of the minimum criteria rule (Section 9J-5 Florida Administrative Code).

The Model Conservation Element provided by the Florida Game and Fresh Water Fish Commission suggests excellent policies such as maintaining upland buffers, establishing wildlife corridors, and maintaining the current complement of wildlife species (Florida Game and Fresh Water Fish Commission 1987.) However no, information is available to tell planners the proper dimensions or the specific ingredients of a local refuge system that will maintain current biological diversity. Without the credibility of research, recommendations that will benefit wildlife have gone unheeded because of the intense economic and political pressures to develop natural areas near and in cities (Murphy 1988).

Preserving viable populations on each development site certainly is not feasible. However, establishing a properly designed conservation reserve system in the basin will protect all existing species from extinction. Setting aside small, token parcels on each development site will not prevent extinctions unless the set-asides are part of a planned conservation reserve system for the entire basin. This reserve will be delineated by assessing the habitat values of the basin.

Rationale

Issues Related to Resource Utilization/Management

There are many issues related to the wildlife resources in the Econlockhatchee River Basin. These problems must be clearly understood before they can be properly addressed. The major wildlife issues include: (1) habitat fragmentation, (2) wildlife corridor misconceptions, (3) decrease in landscape diversity, (4) reduction in habitat quality, (5) impacts of adjacent land use, (6) impacts of public recreation, (7) impacts of cattle grazing, and (8) impacts of silviculture.

Many of the habitats in this basin already have been fragmented or reduced in size. Major east-west highways such as Routes 420, 50, and 528 have divided the basin into four large habitat blocks. These roads are serious obstacles to north-south animal movements along the Econ River. Their effectiveness as barriers increases as urban sprawl travels down these infrastructures. Highways also are responsible for significant mortality rates of many species.

Other unnatural modifications of native habitats have encroached from the east and west. Many acres have been deforested for agricultural, silvicultural, and housing construction purposes. The relatively unaltered, native habitat has been compressed into four somewhat disjunct corridors along the Big Econ River.

One of the reasons for the great richness of wildlife in the Econ Basin is because of its historic linkages with the vast flatwoods to the east and the sandhills to the west. Several current land use practices probably are interfering with wildlife movements which are essential for recolonization and maintaining genetic variation in viable populations. Very narrow token strips of vegetation that do not actually connect large habitat areas are commonly used in landscaping to provide visual screening and are mistakenly sold as wildlife corridors. These strips support very few, if any, wildlife that are sensitive to development and in greater need of conservation.

Most wildlife species use more than one vegetation community to obtain their life-sustaining requirements. Semi-aquatic and wetland-dependent wildlife need access to uplands to feed or nest at different times of the year. Conversely, upland species also are dependent on wetland resources. Even if the dependency is restricted to only a couple of hours each year, these feeding and nesting requirements often are essential to survival and reproduction.

Several upland patches in the Econ Basin have been developed, altered, and isolated from once-adjacent wetlands. Limiting contiguous habitat diversity will cause local extinctions of many species.

The quality of habitats in the study area varies from relatively natural and good to extremely modified and poor. The highly exploited areas along the Little Econ retain very little value for wildlife that need protection.

Although development has been restricted in the Econlockhatchee Basin, its impacts have far-reaching effects. Noise and other pollutants originating from developed areas penetrate adjacent natural areas and interfere with courtship, feeding, and other behaviors of animals. Free-ranging cat and dog pets exert unnaturally high predation pressure on ground-feeding and nesting species. Nest predators and competitors are attracted to open areas in and along the forest canopy and cause reductions and even local extinctions of native, forest-adapted species.

A common protection strategy for development-sensitive areas is to purchase and include them into the local or state park system. However, once it receives a parkland title, it is subjected to other forms of habitat alteration and disturbance--park development and use. Human impacts on wildlife and their habitats have been documented in several parks and refugia. Vistor use was reduce this year at Itchetucknee State Park because the current use level was visibly destroying the aquatic vegetation. Not assessments of the obvious direct disturbances of wildlife were made. Many bird species at Ding Darling Refuge were found to be adversely affected by the thousands of visitors who drive and walk through this public area. Endangered manatees (*Tichechus manatus latirostris*) that concentrate in King's Bay at Crystal River each winter are subjected to harassment and are forced away from the relatively warm water springs by hundreds of people who are attracted to this critical habitat area located on public property.

The disturbance factor in some of our public lands is no less than that which occurs in residential developments. Wildlife species that are adversely affected by development are sensitive to human presence regardless of whether it occurs on public or private land.

Scope of the Study

Developing an effective management and protection plan for the wildlife resources in the Econlockhatchee River Basin will be based on: (1) a literature review of the Econlockhatchee River Basin wildlife resources and appropriate wildlife conservation principles, (2) an assessment of the status of the resource, (3) an identification and evaluation of existing and potential threats, and (4) and identification of actions that will minimize development impacts and give the best assurance for preserving the wildlife integrity of the basin.

Due to the short time frame of this study, existing sources of information were used to assess the current status of the wildlife resource and their habitats. A comprehensive review of literature that relates to wildlife in the Econ and to wildlife conservation issues that apply to the study area was conducted. An aerial survey was made of the basin. Aerial photos and maps of vegetation communities and development trends were also analyzed.

The following data bases were obtained from several sources or created during the study to develop a description of the wildlife resources in the basin:

* Distribution of documented occurrences of listed species. Florida Natural Areas Inventory, Florida Game and Fresh Water Fish Commission, and Orange County Planning Office.
* Distribution of wading bird rookeries. Nongame Section of Florida Game and Fresh Water Fish Commission.
* Breeding bird survey data. U.S. Fish and Wildlife Service, Florida Audubon (Breeding Bird Atlas).

* Fisheries data. Florida Game and Fresh Water Fish Commission, Florida Museum of Natural History.
* DRI data. East Central Florida Regional Planning Council, and Seminole, Orange, and Osceola county planning offices.
* Species lists. Created from information obtained from the University of Central Florida and various references that describe species' distributions and habitat uses.

During the next project phase, this information will be used to assign values to several habitat evaluation criteria. As time allows, these values will be compiled and digitized for randomly selected vegetation communities in the basin. A comparison of total values for each community will help to identify important wildlife habitat systems. This process will provide an objective, quantified, defensible basis for delineating wildlife preservation areas and developing an effective protection plan for the Econ Basin wildlife resources.

The variables selected for this purpose were chosen because of their ecological significance in maintaining wildlife populations. Criteria that will be used in this study and their potential point values follow.

1. Size:

> 75 acres	= 5 pts.
10-75 acres	= 3 pts.
≤ 10 acres	= 1 pt.

2. Landscape Diversity:

≥ 3 plant communities bordering	= 5 pts.
2 plant communities bordering	= 3 pts.
1 plant community bordering	= 1 pt.

3. Insularity:

0-30% of perimeter developed	= 5 pts.
31-69% of perimeter developed	= 3 pts.
70-100% isolated	= 1 pt.

4. Quality:

Relatively natural state	= 5 pts.
Some development (e.g. timbering or pasture)	= 3 pts.
Highly developed	= 1 pt.

5. Uniqueness in basin:

Vegetation type makes up 1-25% of entire basin	= 5 pts.
Vegetation type makes up 26-50% of entire basin	= 3 pts.
Vegetation type makes up > 50% of entire basin	= 1 pt.

6. Quality of Adjacent Areas:

Relatively natural with no development	= 5 pts.
Minor development present	= 3 pts.
Major development has occurred	= 1 pt.

7. Biological Diversity in Habitat:

   The major vegetation community types will be ranked by the number of wildlife species that occur in each. The highest criterion value will be given to the community type with the highest number of species.

8. Proportion of Imperiled Species:

   The percentage of total species occurring in the major community types that are imperiled will be determined (Millsap et al. 1990). Then the communities will be ranked by assigning the highest ranking number to the community with the greatest percentage of imperiled species.

The most accurate method of determining current baseline data on wildlife species within the basin would be through systematic species' surveys. The need for this is exemplified by the fact that only 8 of the 22 listed (endangered, threatened, and special concern) species that are assumed to occur in the basin have been documented. The brief surveys that are conducted during DRI proposal preparation would be unlikely to document species such as the gopher frog (*Rana areolata aesopus*).

Definition of Terms

Biota -- The animal and plant life of a particular region considered as a total ecological entity.

Carrying Capacity -- The size of a population that an environment or habitat can support indefinitely.

Community, Ecological -- A natural assemblage of plants and animals that live in the same environment, are mutually sustaining and interdependent, and are constantly fixing, using, and dissipating energy.

Community, Wildlife -- All the populations of different species of animals that live in the same environment.

Cursorial -- Adapted to or specialized for running as opposed to flying, crawling, etc.

Diversity, Biological -- The composition of a particular environment or habitat as it relates to the plant and animal species present and their relative abundance.

Extirpation -- Extinction of a species from a particular area (not its entire range) where it formerly occurred.

Genetic Viability -- The chance of survival from egg to adult.

Habitat, Wildlife -- The area or type of environment in which an organism or biological population normally lives or occurs.

Insularity -- Of or relating to the extent that a specific habitat area is surrounded by dissimilar landuses that in an ecological sense isolates it from natural animal and plant dispersion mechanisms.

Integrity, Biological -- All the plants and animals that are characteristic of an area and all the processes that result from interactions between these species and their environment.

Life Requisites -- Those components of a habitat that an organism needs to survive.

Mesic -- Between very wet and very dry.

Overstory -- The layer of foliage (leaves and branches) formed by the largest trees in a forested area.

Population, Minimum Viable -- The smallest number of individuals that will give 99% probability of the species surviving in a particular area for at least 1,000 years.

Riparian -- Of or relating to or living or located on the bank of a flowing watercourse (as a river or stream) and also an isolated water source such as a pond or lake.

Semi-aquatic -- Adapted for living near water and needing water to survive but living in water all the time such as fish.

Silviculture -- Activities of man involving regeneration, tending, and harvesting a forest.

Species Richness -- The number of different species in an area.

Succession, Vegetational -- The process of change in the types of plants occupying an area as plants mature, are replaced, and otherwise respond to the environment.

Taxa -- Plural of taxon.

Taxon -- A group of organisms constituting one of the categories in taxonomic classification of living organisms such as class, order, family, genus, species.

Territory, Breeding -- An area usually including the nesting or denning site and possibly a variable foraging range that is preempted by an individual male animal and defended against the intrusion of rival individuals.

Understory -- The foliage lying beneath the tallest trees consisting mainly of seedling trees, small trees, shrubs, and herbaceous plants.

Vegetation, Transitional -- Areas that contain plants that are characteristic of identifiable adjacent plant communities.

Vertebrate -- Of or relating to the taxonomic subphylum "vertebrata" that compromises bilaterally symmetrical animals with a segmented spinal column or in primitive forms with a persistent notochord, a tubular dorsal nervous system divisible into brain and spinal cord, an anterior head bearing a mouth and the major sense organs, an internal articulated skeleton of bone and cartilage, respiration by gills or lungs, and not more than two pairs of limbs which may be modified as grasping, walking, swimming or flying organs in different members of the division, and that includes the mammals, birds, reptiles, amphibians, fishes, elasmobranchs, and cyclostomes and sometimes the lancelets.

Water-Dependent -- Of or relating to the need for water as a necessary habitat component for survival.

Wetland -- Lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface.

Wetlands, Ephemeral -- Lands that fluctuate between wet and dry stages to the extent that the needs of organisms depending on wet environments are only ocassionally and temporarily satisfied.

Xeric -- Of or relating to an extremely low amount of moisture available for the support of plant life.

Review of All Pertinent Literature

Resources of the Econlockhatchee Basin

The literature data base for wildlife resources in this basin is limited. Dr. Jack Stout and others have collected information on small mammals found in different communities including sand-pine-scrub on the campus of the University of Central Florida. Stout and Demmer (1982), and Stafford and Stout (1983) reported on dispersal movements of cotton rats. Habitat partitioning also was studied (Swindell 1977).

Stout et al. (1989) and Bard (1989) reported on the home range, movements, habitat use and survival of relocated gopher tortoises near UCF campus.

In a comprehensive report on short-tailed hawks, Ogden (1974) found several nesting pairs in the Econ Basin. He remarked that this area provided excellent habitat for this species because of the patches of large trees adjacent to open country. This hawk prefers to nest in swamps and feeds in nearby pastures, marshes, or native prairies.

Very little is known about the fish communities in the Econ. Williams and Bruger (1972) found that American shad spawned in the Econ in 1969 and 1970. Gerry (1983) also reported that the upper Econ is near the southern limit of the geographic range of the freckled madtom and blackbanded darter.

Issue 1. Habitat Fragmentation

The effects of fragmenting or reducing habitat size on animal communities (especially birds) has been popular research topic during the last two decades. These investigations have provided the scientific bases for the proper designing of nature preserves surrounded by areas with little or no habitat values.

Most early work on this problem was essentially a confirmation of the familiar species-area relationship - larger pieces of habitat support more species (Arrhenius 1921, Gleason 1922, Preston 1960 and 1962, MacArthur and Wilson 1967).

The original intent of this theory proposed by MacArthur and Wilson (1967) was to explain species richness on oceanic islands that are isolated from mainlands. More recently, forest fragments also have been portrayed as islands because they are patches of natural habitats surrounded by a sea of culturally modified land (Terborgh 1974, Sullivan and Shaffer 1975, Wilson and Willis 1975, Diamond and May 1976, Forman et al. 1976, Galli et al. 1976, and many others).

The process of habitat fragmentation is accompanied by insularization of fragments, i.e., isolated pieces of habitat surrounded by dissimilar habitat. Eventually, fewer native species will be found in a habitat island than in a sample area of equal size within an extensive block of habitat (Harris 1984). The number of species may not change much, or may even increase in isolated habitats, but species composition will shift toward the more common non-forest-dependent species such as cardinals, pigeons, doves, blue jays, house sparrows, and mockingbirds. These adaptable species are prevalent in the developed landscape and do not need reserves or special protection for survival.

The equilibrium number of species found on an area is a function of immigration to the area and extinction of species originally present. In general, species capable of flight exhibit significant immigration to isolated habitat islands. Cursorial (non-flying) animals are less likely to disperse across inhospitable terrain (Frankel and Soule 1981). McLellan et al. (1986) suggest that extinctions of species increase rapidly once a critical percentage of the original habitat has been destroyed.

Smaller forest islands surrounded by clear cuts or agricultural fields contained fewer bird species than larger contiguous stands (Linehan et al. 1967, Moore and Hooper 1975, Forman et al. 1976, Galli et al. 1976, McElveen 1978, Wilson and Carothers 1979, Stauffer and Best 1980, Martin 1980, Robbins 1980, Tassone 1981, Ambuel and Temple 1983, Lynch and Whigham 1984, Blake 1986, Blake and Karr 1987, Temple 1986).

Similar results have been shown from Florida studies. Harris and Wallace (1984) reported that the number of breeding bird species occupying habitat islands in north central Florida hammocks increased as a direct function of island size. Of the 45 bird species that commonly breed in expansive tracts of north Florida hardwood forests, only 24 used the 12 forest island fragments.

Research in urban areas also has suggested that the species-area concept applies when forest fragments are surrounded by development. In study areas bounded by housing developments, farm land, streams, and rail roads, Burr and Jones (1968) found bird species diversity to be directly related to urban parkland habitat size in Delaware. Gavareski (1976) reported identical numbers of non-urban bird species (29) in a large rural forest and a large undeveloped urban park but only 21 non-urban species in a small undeveloped urban park in Seattle, Washington.

Few studies have tested the validity of this model with other taxa. Variations in mammalian species richness was reported by Kitchener et al. (1980b) and Matthiae and Sterns (1981). Shreeve and Mason (1980) found area to be correlated with the number of butterfly species.

There are many potential interpretations of the species-area relationship. Four general explanations are (1) larger areas support more kinds of habitats (and thus more habitat-specific species), (2) larger areas offer bigger "targets" for organisms dispersing across the landscape, (3) larger areas maintain larger populations that are less vulnerable to extinction due to random or deterministic population fluctuations, and (4) larger areas support animals with large territory and home range size that cannot be supported in small areas. Any one of these explanations is powerful enough to support the general recommendation that nature preserves should be as large as possible (Soule and Wilcox 1980, Frankel and Soule 1981, Schonewald-Cox et al. 1983, Harris 1984, Soule 1986).

A great deal of recent literature in the field of island biogeography has discussed the effects of inbreeding and genetic drift on wildlife due to genetic isolation and small population sizes (Miller 1979, Soule 1980, Senner 1980, Wilcox 1980, Franklin 1980). Inbreeding has the effect of decreasing population heterozygosity (genetic variation) by increasing the chance that progeny will receive duplicate alleles from a common ancestor. This loss of genetic variation can have both immediate and future implications for a species' survival. Inbreeding can lower species vigor and fecundity within a few generations (Soule 1980). The very reduced population of Florida panthers may be suffering from the effects of inbreeding. All five males examined have had greater than 93% abnormal sperm (Roelke

1986). Over the long term, inbreeding also can limit the ability of a population to evolve to meet changing environmental conditions (Soule 1980, Harris et al. 1984).

In order to develop a conservation strategy that addresses the need to assure continued perpetuation of all currently existing wildlife populations within a large geographic area, minimum viable or minimum functional population considerations must be made. A minimum viable population is the lowest number of individuals that can assure the capability of the population to persist through time dealing successfully with agents of extinction (Shaffer 1981). Put in more specific terms, a minimum viable population can be defined as the smallest population that will give a 99% probability of surviving at least 1,000 years (Shaffer 1981). Too small a population is subject to extirpation due to the accumulation of detrimental genetic make-up through inbreeding (Ralls and Ballou 1983). It is well recognized that population extinction is inversely related to population size in its frequency of occurrence (MacArthur 1972, Diamond 1984). Genetic variability provides a basis for populations to adapt to a changing environment.

Minimum viable populations are dangerously close to extinction or extirpation and should not be considered as bottom line constraints in land-use decisions. If the intent of creating preserves is to prevent the extirpation of species from an area, then specific standards should be set to higher, ecologically functional levels rather than minimum viable levels.

It is important to note that the process of extirpation for longer-lived species may take several decades. Therefore, the impacts of some ineffective land-use decisions will not be realized for several generations.

Once the minimum viable population size is determined then the minimum area required to support that population can be calculated by extrapolating the home range size of the average individual. In landscapes with isolated wetland habitats, area requirements should be satisfied in large contiguous blocks. In flowing water wetlands that are situated between two larger habitat islands, area requirements may be satisfied merely by providing the appropriate link or wildlife corridor.

Many recent studies have examined methods of determining minimum viable population size (Shaffer 1981, LaCava and Hughes 1984, Samson et al. 1985, Reed et al. 1986, Cox et al. 1987). Because this is an evolving science, accurate and undisputable figures are not available for population sizes that will be able to remain genetically viable over time. Cox et al. (1987) stated that 40-50 gopher tortoises satisfied several conditions for population viability for at least several hundred years. LaCava and Hughes (1984) determined that a population of 46 northern goshawks was adequate to maintain genetic variability. Reed et al. (1986) calculated the minimum population of goshawks to be 122 plus the number of nonbreeders.

These authors also disagreed with the minimum number of elk that could remain genetically viable. The LaCava and Hughes (1984) estimate was 214 and Reed et al. (1986) concluded that twice as many individuals (426) were required.

The major variables in the population models used to calculate minimum viable population size include: the number of breeding males and females, the number of young born, the probability that a newborn survives to the mean age of reproduction, and the mean age of all males and females that reproduce. Wildlife species composition in east central Florida's significant wetlands vary tremendously with respect to these factors.

Reed et al. (1986) recommended an effective population size of more than 50 for short-term survival of species and 500 for long-term population and species survival. Franklin (1980) warned that populations as large as 300 individuals may be needed to provide for minimum levels of persistence for populations faced with consistently harsh conditions over 200 years. Land managers and planners should, of course, aim above the minimum levels whenever possible because the consequences of falling below are extreme and these population models have not been substantially validated.

Other literature has questioned the effectiveness of fragmented parks and preserves in maintaining viable populations of animals which require large ranges or activity areas (Pickett and Thompson 1978, Lovejoy and Oren 1981, Harris and Noss 1985, Harris 1984, Noss and Harris 1986). In Florida, black bears may range over 15,000 acres and bobcats over 5,000 acres. An otter may require several miles of linear river and riparian habitat (Harris 1985).

Application of the species-area relationship or island biogeography theory is useful in determining the minimum area needed to support viable or functional populations of species in these fragments (Diamond 1975, 1978). Rosenberg and Raphael (1986) found that highly isolated Douglas-fir forest stands (>50% insularity) should be at least 125 acres to preserve the full complement of associated vertebrate species. Harris and Wallace (1984) found that small (< 75 acres), mesic hardwood hammock islands in Florida supported only 53% of the bird species that normally breed in this habitat type.

The best strategy for isolated preserve design has been a topic of considerable debate during the past decade. Simberloff and Abele (1976) suggested that the species-area relationship does not imply that a large reserve is always the optimum conservation strategy. Pickett and Thompson (1978) introduced the concept of "minimal dynamic area" as the smallest area capable of maintaining all ecosystem components in the face of a natural disturbance. Kushlan (1979) has shown that shape and area were inadequate design criteria to predict wildlife diversity in Everglades National Park. Frankel and Soule (1981) and Cole (1981) refuted this concept and emphasized large preserves. Higgs (1981) took exception to this generality. Temple (1986) presented the core-area (the area of forest more than 100 m from an edge) model for recommending preserves. Seagle (1986) suggested that elements of both the area-per se and habitat-diversity hypotheses contribute to the development of species-area relationships through interaction between area and landscape dynamics. Soule and Simberloff (1986) have focused attention from the minimum-sized fragment that will contain a species to the area necessary to maintain minimum viable populations of species.

It is important to note that not only will some species not use small preserves, but there are no species that are restricted to small habitat patches. This is highly relevant to the design of wildlife preserves.

Issue 2. Wildlife Corridor Misconceptions

Wildlife corridors can be defined as bands or parcels of land which allow safe passage of wildlife between larger blocks of habitat. This contiguity effectively increases the size of protected lands and their ability to maintain viable wildlife populations. Genetic variation is maintained because genetic material is carried freely back and forth across the corridor and among large habitat blocks by dispersing wildlife. Scattered animals also can recolonize areas which have suffered from local extinctions (Fahrig and Merriam 1985).

MacClintock et al. (1977) provided evidence that forested corridors increased the number and diversity of breeding birds in smaller forests that were connected to larger habitat tracts. Wildlife populations in isolated blocks of forest have been shown to have lower growth rates than populations in forest blocks tied together by corridors (Fahrig and Merriam 1985). Harris (1984) suggested the use of riparian corridors to link isolated habitat islands. Kautz (1984) recommended preserving forested corridors approximately 100 meters wide. Noss (1987) stated that more research is needed to develop optimal connectivity strategies but active methodologies to prevent fragmentation must proceed quickly, with or without sufficient data. Brown et al. (1990) provided evidence to show that 550 foot wide corridors (buffers) on one side of a river would be sufficient space to maintain about 50 % of the species associated with swamp wetlands. Smaller buffers would give the same results in marsh systems and larger buffers are required in sandhills.

Although the term wildlife corridor is used in many DRI proposals and Comprehensive Plans, the concept behind the term is poorly understood. Planners and developers often refer to 10 foot wide green areas between houses as corridors and conservation areas. These narrow strips only provide food and cover requirements for species such as blue jays, cardinals, doves, and mockingbirds that are commonly found in developed areas. These token corridors support very few if any wildlife that are sensitive to development and in greater need of conservation efforts. In fact, these areas have been referred to as "ecological traps" because of the abnormally high predation and cowbird parasitism that occurs (Gates and Gysel 1978, Wilcove et al. 1986).

Forman (1983) has stated that width is the most important variable affecting corridor function. Stauffer (1978) found that bird species richness increased significantly with the width of wooded riparian habitat and half of the species were restricted to wider strips. Tassone (1981) reported similar results from a study of hardwood leave strips in large clear cut areas. Acadian flycatchers were only infrequently found in corridors less than 50 meters. Hairy and pileated woodpeckers required minimum strip widths of 50 and 60 meters respectively, while the northern parula required at least 80 meters. In a preliminary study, Smith (unpub.) found that the minimum width of forested riparian habitats for yellow-billed cuckoos, barred owls and acadian flycatchers in Gainesville, Florida was 180 feet. Prothonotary and hooded warblers were not recorded in any riparian habitats up to 450 feet wide, but were found in a nearby large state preserve, San Felasco Hammock.

The importance of stream and river-associated habitats as wildlife corridors has received much attention. However, to function effectively as an area through which animals will travel and gain access to larger connected habitat areas, the corridor must be of sufficient size and quality to provide essential requirements for animals to be attracted to it. Cursorial (non-flying) animals are especially unlikely to disperse across unsuitable terrain (Frankel and Soule 1981). Brown et al. (1990) presented a scientific basis for wildlife buffers (development set backs) of 322 to 732 feet for significant wetlands in east central Florida.

Issue 3. Decrease in Landscape Diversity

Most wildlife species utilize more than one habitat type to obtain their requirements. Decreases in landscape diversity have limited the amount of resources available for wildlife. Several authors have substantiated the close association and interaction of wildlife in wetland and adjacent upland communities. Fredrickson (1978) reported that various species more commonly associated with wetlands or uplands make seasonal or daily shifts into different habitat types to escape flooding, to forage, to disperse or to hibernate. Examples that he cited are: turkey river, otter, swamp rabbit, deer, bobcat, and gray fox. Other species such as raccoon, gray squirrel, tree frogs and many woodland bird species occur with similar frequency in both wetlands and uplands. Fredrickson also points out the paucity of specific data describing the relationship between remnant lowland area size and animal numbers and distribution.

Bottomland hardwoods are integrally coupled to the surrounding uplands (Wharton et al. 1982). Terrestrial lowland fauna may be coupled to the uplands, as when deer who base their home range in floodplains graze in uplands. Conversely, upland forms such as the black racer, slimy salamander and pine vole may use the floodplain at drydown. Although many species breed in both habitat types, their densities may differ considerably between adjacent areas. However, the lower density populations may serve as important recruitment sources. The narrow greenbelts of bottomland hardwoods also provide routes for migration and restocking.

Many semi-aquatic Florida turtles such as the mud turtle and snapping turtle loaf and feed in marshes and need sandy upland sites to lay eggs (Weller 1978). The river cooter is an example of another turtle which is largely confined to permanent water but must trek to adjacent uplands to deposit eggs (Patrick et al. 1981). Paul Moler (Herpetologist, Florida Game and Fresh Water Fish Commission, Gainesville, pers. comm.) said documented cases of Florida aquatic turtles laying eggs several hundred yards from a river is not uncommon. Weller (1978) also indicated a need for more information relating to the wetland-upland interface. He stated, "Upland areas often serve as buffers, nesting areas, or food resources for wetlands wildlife but their relative importance is undocumented."

The eastern indigo snake is classified as a wetland species but frequently occurs in dry, sandy areas (Kockman 1978). Speake et al. (1978) found that indigo snakes concentrated on the higher ridges of sandhill habitat during winter and moved down into stream bottom thickets in summer. Shelter provided by gopher tortoise burrows is critical to the survival of this snake while it is in upland areas. Peak mast production occurs at different times of the year in uplands and lowlands (Harris et al. 1979). Winter and spring is the fruiting season for most bottomland species while upland plants bear fruit in the summer and fall. Correspondingly, both upland and wetland nesting birds often concentrate in wetland areas during the non-nesting season (Wharton et al. 1981). Wild turkeys may be found in a variety of wet and dry habitats and normally depend on acorns as a staple food in Florida. But they also have been known to eat crawfish (Wild turkeys were recently reintroduced into the Rock Springs Run State Reserve on the Wekiva River). During the egg-laying season, female wood ducks eat a large percentage of invertebrates obtained from the wetland-upland transitional areas (Fredrickson 1979). Pileated woodpeckers nest and roost primarily in wet hardwoods and cypress habitats but forage in uplands (Hoyt 1957, Jackson 1978). Conner et al. (1975) did not find any pileated woodpecker nest trees farther than 150 meters from water in southwestern Virginia.

Landers et al. (1979) found that black bears also respond to seasonal differences in mast production. In North Carolina, they shift their food preferences from predominantly bottomland species in the winter and spring to predominantly upland fruits and nuts in summer and fall. Florida bears primarily inhabit "swamps" in the center of the state but are long distance travellers utilizing both wetlands and uplands (Williams 1978). They eat acorns, palmetto berries and the terminal bud ("swamp cabbage") of the Cabbage Palm.

Jennings (1951) observed that gray squirrels in the Gulf Hammock region of Levy County, Florida were dispersed through all habitats while food was plentiful in the fall. When red maple and elm began to bud and produce seed in mid-January, the squirrels began to concentrate in the hydric hammocks and swamps to utilize this food source. As upland foods became available in the spring and the lowland areas flooded, the squirrels moved to higher elevations.

Kantola (1986) found higher fox squirrel densities in ecotone or transitional areas than in upland areas on the Ordway Reserve in Putnam County, Florida. However, she also reported that home-range size and use within ecotones and uplands may vary with seasonal food abundance, reproductive activity and climate.

More than 33% of the 30 small vertebrates species caught by pit-fall traps in the floodplain of the Chattahoochee River in Georgia were classified as upland species (Wharton et al. 1981). Whereas only 14% of 21 small vertebrates sampled by the same method along the Alcovy River in Georgia received the same classification. This dissimilarity was attributed to vegetation structural differences in the floodplain.

Many researchers have been interested in the response of small mammals to flooding. Most studies concluded that floodplains were marginal habitats for these species. However, Batzli (1977) found that Illinois floodplain populations of the white-footed mouse were remarkably similar in density, adult survival and age structure to that in the adjacent upland areas. The exchange of individuals between these two communities consisted mainly of a few floodplain mice occasionally moving into the uplands. He suggested that mature trees with abundant holes and cavities may be necessary refuges for small mammal survival during flooding.

In a blackwater creek bottom in South Carolina's inner Coastal Plain, Gentry et al. (1968) found that the cotton mouse, short-tailed shrew and southeastern shrew were two, three and ten times respectively more abundant in the bottomland hardwood than in the adjacent uplands. Whereas, golden mouse specimens were collected only from the hardwoods.

Because wetlands often are the last land to be developed, some species normally considered upland wildlife are sometimes forced to adapt to wetlands that can supply their habitat needs (Schitoskey and Linder 1978). When upland requirements for animals are destroyed, they may concentrate in the nearby wetlands. Ozoga and Verme (1968) reported that deer mice, which are upland-dependent, were also found in the wetlands. White-tailed deer, an edge species, is known to adapt well the swamps and lowland areas (Verme 1961, Verme 1965, Sparrowe and Springer 1970). Weller and Spatcher (1965) found that upland bird species such as the meadowlark and mourning dove nested in unflooded portions of wetlands.

High densities of prey species also attract upland predators such as the skunk, raccoon and red fox. Bailey (1971) found that striped skunk densities were greater in wetlands than in uplands where cultivation and other development adversely affected upland feeding sites. This situation is suspected to cause an abnormally high skunk predation rate on waterfowl eggs. Another example is prairie raccoons feed in farmyards during early spring. However, as the growing season progresses, use of wetlands increases where relatively more foods are available than in the adjacent cultivated uplands.

Bobcats in the Welaka Reserve showed a preference for bottomland hardwoods (Progulske 1982). More than 20% of the 269 recorded locations of two radio-collared bobcats from July 1980 to December 1981 were in this type of overstory habitat. The other locations were spread among seven different upland habitat types.

Melquist and Hornocker (1983) found that although Idaho otters generally followed streambeds, they often took shortcuts across peninsulas formed by stream meanders. Overland travel of up to about 3 kilometers was recorded. Extensive crosscountry movements considerably reduced the distance an animal would normally have had to travel to reach the same destination by water. However, these movements also subjected the animals to highway hazards. Three of nine known mortalities were road-kills. In Great Britain, Chanin and Jefferies (1978) reported that in some areas dead otters were found repeatedly at the same location on roads over a number of years.

In a report that synthesized extant literature for Southeastern bottomland hardwood swamp habitats, Wharton et al. (1982) stated that bottomland animals do not occur in the same distinct zonal pattern as plants ranging from aquatic to upland ecosystems. Wetland inhabitants are opportunists, and many move freely into irregularly flooded or dry zones over the year. They also noted that some overlap among zones occurs, especially in the transitional areas characterized by periodic annual flooding and a duration of flooding during a portion of the growing season. Their examples of overlapping species that might occur along the Wekiva River are: the mole salamander, slimy salamander, narrowmouth toad, spadefoot toad, cricket frogs, chorus frogs, box turtle, five-lined skink, southeastern five-lined skink, brown snake, garter snake, ribbon snakes, rat snakes, kingsnake, southern black racer, coachwhip snake, barred owl, downy and red-bellied woodpeckers, cardinal, turkey, common yellowthroat, wood thrush, eastern wood peewee, white-breasted nuthatch, Swainson's warbler, carolina wren, yellow-throated vireo, cotton mouse, golden mouse, short-tailed, least and southeastern shrews, woodrat, marsh rabbit, pine vole, and eastern mole.

The use of various bottomland hardwood ecological zones by wildlife differs by species, season and flooding regime (Larson 1981). Some are site specific during the breeding period while at other times may use a broad range of ecological zones. Larson also referred to many of the species examples use by Wharton et al. (1981).

Many studies have documented wetland wildlife species use of adjacent uplands. Removal or alteration of this important habitat type could destroy critical requirements for many species and thus render the riverine system no longer inhabitable for them.

Issue 4. Reduction in Habitat Quality

Food, cover, and water are life-sustaining elements for all wildlife species. If every requirement for an animal is available in a particular area, the area is considered to be good quality habitat for that species; if one or more of a species' requirements is not available, the area is not suitable.

Some habitats are more suitable (of greater quality) than others and produce greater densities of wildlife than those of poorer quality. Much of the variability observed in numbers of species and numbers of individuals between populations in similar or different habitat types results from differences in available food, cover, water, and other requirements (Black and Thomas 1978). Habitats with a high suitability (abundant food, cover, and water resources readily available) have a greater potential to support more individuals per area. The number of individuals within a population for which a particular area is able to supply all energetic and physiological requirements over a long period, barring no major perturbations, is called carrying capacity (Smith 1974). Numbers of species and numbers of individuals within species often fluctuate due to a variety of causes including diseases, catastrophic events, predation, and competition. However, the carrying capacity potential of an area remains relatively unchanged. Therefore, the extent of a buffer required to perpetuate populations is highly dependent on the long-term quality of the habitat in question.

By far, the most common cause of wildlife population reduction is natural landscape alteration through agriculture, silviculture, or construction activities. Altering or changing natural conditions to which species are adapted often harms native wildlife communities by destroying key elements that make a habitat suitable. An obvious example is the removal of snags (dead trees) that provide essential nesting structures, food sources, and perches for many birds, mammals, reptiles, and amphibians. A common misconception is that no harm is done because there are plenty of other undeveloped areas containing the same requirements. On the contrary, other areas that have the necessary elements for a particular species are probably already occupied at a saturation level, leaving no room for individuals that are ousted by development occurring elsewhere. Therefore, the most effective method of protecting wetland wildlife resources would be to preserve areas in their most natural conditions.

Timber harvesting stops natural succession of aging forests. This results in forest landscapes dominated by relatively young, even-aged stands. These young forests lack the structural and functional diversity of older forests. These managed forest landscapes may be ecologically inadequate to ensure long-term forest productivity (Maser and Trappe 1984, Spies and Franklin 1988) and the perpetuation of the full array of wildlife populations (Norse et al. 1986). Many species of wildlife including flying squirrels, several species of bats, pileated woodpecker, red-cockaded woodpecker, a variety of cavity-nesting birds, and several species of amphibians are dependent on old, mature forests. Exctinction of the ivory-billed woodpecker (*Campehilus principais*) in the United States and the endangered status of the red-cockaded woodpecker are associated with the loss of old forests (Thomas et al. 1988). Forests in the Econ Basin should be allowed to mature naturally so they can maintain some semblance of natural biotic diversity and ecosystem function.

A few studies have shown how habitat quality is diminished through development. The only known investigation of urban birds in the southeastern United States was conducted in Pinellas County residential suburbs (Woolfenden and Rohwer 1969). They found that many native species were replaced by exotics when natural areas were developed and breeding pair densities increased with the maturing of the planted vegetation. Similar results were reached by Tweit and Tweit (1986) in Tucson, Arizona and Vale and Vale (1976) near Oakland, California. Some authors have reported that insectivorous birds declined, and omnivorous and grainivorous species increased as residential suburbs were built into naturally forested landscapes (Beissinger and Osborne 1982, DeGraaf and Wentworth 1981). DeGraaf

(1986) and (1987) also noted that insectivorous birds were more prevalent near urban woodlots in Massachusetts. Beissinger and Osborne (1982), Goldstein et al. (1986), and DeGraaf and Wentworth (1986) described relationships between vegetation volume in residential areas and bird species richness, and recommended extensive landscaping with native plants and retaining sizeable natural forest patches. Goldstein et al. (1983) examined some of the trade-offs among wildlife, visual and recreational amenities associated with different arrangements of a given amount of greenspace and encouraged preserving large forested clumps instead of thin borders.

There are no accurate and easily applied methods to specifically quantify habitat quality. However, the following qualitative classifications can be used when assessing site values for wildlife.

1) High Quality: If an area is still in a relatively natural state, and large enough to provide requirements for at least one pair of most species associated with the habitat type occupying the area, it is suitable for those species.
2) Medium Quality: If an area has been cleared for agricultural or silvicultural purposes but no permanent structures such as roads and buildings have been constructed, it still has some current wildlife value and a potential for increased future wildlife habitat values. Because these areas can be converted easily back into native habitat, they should not be excluded from any buffer areas.
3) Low Quality: If an area has been cleared and developed with roads, buildings, and other permanent structures, its suitability for wildlife dependent on the original natural habitat type would be minimal.

Issue 5. Impacts of Adjacent Land Use

The question of how large a habitat area must be to maintain biological integrity cannot be answered without considering the impacts of land uses adjacent to the preserve. The negative effects of induced edge on species have been reported by Faaborg (1980), Samson (1980), Noss (1981, 1983), Samson and Knopf (1982), Harris (1984), and Noss and Harris (1986). The type of habitat on the outside of a forest edge determines the nature of edge effects. A general principle is that the greater the contrast between habitat types, the greater the edge effect (Harris 1984). Modified areas surrounding a forest fragment are usually altered into earlier successional stages. These types of habitats are then attractive to pioneering species that invade several hundred meters into the adjacent forest fragment and alter species composition and relative abundances.

The negative impacts of induced (man-made) edges in a forested system and of the noise and domestic animal problems associated with development adjacent to natural habitat areas have been reported by Brown et al. (1990). Some of the major points will be highlighted here.

Whitcome et al. (1976) provided evidence that, in areas along forest edges avian brood parasites (brown-headed cowbirds), nest predators (small mammals, grackles, jays, and crows), and non-native nest hole competitors (e.g. starlings) are usually abundant. Gates and Gysel (1978) found that a field-forest edge attracts a variety of open-nesting birds, but such an edge functions as an "ecological trap." Birds nesting near the edge had smaller clutches and were more subject to higher rates of predation and cowbird parasitism than those nesting in either adjoining habitats. This abnormally high predation rate is related to the artificially high densities of many opportunistic animals near forest edges and in disturbed habitats including suburbs; (Wilcove et al. 1986).

The cowbird problem is a relatively new but very real dilemma in east central Florida. This bird feeds in open areas and lays its eggs in other species' nest found along forest edges. Many birds cannot distinguish this foreign egg from their own and devote all of their energy to raising the young cowbirds. The eggs of the host species are either removed by the adult cowbird or are pushed out of the nest by the more aggressive cowbird nestling. Several species such as the Kirtland's warbler have been seriously affected by nest parasitism, and now the extinction of the Bachman's warbler is expected due to this alien source of mortality. The Florida Breeding Bird Atlas surveys in east central Florida have revealed an increased presence of the cowbird as the naturally forested landscape is cleared and more open habitat is provided for this species.

Any forest tract has a "core area" that is relatively immune to deleterious edge effects and is always far smaller than the total area of the forest (Temple 1986). Relatively round forest tracts with small edge-to-interior ratios would thus be more secure, whereas thin, elongated forests (such as those along unbuffered riparian strips) may have very little or no core area and would be highly vulnerable to negative edge effects.

Predation and harassment of wildlife by free-ranging domestic cats and dogs are other detrimental effects of development adjacent to significant wildlife habitat areas. Several authors have documented the occurrence to wildlife prey in the diets of free-ranging cats and dogs and the effects of their predatory behavior on individual wildlife animals and populations (Errington 1936, Korschgen 1957, Smith 1966, Gilbert 1971, Jackson 1971, Gill 1975). Cats can be especially devastating on local wildlife populations. Hunting is a feline instinct, and predation rates are not related to hunger (Davis 1957, Holling 1966, Holling and Buckingham 1976). Bradt (1949) reported that a single cat, who regularly consumed domestic food, killed over 1,600 mammals and 60 birds in Michigan during an 18-month period. Local extinctions of the Anastasia beach mouse along Florida's coast (Stephen R. Humphery, pers. comm. 1989); a dove on a south Pacific island (Jehl and Parkes 1983); and diving petrels, broad-billed prions, yellow-crowned parakeet, robin, fern-bird, brown creeper, Stewart Island snipe and banded rail in New Zealand (Fitzgerald and Veitch 1985) have been attributed to cat predation. Churcher and Lawton (1989) concluded from their study that domestic cats kill at least twenty million birds a year in Britain.

Cats and dogs can be especially devastating on ground feeding and ground breeding species. These guilds represent the majority of semi-aquatic and wetland-dependent wildlife species in east central Florida (Brown et al. 1990).

Sound is a physical phenomenon and defined as an oscillation in pressure of a medium measured in decibels (dB); (American National Standards Institute 1971). Sometimes, sound is noise which is defined as unwanted or undesirable sound (U.S. Environmental Protection Agency 1978). This annoyance factor of sound negatively impacts all hearing animals. Along with air and water contaminants, noise has been recognized as a serious pollutant.

The physiological impacts of noise on people is well documented. Short-term exposure to very high sound levels (120 to 130 dB) and long-term exposure to lower levels (80 dB) can cause temporary or permanent changes in human ability to hear (Carelstam 1972), and increased blood pressure, elevated rates of heartbeat and respiration, muscle tension, hormone release, cardiovascular disorders and increased susceptibility to disease (Alexandre and Barde 1981). Long-term exposure above 55 dB interferes with activity and causes annoyance for people in outdoor settings (U.S. Environmental Protection Agency 1974). However, the physiological and behavioral impacts on wildlife are little known.

Noise associated with construction, operation, and maintenance of developments can cause harmful impacts on wildlife. Animals that rely on their hearing for courtship and mating behavior, prey location, predator detection, homing, etc., will be more threatened by increased noise than will species that use other sensory modalities. However, due to the complex interrelationships that exist among all the organisms in an ecosystem, direct interference with one species will indirectly affect many others.

Unfortunately, few data are available that demonstrate the specific effects of noise on wildlife . Much of what is found in the literature lacks specific information concerning sound intensity, spectrum, and duration of exposure. There have been no systematic studies with experimental designs that show definite relationships between specific noise disturbances for various species and different sound levels. Brandt and Brown (1988) conducted an extensive literature search on this topic and found that most of our current knowledge of sound impacts on wildlife are based on observations of animal reactions to aircraft overflights and laboratory studies. Because such little research emphasis has been given to this topic, it is not surprising that results are inconclusive and sometimes contradictory.

While general understanding and consequences of noise impacts on wildlife are not very specific, a few conclusions are obvious. Short-term exposure to loud sounds can cause physiological changes in animals as it does in humans. Chronic lower level sounds (55 dB) are annoying to humans and also probably make an area relatively less desireable to wildlife. Some, but not all, species can adapt to some sounds. Human activity also disturbs wildlife and can have similar effects such as nest abandonment. Noise and human activity will negatively impact semi-aquatic and wetland-dependent wildlife from the landward side as well as the water side if the water is used for recreational purposes.

Edge effects have been shown to negatively impact wildlife species within at least 300 feet of forest boundaries. Studies of nature reserve boundaries have provided data that support the need for buffer zones of decreasing use outside reserve boundary (Unesco 1974, Dasmann 1988, Schonewald-Cox 1988). The core of these areas must be protected from cats, dogs, human activities, noise, predators, exotic competitors, parasitism and other detrimental effects of development.

Issue 6. Impacts of Public Recreation

Assessing direct impacts of human recreational activities on wildlife is a newly evolving science. Boyle and Samson (1985) summarized 106 recreational impact studies and reported that 73% of these concluded nonconsumptive activities negatively affected bird communities. Hiking and camping affect wildlife through trampling of habitat (Liddle 1975), disturbance of animals (Ward et al. 1973, Aune 1981) and less directly through discarded food or other items (Foin et al. 1977). Klein (1989) documented effects of visitor use on avian species at Ding Darling Refuge, Florida. A majority of the species that she classified as most sensitive to humans (reacted negatively to human presence) occur in the Econlockhatchee Basin. These include: pied-billed grebe, white ibis, willet, sanderling, dunlin, and blue-winged teal. The average minimum distance from humans tolerated by these species was 260 feet.

Human disturbance of waterbird colonies has been shown to cause nest losses through predation (Schreiber and Risebrough 1972, Hand 1980, Anderson and Kieth 1980) and nest abandonment (Hunt 1972, Ellison and Cleary 1978). Some duck species and the great crested grebe did not winter in one reservoir since it was opened to sailboats, even though these species were observed elsewhere in the vicinity (Batten 1977). Rodgers and Burger (1981) reported that human activities in waterbird colonies may delay nesting for some pairs, eliminate late-nesting pairs, or cause late-nesting pairs to shift to other less suitable nesting sites. Tremblay and Ellison (1979) reported that visits to black-crowned night heron colonies just before or during laying provoked abandonment of newly constructed nests and either predation of eggs or abandonment of eggs followed by predation. This study also concluded that herons did not nest in areas where human interference occurred. Ellison and Cleary (1978) found similar results with double-crested cormorants. Wintering eagles were more disturbed by infrequent activities than by regular activities (Stalmaster and Newman 1978). Landin (1978) recommended protecting all wading bird nesting areas from human activities during the nesting season.

Effects of boating and swimming have been reported primarily for birds. In a comprehensive review, Liddle and Scorgie (1980) noted that wildlife is affected through sight and sound of recreationists, pollution from boats and recreational facilities, and habitat changes caused by vegetation control practices and facility construction. Beach and shore recreationists can disrupt shorebird breeding (Norman and Saunders 1969) or force birds into less preferred habitats (Erwin 1980).

Lynch and Whitcomb (1978) reported that existing urban and suburban parks in the Washington, D.C. area have failed as avifaunal preserves. From 1950 to 1970, many specialized, fragment-sensitive species were extirpated locally and replaced by generalized permanent residents. They attributed this unnatural change to inadequate size of parks, isolation from sources of potential colonists, and increasing levels of disturbances related to human activities (trampling of understory vegetation, repeated disturbance of nesting and feeding birds, predation by cats and dogs, competition for food and nest sites with native and introduced common species that invade forest patches, increased levels of brood-parasitism by the brown-headed cowbird, and increased levels of pollution by noise, light, and toxic chemicals).

Issue 7. Impacts of Cattle Grazing and Related Activities

It is difficult to determine specific impacts of cattle grazing that may occur on ecosystems and wildlife within the Econ Basin. These impacts, positive or negative, would depend on several variables such as the number and density of cattle, type of ecosystem, the current condition of the vegetation, the amount of vegetation or forage available, the time of year, the grazing schedule, the size of the area, surrounding land use, and the species of wildlife present also affect the impact of cattle in a given area. Data found through our literature search suggest that if grazing is controlled at some level, it can be compatible with wildlife conservation efforts. The impacts of several activities associated with grazing such as creating and maintaining improved pastures also will be addressed in this section.

Most grazing/wildlife studies have focused on the competition of wildlife and cattle for food resources in western rangelands. Landowner interest in managing game species as a valued commodity has stimulated some research on the compatibility of cattle grazing and game management. Several studies have concluded that grazing must be controlled to effectively manage for game species. Elk preferred spring feeding sites in Montana that were **moderately** grazed previously by cattle (Grover and Thompson 1986). However, Knowles and Campbell (1982) indicated that the availability of forested cover vegetation also is an important factor for elk selection of an open feeding area. Proper livestock grazing has been shown to maintain or improve habitat for mule deer (Austin and Urness 1986). Contrarily, Compton (1986) found that white-tailed deer avoided areas with cattle in eastern Montana.

Mearns quail food supply on an Arizona Ranch was not reduced but the elimination of escape cover and nesting grass by cattle was detrimental, especially to breeding populations (Brown 1982). Murray (1958) reported that overgrazing diminished the food supply and reduced escape cover in bobwhite habitat. Jackson (1969) also found overgrazing reduced the concealment value of escape cover. Klimstra and Scott (1957) found little or no use by nesting bobwhites where heavy grazing occurred. Johnsgard (1973) noted that bobwhites existed in large numbers in western and southern Texas wherever excessive grazing did not occur. Overgrazing also limited woodcock numbers in Oklahoma (Lambert 1980).

Most of these game species are open-canopied, early successional species. Game species comprise less than 10% of Florida's terrestrial wildlife and it is our opinion that they are not good indicators of cattle grazing impacts on obligate forest species.

There also are some studies that provide evidence of grazing practices benefit nongame wildlife. Grazing was found to improve habitat for long-billed curlews in Idaho (Bicak et al. 1982). This is not unexpected because many birds in the sandpiper family prefer open areas with very little vegetation for nesting (Harrison 1975). However, total numbers of terrestrial nongame birds were significantly greater on ungrazed than on grazed bottomland areas in Colorado (Crouch 1982).

Significant differences also were found in small mammal communities between grazed and ungrazed sites in both riparian and nonriparian habitats in Idaho (Johnson 1982). However, few differences between pastures in small mammal communities were evident prior to grazing, one month following grazing, and no differences in numbers or distribution of small mammals were observed five months following grazing levels **recommended by SCS** in Colorado (Samson et al. 1988). Consistent differences also were not found in abundance, diversity, and microhabitat of small mammals between an ungrazed and a **deferred-rotational grazed** areas in Nevada (Oldemeyer and Allen-Johnson 1988).

Platt (1985) reported that snakes and lizards were much more abundant and diverse in a natural sand prairie than in a pasture in central Kansas.

Trampling and grazing also have been found to be detrimental to the recovery of listed plants such as Mesa Verde Cactus (Benson 1984) and Gypsum wild buckwheat (U.S. Fish and Wildlife Service 1984).

Among four treatments tested at the University of Florida, intensive grazing for about two weeks followed by four months of rest reduced roughage and stimulated desireable plant growth the best (Moore and Terry 1979). Such a grazing system requires a minimum of nine pastures and three years to complete the grazing cycle.

After a review of the literature, May and Davis (1982) concluded there is little question that overgrazing and excessive livestock use of streamside areas can exert negative imfluences on stream ecosystems. They added that these influences can be minimized with proper planning and controlled livestock use.

Trout stream habitat was detrimentally influenced by livestock grazing in Montana (Hitchcock 1988).

Many amphibians prefer ponds with emergent vegetation (Delzell 1958, Collins 1975, Conant 1975, Fellers 1979, Collins 1982). It is our opinion that removal of emergent vegetation by grazing will reduce the suitability of wetlands for these species.

Bue et al. (1952) found that grazing intensity was inversely related to pairs of breeding waterfowl and use of shorelines by broods in South Dakota isolated ponds. These authors recommended a stocking rate of 27 acres per cow per year and fencing out a portion of the pond shorelines. Rees (1982) reported that grazing had both positive and negative impacts on different waterfowl species in Washington.

Snyder (1978) observed that during the winter heavily grazed river bottoms did not provide adequate cover for bobwhites.

Holder et al. (1980) recommended an upper density of one animal unit per 2.5 hectares to maintain preferred dusky seaside sparrow habitat in cordgrass marshes.

Wildlife species diversity is strongly influenced by vegetation composition and structural heterogeneity or diversity within a habitat type (MacArthur et al. 1962, MacArthur 1964, Weller 1978). This type of heterogeneity is a function of foliage height and cover diversity. The vertical and horizontal stratification of plants within a forest habitat is positively correlated with the variety of species that reside in that ecosystem. Therefore, it is our opinion that alteration of ground vegetation caused by grazing impacts species that feed or nest at this level. Mosconi and Hutto (1982) reported significant differences in bird species composition and density between heavily-grazed and lightly-grazed riparian plots in Montana. Brown et al. (1990) showed that more wildlife species are dependent on the ground layer than any of the other vertical strata in most east central Florida vegetation communities.

If a forested area is cleared of all woody vegetation and replaced by a completely different monoculture ecosystem of only ground vegetation, it is logical to assume that this area will no longer be suitable for wildlife species dependent on a forested environment. In fact, studies have demonstrated that wildlife species composition is different between various communities that have dissimilar characteristic plant species (Robertson 1955, Rohwer and Woolfenden 1969, Hirth and Marion 1979, Cutright 1981).

Therefore, removal of the woody vegetation would be detrimental to species that are associated with the upper canopy, and beneficial to those that are adapted to a more open, low vegetation community. Brown et al. (1990) reported that more than 50% of wildlife species in most east central Florida forested vegetation communities are dependent on trees for feeding or nesting. Because of differences in microclimates and other habitat variables, species composition of ground feeding or nesting guilds in forested and open vegetation communities are dissimilar. Ground species that use both habitats also may show a preference. For example, Gopher tortoise densities in improved pastures in Florida were estimated to be only 2.59/acre compared to 5.26/acre in a scrubby flatwoods (Cox et al. 1987).

No data were found that compare wildlife use between improved pastures and native prairies without overstory canopies. However, it is our opinion that the greater vegetation diversity in the native prairies would harbor a greater diversity of wildlife.

Ditching and lowering of the water table eliminates or at least reduces the amount of water in sloughs and isolated wetlands that may contain water only during periods of high rainfall. These temporary wetlands are important for many wildlife species. Some amphibians such as the oak toad, chorus frog, little grass frog, pinewoods treefrog, squirrel treefrog, eastern narrowmouth toad, and eastern spadefoot toad breed almost exclusively in temporary wetlands that do not contain predatory fish (Heyer et al. 1975, Woodward 1983, Morin 1983, Caldwell 1987, Moler and Franz 1987).

The endangered wood stork and other wading birds depend on a variety of water feeding areas to maintain feeding efficiency during different hydrologic regimes (Frederick and Collopy 1988). Ogden and Nesbitt (1979) attributed shifts of stork rookery sites in central and north Florida from cypress swamps to impoundments and mangrove islands, to unfavorable drainage practices. Some wading bird foraging may be ineffective in anything but very shallow water (Jenni 1969, Kushlan 1976). For example, Kushlan (1974) found that white ibises avoided water deeper than 10 cm when foraging; though they are tall enough to wade in water 16 to 25 cm deep (Kushlan 1974, Powell 1987). Frederick and Collopy (1988) stated that at least part of the 95% reduction in wading bird numbers in the Everglades is attributed to the conversion of seasonal wetlands into drained agricultural land.

Many waterbirds use different types of wetlands for mating and for rearing young. Individual mallard hens used more than 20 different wetlands during the nesting season in the prairie pothole region (Dwyer et al. 1979). Lowering the water table would reduce the number of wetlands and, therefore, reduce the carrying capacity of the area for wildlife.

Chabreck (1968) reported that marsh drainage to improve cattle range negatively effects most marsh wildlife.

Issue 8. Impacts of Silviculture

Alteration or manipulation of vegetation in any area will impact wildlife species living there. Some animals will benefit by these changes and others will lose life sustaining requirements. Removing trees will enhance the landscape for wildlife that prefer early succession, open habitats. Such areas will become unsuitable for species that depend on mature trees for food and cover.

During a 15 year study of wildlife responses to even-aged silvicultural practices in Alabama, potential food availability was highest for deer, turkey and quail during years 3 and 4 of the study (Johnson 1986). Use generally increased for deer, however, their overall physical condition decreased following crown closure. Use decreased for quail, squirrels, raccoons and opossums while turkey and rabbit usage was generally stable. No data was collected on other species.

Bird and small mammal abundance and diversity was greater in a mature longleaf pine stand than in nine-year-old slash pine plantations Harris et al. (1975).

Of 55 amphibian, reptile and mammal species observed in Douglas-fir forests in northwestern California, nine species were strongly associated with older stands and 11 species were strongly associated with younger stands (Raphael 1988). Assuming that current forestry practices would continue, the overall estimated trend is for increased abundance among species associated with open, drier habitats, and decreased abundance among species associated with moist, old-age coniferous forests. Most of the *increasers* are widespread species with large distributions. In contrast, the decreasers are almost all species with rather restricted total ranges, most of which are in threatened habitats.

Following harvest in flatwoods stands in north Florida, bird use shifted from being evenly dispersed to concentrating in cypress domes and edges of stands (Marion and O'Meara 1982). Amphibian and reptiles abundance post harvest was only half of that recorded in pre-harvest areas.

Even selective logging can alter wildlife species composition. Red-tailed hawks were able to displace red-shouldered hawks from mature forests with crown closure < 79% (Bryant 1986).

Clearcutting in mixed oak stands in Virginia initially reduced breeding bird species diversity and abundance (Conner and Adkisson 1975). This management practice also altered species composition.

Although clearcutting in north Florida flatwoods did not affect amphibian species richness, reptile richness was lower in the maximum-treatment clearcut, amphibian abundance was reduced, reptile abundance was reduced, and species composition was altered (Enge and Marion 1986).

Reported average ages of cavity trees for the endangered red-cockaded woodpecker range from 63-176 years for longleaf pine and 70-76 years for slash pine (U.S. Fish and Wildlife Service 1985).

DESCRIPTION OF RESOURCE CHARACTERISTICS

Characteristics of Wildlife in East Central Florida and the St. Johns Basin

A great diversity of wildlife occupy the various habitats found in east central Florida. Many of these areas are unique and jeopardized by growth and development in this section of the state. More than 30 natural communities have been identified by the Florida Natural Areas Inventory as threatened or endangered in the state. Although most of the listed ecosystems are wetlands, nearly half (13) are uplands. A large part of the uplands (five) are xeric scrub communities which occur only on the excessively drained, sandy soils which are largely associated with ancient dune lines.

The Econlockhatchee River Basin is relatively flat. Ground elevations range from about 5 feet near the confluence with the St. Johns River to about 70 feet in the headwater marshes in Osceola County and several scrub patches of about 80 feet west of the river.

The predominant landscape association in the area is flatwoods with swamps and hydric hammocks following river and streams channels and isolated wetlands interspersed throughout. Ground elevation increases from East to West. In the Econ Basin area, there are several small patches of scrub habitat. This high landscape diversity provides many different feeding and nesting resources for a variety of wildlife.

Longitudinally, Central Florida also is a transitional area where ranges of tropical and temperate species overlap. Many large lakes such as Jessup, Harney, and Monroe provide large areas of open water habitat.

Characteristics of Wildlife in the Econ River Basin

Habitats can be characterized by a dominant plant form or some physical characteristic (Ricklefs 1973). Each species requires a particular habitat or a combination of habitat types (ecological communities) to supply the space, food, cover, and other requirements for survival. Thus wildlife species are products of their habitats.

To properly assess the value of wetland buffers or any other conservation/management scheme, it is important to understand the wildlife communities that may be potentially benefitted or adversely impacted by any activities that will alter the natural landscape.

The first step in this method involved developing wildlife species lists (Appendix C, Tables C.1 - C.5) based on checklists published by the Florida Game and Fresh Water Fish Commission; the Florida Breeding Bird Atlas surveys; the Rare and Endangered Biota of Florida series; several other references; and personal knowledge. All native, vertebrate species known to breed in the Econ River Basin are listed by taxonomic class. Migrant species that are found in this area during non-breeding seasons are not included.

Of the 706 non-fish, vertebrate, native species identified by the Florida Game and Fresh Water Fish Commission to occur in the state, 214 (30%) are assumed to be present in the Econ Basin (Table 3.1 and Appendix C, Tables C.2 - C.5). The largest taxonomic class was birds and the smallest was mammals. The distribution of these species among the three Counties (Seminole, Orange, and Osceola) is fairly even.

The next step was to determine which habitat types were utilized by these species. We used many references as well as personal knowledge to compile this listing. Although all vegetation communities support large numbers of wildlife, flatwoods and hardwood hammocks have the greatest species richness (Table 3.1 and Appendix C, Tables C.6 - C.9).

Some species occur almost exclusively in only wetlands or in uplands (Table 3.2). More than 50% of the species found in the Econ Basin use both wetlands and uplands in order to satisfy their life sustaining requirements.

The range of wildlife species and their susceptibility to extinction are important criteria to consider for the development of an effective protection plan. As a result of the diverse landscape in this system, 27 non-fish species and subspecies occur here but not outside of the state (Muller et al. 1989; Tables 3.3 and 3.4). These species are endemic to the state of Florida. The number of endemics is evenly distributed across habitats.

The Nongame Section of the Florida Game and Fresh Water Fish Commission recently completed a two year project of ranking species according to biological vulnerability, extent of current knowledge of population status, and management needs. The result of this effort was a list of wildlife most in need of conservation attention in Florida (Millsap et al. 1990). According to this ranking system, 21 species are in danger of becoming extinct (imperiled; Table 3.3 and 3.5). Using this method, the most important or vulnerable habitats are xeric scrub and flatwoods.

Of all the species that occur in the basin, 21 are listed by either the U.S. Fish and Wildlife Service or the Florida Game and Fresh Water Fish Commission as endangered, threatened or special concern species (Tables 3.3 and 3.6). Flatwoods contain the largest number of listed species.

Of the 21 listed species, 52 occurrences of 8 species (not counting reports of wading bird colonies) in and near the basin have been documented (Map 3.1). Distribution patterns of this conservative data base include several bald eagle nests along the shorelines of Lakes Jessup and Harney and also along the St. Johns River. Several scrub species have been documented on the campus of the University of Central Florida and on both the north and south sides of Route 528.

Each major habitat in this basin has more than two dozen species with special ecological or legal status (endemic, imperiled, or listed; Table 3.7). More than 1/5 of all species in the Basin are either unique to Florida or are in jeopardy of becoming extinct. The greatest percentage was found in the group of species that use ephemeral wetlands.

To better understand how these communities function ecologically, feeding and breeding zones (guilds) were determined for each habitat type. The guilding technique for describing and evaluating impacts on wildlife communities was first proposed by Root (1967). He defined a guild as a group of

Table 3.1 Number of wildlife species associated with various habitats that occur within the Econ Basin.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	Totals
Xeric Scrub	9	33	45	24	**111**
Flatwoods	14	39	79	26	**158**
Hardwood Hammock	15	40	71	25	**151**
Cypress Swamp	23	27	49	20	**119**
Swamp Hardwoods	23	31	52	20	**126**
Freshwater Marsh and River	17	21	41	16	**95**
Ephemeral Wetland[1]	19	-	13	-	**32**
Totals	**26**	**50**	**104**	**34**	**214**
	(12%)	(23%)	(49%)	(16%)	(100%)

[1] Only species that are dependent on ephemeral are included in this category.

Table 3.2 Number of wildlife species that occur almost exclusively in wetlands, that occur in both wetlands and uplands, and that occur almost exclusively in upland habitats within the Econlockhatchee River Basin. Wildlife use of the various wetland and upland habitats are shown in Appendix C, Tables C.6. - Table C.9.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	**Totals**
Wetlands	7	4	20	4	35 (16%)
Wetland and Uplands	19	30	51	19	119 (57%)
Uplands	0	16	33	11	60 (27%)
Totals	**26**	**50**	**104**	**34**	**214** (100%)

Table 3.3 Wildlife of the Econlockhatchee River Basin that have important ecological and legal status.

	Ecological Status		
Species	Endemic[1]	Imperiled[2]	State/Fed. Status[3]
Fish			
Seminole Killifish	1		
Flagfish	1		
Amphibians			
Florida Cricket Frog	4		
Florida Chorus Frog	3		
Florida Gopher Frog		3	SSC/NL
Striped Newt	2	2	
Peninsula Newt	3		
Narrow-striped Dwarf Siren	3		
Reptiles			
American Alligator			SSC/T
Florida Snapping Turtle	4		
Florida Chicken Turtle	3		
Peninsula Cooter	3		
Florida Redbelly Turtle	2		
Florida Box Turtle	4		
Striped Mud Turtle	4		
Florida Mud Turtle	3		
Gopher Tortoise		3	SSC/NL
Florida Worm Lizard	1		
Peninsula Mole Skink	3	3	
Florida Scarlet Snake	3		
Eastern Indigo Snake		3	T/T
Florida Water Snake	4		
Rough Green Snake	3		
Florida Pine Snake		3	SSC/NL
South Florida Swamp Snake	3		
Short-tailed Snake	1	2	T/NL
Central Florida Crowned Snake	3	2	
Eastern Diamondback Rattlesnake		3	
Birds			
Little Blue Heron			SSC/NL
Snowy Egret			SSC/NL
Tricolored Heron			SSC/NL
Wood Stork			E/E
Short-tailed Hawk		1	
American Swallow-tailed Kite		2	
Southern Bald Eagle		3	T/E

Table 3.3 continued.

	Ecological Status		
Species	Endemic[1]	Imperiled[2]	State/Fed. Status[3]
Birds (continued)			
Florida Everglade Kite	4	1	E/E
Southeastern American Kestrel			T/NL
Crested Caracara		1	T/T
Limpkin			SSC/NL
Sandhill Crane	4	1	T/NL
Burrowing Owl		3	SSC/NL
Red-cockaded Woodpecker		2	T/E
Florida Scrub Jay	3	2	T/T
Mammals			
Sherman's Fox Squirrel	3	3	SSC/NL
Round-tailed Muskrat	2		
Florida Mouse	1		SSC/NL
River Otter		3	
Long-tailed Weasel	3		

[1] Endemic:
1 = species' entire distribution occurs entirely within the state of Florida.
2 = species is nearly endemic
3 = Florida subspecies of this species is endemic
4 = Florida subspecies of this species is nearly endemic

[2] Imperiled refers to the vulnerability of a species to extirpation as determined by a ranking system developed and used by the Florida Game and Fresh Water Fish Commission to assess the ecological status of 668 native vertebrate species in the state (Millsap et al. 1990).
1 = highest vulnerability indicated by a biological score $\geq$ median score for Endangered Species
2 = higher vulnerability indicated by a biological score $\geq$ median score for Threatened Species
3 = high vulnerability indicated by a biological score $\geq$ median score for Species of Special Concern

[3] State (Florida Game and Fresh Water Fish Commission)/Federal (U.S. Fish and Wildlife Service) legal status:
SSC = Species of Special Concern
T = Threatened Species
E = Endangered Species
NL = Not Listed

Table 3.4 Number of **Endemic** species and subspecies[1] associated with various habitats within the Econlockhatchee River Basin.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	Totals
Xeric Scrub	1	12	2	3	18
Flatwoods	1	12	1	3	17
Hardwood Hammock	2	12	-	1	15
Cypress Swamp	5	10	-	1	16
Swamp Hardwoods	4	10	-	1	15
Freshwater Marsh and River	3	9	2	1	15
Ephemeral Wetland	5	-	-	-	5
Totals	**5**	**15**	**3**	**4**	**27**

1 Endemic species and subspecies have distributions that occur entirely or almost entirely within the state of Florida.

Table 3.5 Number of **Imperiled** species[1] associated with various habitats within the Econlockhatchee River Basin.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	Totals
Xeric Scrub	2	7	6	1	16
Flatwoods	1	6	7	2	16
Hardwood Hammock	-	5	4	1	10
Cypress Swamp	2	1	3	2	8
Swamp Hardwoods	-	1	3	1	5
Freshwater Marsh and River	-	-	4	1	5
Ephemeral Wetland	2	-	-	-	2
Totals	**2**	**7**	**9**	**2**	**20**

1 Imperiled species are vulnerable to extirpation as determined by a ranking system developed and used by the Florida Game and Fresh Water Fish Commission to assess the ecological status of 668 native vertebrate species in the state (Millsap et al. 1990).

Table 3.6 Number of State and Federally **Listed** species[1] associated with various habitats within the Econlockhatchee River Basin.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	Totals
Xeric Scrub	1	4	6	2	13
Flatwoods	1	4	10	2	17
Hardwood Hammock	-	4	6	-	10
Cypress Swamp	1	1	6	-	8
Swamp Hardwoods	-	2	6	-	8
Freshwater Marsh and River	-	1	8	-	9
Ephemeral Wetland	1	-	4	-	5
Totals	**1**	**5**	**13**	**2**	**21**

[1] Listed species: endangered, threatened, and special concern species.

Table 3.7 Number of combined endemic, imperiled, and listed species[1] associated with various habitats within the Econlockhatchee River Basin.

Habitat Type	Amphibians	Reptiles	Birds	Mammals	Totals
Xeric Scrub	2	16	6	3	27 (24%)[2]
Flatwoods	2	16	12	3	33 (22%)
Hardwood Hammock	2	16	8	2	27 (18%)
Cypress Swamp	6	11	8	2	27 (23%)
Swamp Hardwoods	4	12	8	2	27 (21%)
Freshwater Marsh and River	3	10	9	2	24 (26%)
Ephemeral Wetland	6	-	4	-	10 (31%)
Totals	**6**	**20**	**15**	**5**	**46**

[1] Endemic species and subspecies have distributions that occur entirely or almost entirely within the state of Florida.

Imperiled species are vulnerable to extirpation as determined by a ranking system developed and used by the Florida Game and Fresh Water Fish Commission to assess the ecological status of 668 native vertebrate species in the state (Millsap et al. 1990).

Listed species: endangered, threatened, and special concern species.

[2] Percentage of the number of species that occur in each habitat type within the Econlockhatchee River Basin.

species that exploit the same class of environmental resources in a similar way. Basically, guilding is a functional as opposed to a taxonomic classification of species.

We followed an approach used most commonly by other guilding studies to identify appropriate guilds (Short and Burnham 1982, Verner 1984). We selected feeding sources and physical breeding requirements as the basis for organizing wildlife information in our guilding analysis. We then developed a simple two-dimensional species-habitat matrix with feeding resources along the y-axis and physical features of the habitat required for breeding along the x-axis. Both axes of the matrix were partitioned by physical strata, because of the importance of strata in describing the form and function of ecological communities. Seven strata were selected to describe utilization of food resources in habitats. Two additional categories, "breeds in other habitat" and "feeds in other habitat," were added to to describe situations such as semi-aquatic turtles that feed in one habitat and nest in another. This matrix resulted in a possible 64 (8 x 8) feeding and breeding combinations for each habitat type.

Appropriate feeding and breeding strata used by each species were compiled and then species were assigned to these guilds within each habitat type (Appendix C, Tables C.10 - C.15). Several species that use more than one habitat were placed in all relevant habitat matrices. However, each species was not represented more than once within each habitat type. Species such as bats, nighthawks and other that feed on on flying insects were categorized as feeding in the canopy layer.

The number of species utilizing each feeding/breeding guild block is shown in Appendix C, Figures C.1 - C.6. The number in the center of each block signifies the number of different species in that guild. The number in the upper-right corner of a block indicates the number of listed (endangered, threatened, special concern), imperiled, and endemic species in the guild (See Table 3.7).

Many species/habitat relationships can be derived from these matrices. Only some of the major interpretations are pointed out here. The ground feeding and ground breeding zones in all upland habitats are utilized by more species than other zones. Water column zones are heavily used in wetlands habitats. Tree canopies are more heavily utilized as breeding zones than feeding zones.

Trees are not as important in marshes as in other habitats, although, members of the heron family use this strata in habitats for breeding.

The next step in our analysis of habitat quantity involved assigning spatial requirement values to each species and then compiling these values for those species that almost exclusively use wetlands, those that use both wetlands and uplands, and those that almost exclusively use uplands (Appendix C, Tables C.16 - C.18). Several spatial requirement data types including the following were used: distance from humans tolerated before taking flight, home range diameter, nest location landward from the waterward extent of the forest, maximum distance found from closest water source, maximum distance from closest water to nest, and distance between captures of the same individual. If spatial requirement data were not found for a species, values were assigned from species that are closely related, similar-sized, found in comparable habitats, and categorized in corresponding guilds. Spatial data varied even within species. Whenever available, ranges of home range values and other spatial data are provided in the tables. All information obtained from the literature are presented as linear distances. Other data formats such as home range area were transformed to linear distances (e.g. diameter of home range).

These values represent distances required by individuals within a species. Much larger areas would be necessary to accommodate the spatial needs of viable populations.

The consequences of providing protection zones of different widths can be estimated by comparing a proposed width with the values presented for various species. For example, a 550 foot wide protection zone measured landward from the edge of the river would provide enough wetland habitat for the river otter because its normal movement patterns parallel the river channel (Figure 3.1). The data also support the assumption that the hooded warbler's needs would be satisfied. The northern parula warbler has relatively small area requirements but would have to have access to some uplands. The data do not provide any evidence that the yellow rat snake would be able to continue to survive within a protection zone of only 550 feet. Also, a protection zone that included only wetlands would not address the needs of species such as the red-headed woodpecker that occur almost exclusively in uplands. Although the river probably does not present much of a barrier to the red-shouldered hawk, its spatial needs are much greater than a 550 foot protection zone on either side of the river would provide.

Although these data were not obtained from animals living in the Econ River Basin, they are applicable. These spatial values are credible and believable as evidenced by the fact that most were published in scientific journals reviewed by peers. Determining the appropriate dimensions of a protection zone necessary to provide adequate habitat for wildlife without consideration of these values would be arbitrary.

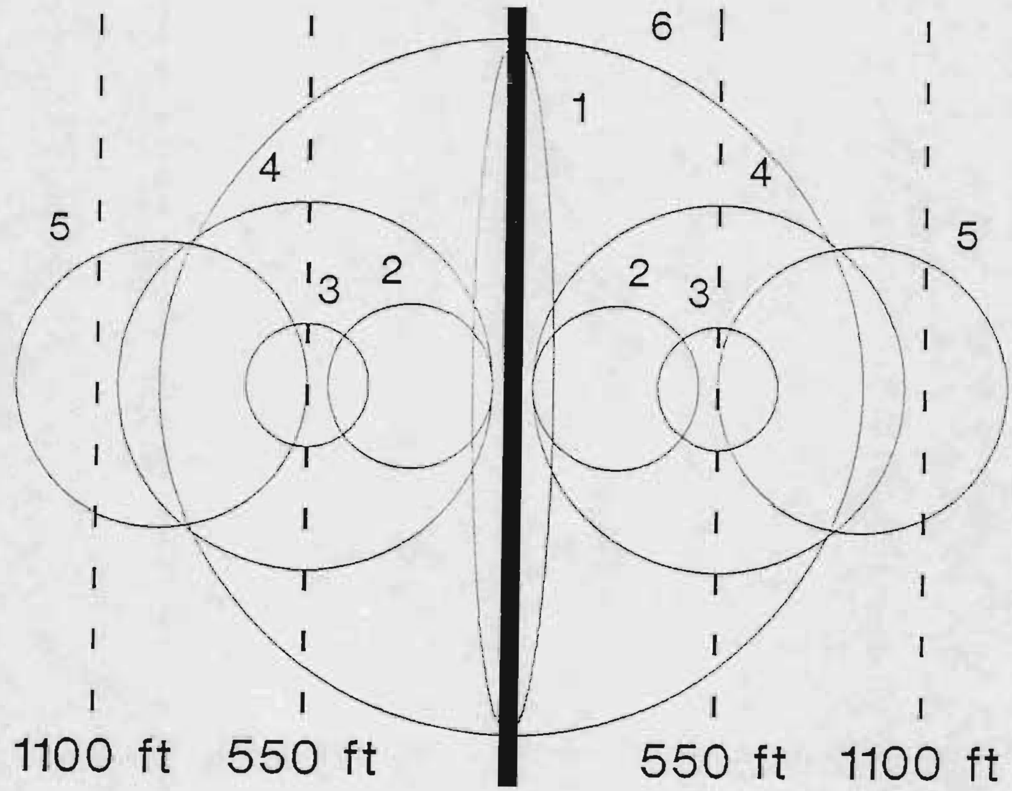

Figure 3.1. Home ranges of various wildlife species overlaid onto a schematic Econlockhatchee River Basin map featuring the 550- and 1100-foot proposed protection zone designations where:

1 = river otter (wetland species with linear home range)
2 = hooded warbler (wetland species)
3 = northern parula warbler (wetland and upland species with small home range)
4 = yellow rat snake (wetland and upland species with large home range)
5 = red-headed woodpecker (upland species)
6 = red-shouldered hawk (wetland and upland species with large home range encompassing both sides of the river)

MANAGEMENT ALTERNATIVES

Managing Natural Resources

A management and protection plan that will effectively preserve the wildlife integrity of the Econ Basin should address the issues discussed earlier in this section: habitat fragmentation, wildlife corridor misconceptions, decrease in landscape diversity, reduction in habitat quality, impacts of adjacent land use, and impacts of public recreation. Some general principles that form the basis for prudent wildlife management decisions in urbanizing areas follow.

Setting aside large areas of contiguous natural habitat as wildlife preserves is an effective and cost efficient way to maintain viable populations of many species. However, minimum viable population levels are dangerously close to extinction and should not be considered as bottom line constraints in land-use decisions. If the intent of creating preserves is to prevent extinction of species from an area, then specific standards should be set to higher, ecologically functional levels rather than minimum viable levels.

A broad, holistic perspective is more biologically sound and provides greater access to uplands than a site by site approach. The most serious problem confronting Florida's wildlife is fragmentation of natural habitat areas into small, isolated parcels that are not large enough to sustain viable populations. Growth management decisions must focus on maintaining the biotic integrity of systems by designing areas that will perpetuate functional communities and not merely token remnants. If management concerns are directed only toward endangered animals, many other species will suffer from lack of consideration and eventually will be deserving of endangered status.

Wildlife species in the Econ Basin occur in aquatic, wetland, and upland habitats. Some such as fishes and sirens are restricted to aquatic environments. Eastern mud snakes, prothonotary warblers, and marsh rabbits occur primarily in wetlands. Others including scrub jays, Bachman's sparrow and red-cockaded woodpeckers are found only in uplands. Many species use a variety of habitats to satisfy their needs. A protection plan that adequately addresses the requirements for all species in the Basin would delineate sufficient aquatic, wetland, and upland habitats to at least maintain viable populations (about 150 individuals/species).

About 35 wildlife species in the Basin occur almost exclusively in aquatic and wetland habitats. Many other species such as wading birds also are highly dependent on these habitats. A variety of flowing and isolated open water areas are found in the Basin. These species can be protected best by assuring good water quality, and maintaining natural water quantity levels and hydroperiods in the Econ River, its tributaries, and isolated wetlands in the Basin.

About 119 wildlife species occur in both wetlands and uplands. These species usually need access to aquatic and upland environments to satisfy some of their food and cover requirements. Many wetland-dependent wildlife will not be able to survive in areas where access to upland areas is not available. They will be deprived of critical nesting and feeding resources provided by these habitats. For example, several semi-aquatic turtles need upland soils to dig their nests and to sometimes overwinter.

Spatial needs for individuals of various wetland-dependent species found in the Econ Basin were presented in Appendix C, Tables C.16 - C.18. These needs were based on home range sizes, flushing distances, minimum forest habitat widths, nest locations landward from the waterward extent of forest, and other similar data available in the literature.

In some places, wetland habitats on each side of the Econ River are generally wider than 550 feet. The length of this contiguous habitat partially compensates for the width not accommodating spatial needs of all species. This amount of wetland habitat and the availability of adjacent uplands makes it an ideal preservation area for viable populations of wetland-dependent wildlife associated with flowing water systems. Spatial needs for species associated with permanent and ephemeral isolated wetlands can be satisfied by the wetlands contained in the Econlockhatchee Swamp, and the proposed acquisition and corridor areas.

About 60 wildlife species are upland-dependent. Uplands including unique sand pine scrub habitats occur in a variety of locations throughout the Basin. The most efficient use of land for upland wildlife protection would be to locate an upland preserve adjacent to the wetland preserve. This design would: (1) help to buffer the adverse impacts of development and other human-related activities on the wetlands, (2) provide upland habitat needed by some wetland-dependent wildlife, and (3) satisfy requirements for upland-dependent wildlife. An upland conservation area along the entire main branch of the Big Econ and along the Little Econ north of University Avenue of at least 550 feet is needed to protect upland wildlife from extinction. This conservation area does not apply to the tributaries of the Econ River.

All of the scrub/sandhill habitats are rapidly disappearing in Econ Basin and consequently many wildlife species associated with these habitats are probably close to extinction in this area. Acquisition of remaining scrub areas and connectors to the Econ River preservation/conservation zones should be a high priority.

Because the recommended preservation/conservation design is relatively narrow and will somewhat restrict wildlife movements compared to occurrences in the natural landscape, several linkages between the Econ River and larger habitats to the East should be established. These wildlife corridors will allow alternate dispersal routes and a less restricted exchange of genetic material from other populations. The best locations for these linkages are along Highways 50 and 528.

There does not appear to be viable populations of black bear or panther in the Econ Basin, although several sightings have been reported. The need for wildlife corridors still exists. Safe travel is necessary to maintain high levels of variation in the gene pools and to replace animals that die from various causes. Animals do not use travel corridors the same way people use highways only to get from one place to another. Wildlife feed and seek shelter while using their corridors. Therefore, these travel lanes must contain useful resources for species and must also be wide enough to be relatively free from obstacles and disturbances. Major East-West highways such as Routes 420, 50, and 528 have divided the Basin into four large habitat blocks. These roads are serious obstacles to North-South animal movements along the Econ River. Their effectiveness as barriers increases as urban sprawl travels down these infrastructures. Highways also are responsible for significant mortality rates of many species. Safe travel is necessary to maintain high levels of variation in the gene pools and to replace animals that die from various causes. Wildlife underpasses similar to those implemented along Alligator Alley should be designed and implemented. These underpasses should be wide enough to substantially reduce disturbances from encroaching development along the highways.

Most wildlife species depend on a diversity of vegetation types to obtain their essential requirements. Their needs and corresponding movements may change seasonally or more frequently. All areas of the Econ Basin have been altered at one time or another. There are not any pristine habitats. However, disturbance in some areas has been minimal. Other habitats have not been altered for many years and on a small scale show little signs of modification. Areas where construction has not occurred and where there are no asphalt roads and building have the potential to be reverted into natural areas. Pastures that have been intensively grazed and timber areas that have been harvested still contain much of the original seed bank and in time can grow back into the natural communities that once occupied the site. Silvicultural and agricultural practices within the delineated preserve will create large open areas that will fragment the forest canopy and reduce the amount of protection for species that are strictly forest-dwelling animals and are sensitive to disturbances of this nature.

It is easy sometimes for the nonscientific community to develop misconceptions about the status of wildlife communities. Florida and the Econ Basin are home to a variety of species. Some of these, are generalists and quite well adapted to any abrupt changes that may occur in their environment. Others are extremely sensitive to the slightest modifications. A great number of easily observed species in an area does not necessarily mean that the ecosystem is healthy and not experiencing problems. Sensitive species that are most adversely affected by development are not as obvious. Cursory surveys will not reveal their presence. Only 8 of the 21 listed species that are assumed to occur in the Econ Basin have been documented.

Allowing recreation and public use of public lands that have been set aside primarily to protect the natural resources on these lands can sometimes degrade habitats and disturb wildlife to the extent that the intended protection is lost. Designing the development of trails and other recreational facilities should be considered as part of the overall management and protection plan for the resources on the area. Human activities must be controlled so they will not adversely impact wildlife. Access to sensitive areas is not necessary for visitors to enjoy an outdoor experience.

Managing Development Impacts

Proactive comprehensive planning approaches will prevent additional development impacts from occurring in the Econ Basin. Responding to individual DRI's and negotiating reasonable compromises on a site by site basis will not achieve the level of management necessary to protect the biotic integrity of the larger system. The focus should be on the entire Basin and the time should be now.

A complete management program that will provide the best protection for the wildlife resources of the Econ Basin, and also avoid negative impacts and costly mistakes will execute the following recommendations.

1) Apply buffers (development set-backs) to all wetlands within the Basin. See Brown et al. (1990) for the methodology to determine buffers.

2) Develop and implement a management scheme (e.g. prescribed burning) that will help to maintain the best landscape diversity and habitat values.

3) Develop and implement standards for land use adjacent to this preserve that prohibit activities that are not compatible with wildlife protection objectives.

4) Develop a landscape ordinance that requires the use of plants indigenous to communities in the Basin and restricts the removal of understory vegetation so that developed areas will blend into the natural areas in the preserve.

5) Develop standards for storm water control ponds that include the use of native emergent vegetation, littoral zones, and native vegetation along the shore so that these ponds also will serve an ecological function.

6) Develop educational programs and additional incentives that will encourage pet owners to keep their cats and dogs confined to their property.

SUMMARY AND RECOMMENDATIONS

Summary and Recommendations

A management and protection plan that will effectively preserve the wildlife integrity of the Econ Basin should address the following issues: habitat fragmentation, wildlife corridor misconceptions, decrease in landscape diversity, reduction in habitat quality, impacts of adjacent land use, impacts of public recreation, impacts of cattle grazing, and impacts of silviculture. Until a plan is formalized, a moratorium on development in the Basin would assure that remaining critical habitat areas will not be lost.

Many of the habitats in the Basin already have been fragmented or reduced in size. Highways and several other land uses are interfering with wildlife movements. The corridor linkages to Lakes Jessup and Harney, the Tosohatchee State Preserve, and the Lake Conlin Swamp area have been partially severed. Installing underpasses at appropriate locations in the major highways that intersect the Basin will help to resurrect these natural travel lanes.

Important wildlife habitat areas need to be delineated and protected from the adverse impacts of future development. A broad, holistic perspective is more biologically sound and provides greater access to uplands than a site by site approach. The most serious problem confronting Florida's wildlife is fragmentation of natural habitat areas into small, isolated parcels that are not large enough to sustain viable populations. Growth management decisions must focus on maintaining the biotic integrity of systems by designing areas that will perpetuate functional communities and not merely token remnants. If management concerns are directed only toward endangered animals, many other species will suffer from lack of consideration and will eventually be deserving of endangered status.

Buffers for wildlife should be incorporated into all wetland systems. This will provide travel corridors for animals and also protect valuable habitat resources.

The primary objective for any public lands in the Basin should be the protection of the natural integrity of the Basin. Park development and accompanying human activities should be prohibited unless scientific evidence supports such decisions. Most studies reviewed in this report suggested that outdoor, nonconsumptive recreation can be extremely detrimental to wildlife. More research is desperately needed to form the basis for proper multiple use management. If the required protection is not effectively provided on private or public lands, the natural integrity of all systems will be lost. Sensitive species that need large undisturbed areas will continue to follow the path toward extinction.

Limitations and Suggestions for Further Study

The short time frame for this study did not allow a thorough assessment of the wildlife resources in the Econ Basin. The most accurate method of determining current baseline data on wildlife species within the Basin would be through systematic species' surveys. The need for this is exemplified by the fact that only 8 of the 21 listed (endangered, threatened, and special concern) species that are assumed to occur in the Basin have been documented. The cursory surveys that are conducted during DRI proposal preparation would be unlikely to document species such as the gopher frog and indigo snake. A systematic survey schedule for all classes of wildlife in different community types would take at least one year. Data obtained from these surveys would greatly reduce the assumptions upon which decisions determining the fate of the Basin's wildlife resources will be based.

During the next project phase, values will be assigned to several habitat evaluation criteria. As time allows, these values will be compiled and digitized for randomly selected vegetation communities in the Basin. A comparison of total values for each community will help to identify important wildlife habitat systems. This process will provide an objective, quantified, defensible bases for delineating wildlife preservation areas and developing an effective protection plan for the Econ Basin wildlife resources. The application of this method will provide an objective, quantitative approach to delineating a wildlife preserve system. However, several months would be required to make necessary calculations, digitize data, and produce overlays on a GIS system.

The impacts of recreation on wildlife are not well known. More specific information on the effects of various recreational activities on wildlife are needed to provide the basis of prudent multiple use decisions. Several studies have documented flushing distances of visible wildlife in open habitats. But very little is known about the effects of development and use of passive recreational facilities on wildlife that are not as obvious in a forested environment. An ideal study design to investigate this relationship would include collecting baseline data on (1) independent variables such as habitat characteristics and human activities, and (2) wildlife species composition, diversity, and density prior to park development. Periodic follow-ups will reveal any relationships between changes in the independent and dependent variables.

The wildlife habitat values of small "Conservation Areas" on development sites is unknown. A study designed to determine the benefits of various set asides would help developers and development review teams to plan more efficient uses of land. This could be accomplished by comparing wildlife survey data obtained in various set asides with independent set aside variables such size, habitat type, insularity, and quality of adjacent areas.

Highways and roads are major obstacles to wildlife movement and are primary causes of mortality for some species. The construction of underpasses has been proposed many times as a method to reduce these problems. However, no studies have determined the effectiveness of various underpass designs. This could be investigated by selecting several types of underpasses and conducting wildlife surveys at the highway underpasses. The different types of underpass designs could be analyzed as separate treatments in an analysis of the data.

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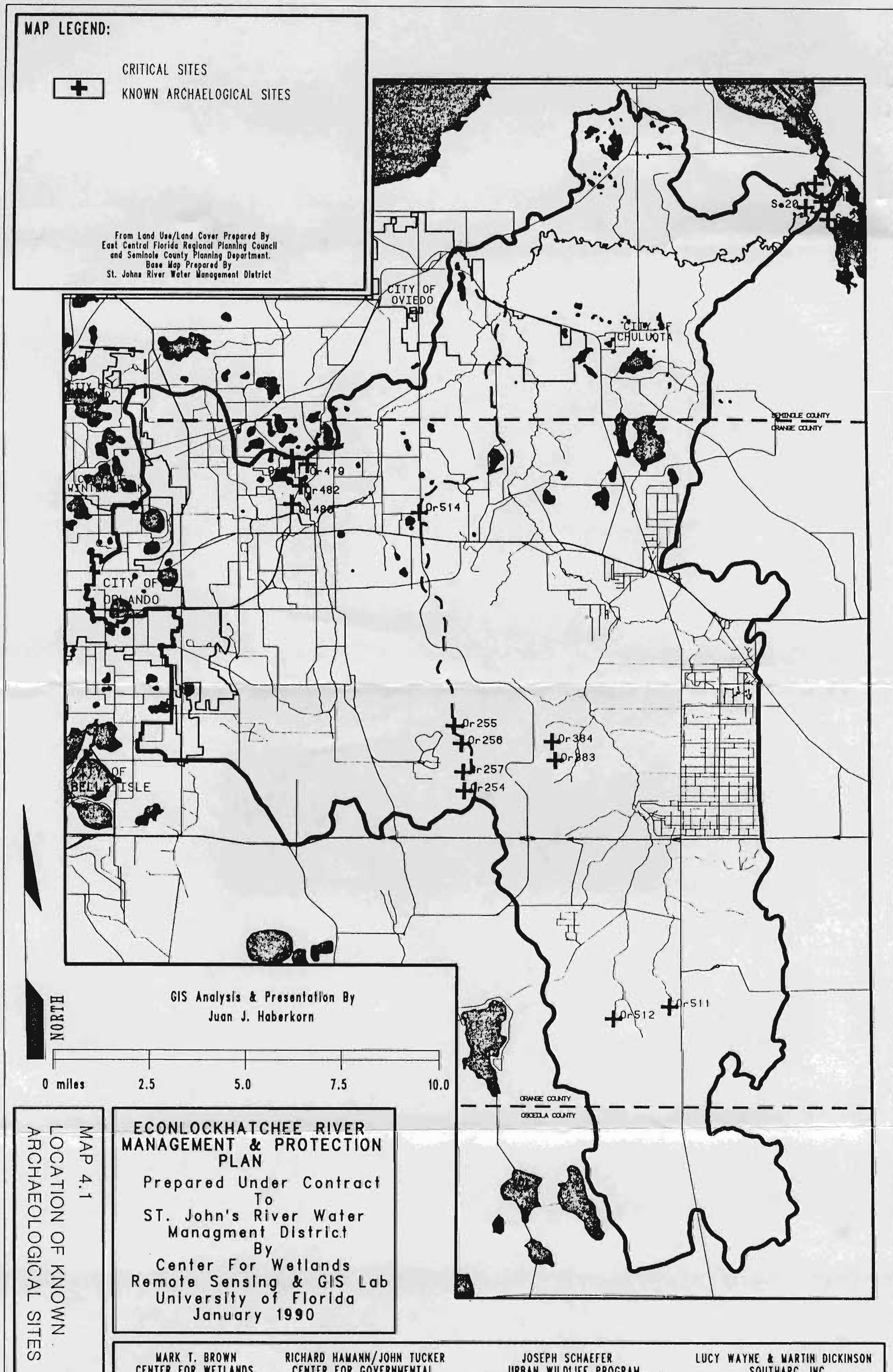
MAP LEGEND:
CRITICAL SITES
KNOWN ARCHAELOGICAL SITES
From Land Use/Land Cover Prepared By East Central Florida Regional Planning Council and Seminole County Planning Department. Base Map Prepared By St. Johns River Water Management District
CITY OF OVIEDO
CITY OF CHULUOTA
CITY OF ORLANDO
SEMINOLE COUNTY
ORANGE COUNTY
OSCEOLA COUNTY
Se20
Or479
Or482
Or480
Or514
Or255
Or256
Or257
Or254
Or384
Or383
Or512
Or511
NORTH
GIS Analysis & Presentation By
Juan J. Haberkorn
0 miles 2.5 5.0 7.5 10.0
MAP 4.1
LOCATION OF KNOWN ARCHAEOLOGICAL SITES
ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN
Prepared Under Contract To ST. John's River Water Managment District By Center For Wetlands Remote Sensing & GIS Lab University of Florida January 1990
MARK T. BROWN CENTER FOR WETLANDS UNIVERSITY OF FLORIDA
RICHARD HAMANN/JOHN TUCKER CENTER FOR GOVERNMENTAL RESPONSIBILITY UNIVERSITY OF FLORIDA
JOSEPH SCHAEFER URBAN WILDLIFE PROGRAM DEPT. OF WILDLIFE & RANGE SCIENCES IFAS, UNIVERSITY OF FLORIDA
LUCY WAYNE & MARTIN DICKINSON SOUTHARC, INC. P.O. BOX 1702 GAINESVILLE, FL. 32602

Appendix C

WILDLIFE SPECIES LIST FOR THE ECONLOCKHATCHEE RIVER BASIN

Table C.1. FRESHWATER FISH of the Econlockhatchee River Basin.[1]

Lamprey Family
Sea Lamprey, (Petromyzon marinus)

Stingray Family
Atlantic Stingray, (Dasyatis sabina)

Gar Family
Longnose Gar, (Lepisosteus osseus)
Florida Gar, (Lepisosteus platyrhincus)

Herring and Shad Family
Gizzard Shad, (Dorosoma cepedianum)
Threadfin Shad, (Dorosoma pentenense)

Minnow and Carp Family
Golden Shiner, (Notemigonus crysoleucas)
Pugnose Minnow, (Notropis emiliae)
Taillight Shiner, (Notropis maculatus)
Coastal Shiner, (Notropis petersoni)

Sucker Family
Lake Chubsucker, (Erimyzon sucetta)

Freshwater Catfish Family
White Catfish, (Ictalurus catus)
Yellow Bullhead, (Ictalurus natalis)
Southern Brown Bullhead, (Ictalurus nebulosus marmoratus)
Channel Catfish, (Ictalurus punctatus)
Tadpole Madtom, (Noturus gyrinus)
Freckled Madtom, (Notorus nocturnus)

Pirate Perch Family
Pirate Perch, (Aphredoderus savanus)

Needlefish Family
Atlantic Needlefish, (Strongylura marina)

Killifish Family
Golden Topminnow, (Fundulus chrysotus)
Marsh Killifish, (Fundulus confluentus)
Seminole Killifish, (Fundulus seminolis)
Flagfish, (Jordanella floridae)
Bluefin Killifish, (Lucania goodei)
Rainwater Killifish, (Lucania parva)

Live-bearer Family
Least Killifish, (Heterandria formosa)
Sailfin Molly, (Poecilia latipinna)

Table C.1. Freshwater fish (continued).

Silverside Family
Southern Brook Silverside, (Labidesthes sicculus vanhvningi)
Inland Silverside, (Menidia bervllina)

Sunfish Family
Everglades Pigmy Sunfish, (Elassoma evergladei)
Bluespotted Sunfish, (Enneacanthus gloriosus)
Banded Sunfish, (Enneacanthus obesus)
Redbreast Sunfish, (Lepomis auritus)
Warmouth, (Lepomis gulosus)
Bluegill, (Lepomis macrochirus)
Dollar Sunfish, (Lepomis marginatus)
Reddear Sunfish, (Lepomis microlophus)
Spotted Sunfish, (Lepomis punctatus)
Florida Largemouth Bass, (Micropterus salmoides floridanus)
Black Crappie, (Pomoxis nigromaculatus)

Perch and Darter Family
Swamp Darter, (Etheostoma proeliare)
Blackbanded Darter, (Percina migrofasciata)

Temperate Bass Family
Striped Bass, (Morone saxatilis)

Sole Family
Hogchoker, (Trinectes maculatus)

[1] It is assumed that all of the fresh water fish occur in all three counties (Seminole, Orange, and Osceola).

Table C.2. Occurrence of AMPHIBIANS in the Econlockhatchee River Basin by County.

Species	Counties		
	Seminole	Orange	Osceola
Toad Family			
Oak Toad, (Bufo quercicus)	x	x	
Southern Toad, (Bufo terrestris)	x	x	x
Treefrog Family			
Florida Cricket Frog, (Acris grvllus dorsalis)	x	x	x
Green Treefrog, (Hvla cinerea)	x	x	x
Southern Spring Peeper, (Hvla crucifer bartramiana)		x	
Pinewoods Treefrog, (Hvla femoralis)	x	x	x
Barking Treefrog, (Hvla gratiosa)	x	x	
Squirrel Treefrog, (Hvla squirella)	x	x	
Little Grass Frog, (Limnaoedus ocularis)	x	x	x
Florida Chorus Frog, (Pseudacris nigrita verrucosa)	x	x	
Narrowmouth Toad Family			
E. Narrowmouth Toad, (Gastrophrvne carolinensis)	x	x	x
Spadefoot Toad Family			
Eastern Spadefoot Toad, (Scaphiopus holbrooki)		x	x
True Frogs			
Florida Gopher Frog, (Rana areolata aesopus)	x	x	x
Bullfrog, (Rana catesbeiana)	x	x	
Pig Frog, (Rana grvlio)		x	x
Southern Leopard Frog, (Rana utricularia)	x	x	
Amphiuma Family			
Two-toed Amphiuma, (Amphiuma means)	x	x	x
Lungless Salamander Family			
Southern Dusky Salamander, (Desmognathus auriculatus)	x	x	
Dwarf Salamander, (Eurvcea quadridigitata)	x	x	x
Slimy Salamander, (Plethodon glutinosus glutinosus)	x	x	
Rusty Mud Salamander, (Pseudotriton montanus floridanus)	x	x	
Newt Family			
Striped Newt, (Notophthalmus perstriatus)	x		
Peninsula Newt, (Notophthalmus viridescens piaropicola)	x	x	x
Siren Family			
Narrow-striped Dwarf Siren, (Pseudobranchus striatus axanthus)		x	
Eastern Lesser Siren, (Siren intermedia intermedia)	x	x	
Greater Siren, (Siren lacertina)		x	

Table C.3. Occurrence of **REPTILES** in the Econlockhatchee River Basin by County.

Species	Counties: Seminole	Orange	Osceola
Alligator Family			
American Alligator, (Alligator mississippiensis)	x	x	x
Snapping Turtle Family			
Florida Snapping Turtle, (Chelydra serpentina osceola)			x
Box and Water Turtle Family			
Florida Chicken Turtle, (Deirochelys reticularia chrysea)			x
Peninsula Cooter, (Pseudemys floridana peninsularis)	x		x
Florida Redbelly Turtle, (Pseudemys nelsoni)	x		
Florida Box Turtle, (Terrapene carolina bauri)	x	x	x
Mud and Musk Turtle Family			
Striped Mud Turtle, (Kinosternon bauri)		x	x
Florida Mud Turtle, (Kinosternon subrubrum steindachneri)		x	x
Loggerhead Musk Turtle, (Sternotherus minor)	x	x	
Stinkpot, (Sternotherus odoratus)	x	x	
Tortoise Family			
Gopher Tortoise, (Gopherus polyphemus)	x		
Softshell Turtle Family			
Florida Softshell, (Trionyx ferox)	x	x	x
Worm Lizard Family			
Florida Worm Lizard, (Rhineura floridana)		x	
Glass Lizard Family			
Eastern Slender Glass Lizard, (Ophisaurus attenuatus longicaudus)		x	
Iquanid Family			
Green Anole, (Anolis carolinensis)	x	x	x
Southern Fence Lizard, (Sceloporus undulatus undulatus)	x	x	x
Skink Family			
Peninsula Mole Skink, (Eumeces egregius onocrepis)	x	x	
Southeastern Five-lined Skink, (Eumeces inexpectatus)	x	x	x
Broadhead Skink, (Eumeces laticeps)		x	
Ground Skink, (Scincella lateralis)	x	x	x
Whiptail Family			
Six-lined Racerunner, (Cnemidophorus sexlineatus sexlineatus)		x	x

Table C.3. Reptiles by County (continued)

Species	Counties Seminole	Orange	Osceola
Colubrid Family			
Florida Scarlet Snake, (Cemophora coccinea coccinea)	x	x	
Southern Black Racer, (Coluber constrictor priapus)	x	x	x
Southern Ringneck Snake, (Diadophis punctatus punctatus)	x	x	x
Eastern Indigo Snake, (Drymarchon corais couperi)	x	x	x
Corn Snake, (Elaphe guttata guttata)	x	x	
Yellow Rat Snake, (Elaphe obsoleta quadrivittata)	x		
Eastern Mud Snake, (Farancia abacura abacura)	x	x	
Eastern Hognose Snake, (Heterodon platyrhinos)	x	x	x
Kingsnake, (Lampropeltis getulus)	x	x	x
Scarlet Kingsnake, (Lampropeltis triangulum elapsoides)		x	x
Eastern Coachwhip, (Masticophis flagellum flagellum)	x	x	
Green Water Snake, (Nerodia cyclopion)		x	x
Florida Water Snake, (Nerodia fasciata pictiventris)	x	x	x
Brown Water Snake, (Nerodia taxispilata)	x	x	x
Rough Green Snake, (Opheodrys aestivus)		x	
Florida Pine Snake, (Pituophis melanoleucus mugitus)	x	x	
Striped Crayfish Snake, (Regina alleni)		x	x
Pine Woods Snake, (Rhadinaea flavilata)	x	x	x
South Florida Swamp Snake, (Seminatrix pygaea cyclas)			x
North Florida Swamp Snake, (Seminatrix pygaea pygaea)	x	x	
Short-tailed Snake, (Stilosoma extenuatum)		x	
Florida Brown Snake, (Storeria dekayi victa)	x	x	x
Central Florida Crowned Snake, (Tantilla relicta neilli)	x	x	x
Penninsula Ribbon Snake, (Thamnophis sauritus sackeni)		x	x
Eastern Garter Snake, (Thamnophis sirtalis sirtalis)	x	x	x
Coral Snake Family			
Eastern Coral Snake, (Micrurus fulvius fulvius)	x	x	x
Viper Family			
Florida Cottonmouth, (Agkistrodon piscivorus conanti)	x	x	x
Eastern Diamondback Rattlesnake, (Crotalus adamanteus)	x	x	x
Dusky Pigmy Rattlesnake, (Sistrurus miliarius barbouri)	x	x	

Table C.4. Occurrence of **BIRDS** in the Econlockhatchee River Basin by County. Species that are present only during the non-breeding season are not included.

Species	Counties		
	Seminole	Orange	Osceola
Grebe Family			
Pied-bill Grebe, (Podilymbus podiceps)	x	x	x
Cormorant Family			
Double-crested Cormorant, (Phalacrocorax auritus)	x	x	x
Darter Family			
Anhinga, (Anhinga anhinga)	x	x	x
Bittern and Heron Family			
Great Blue Heron, (Ardea herodias)	x	x	x
Cattle Egret, (Bubulcus ibis)	x	x	x
Green-backed Heron, (Butorides striatus)	x	x	x
Great Egret, (Casmerodius albus)	x	x	x
Little Blue Heron, (Egretta caerulea)	x	x	x
Snowy Egret, (Egretta thula)	x	x	x
Tricolored Heron, (Egretta tricolor)	x	x	x
American Bittern, (Botaurus lentiginosus)	x	x	x
Eastern Least Bittern, (Ixobrychus exilis exilis)		x	
Black-crowned Night Heron, (Nycticorax nycticorax)	x	x	x
Yellow-crowned Night Heron, (Nycticorax violaceus)	x	x	x
Ibis and Spoonbill Family			
White Ibis, (Eudocimus albus)	x	x	x
Stork Family			
Wood Stork, (Mycteria americana)	x	x	x
Goose and Duck Family			
Wood Duck, (Aix sponsa)	x	x	x
Mottled Duck, (Anas fulvigula)	x	x	x
Mallard Duck, (Anas platyrhynchos)	x	x	x
Ring-necked Duck, (Aythya collaris)	x	x	x
Fulvous Whistling Duck, (Dendrocygna bicolor)	x	x	x
Vulture Family			
Turkey Vulture, (Cathartes aura)	x	x	x
Black Vulture, (Coragyps atratus)	x	x	x

Table C.4. Birds by County (continued).

Species	Counties: Seminole	Orange	Osceola
Kite, Eagle, and Hawk Family			
Cooper's Hawk, (Accipiter cooperii)	x	x	x
Short-tailed Hawk, (Buteo brachyurus)	x	x	x
Red-tailed Hawk, (Buteo jamaicensis)	x	x	x
Red-shouldered Hawk, (Buteo lineatus)	x	x	x
Broad-winged Hawk, (Buteo platypterus)	x	x	x
Northern Harrier, (Circus cyaneus)	x	x	x
American Swallow-tailed Kite, (Elanoides forficatus)	x	x	x
Southern Bald Eagle, (Haliaeetus l. leucocephalus)	x	x	x
Osprey, (Pandion haliaetus)	x	x	x
Florida Everglade Kite, (Rostrhamus sociabilis plumbius)	x	x	x
Caracara and Falcon Family			
Southeastern American Kestrel, (Falco sparverius paulus)	x	x	x
Crested Caracara, (Polyborus plancus)			x
Turkey and Quail Family			
Northern Bobwhite, (Colinus virginianus)	x	x	x
Wild Turkey, (Meleagris gallopavo)	x	x	x
Rail, Gallinule, and Coot Family			
American Coot, (Fulica americana)	x	x	x
Common Moorhen, (Gallinula chloropus)	x	x	x
Purple Gallinule, (Porphyrula martinica)	x	x	x
King Rail, (Rallus elegans)	x	x	x
Limpkin Family			
Limpkin, (Aramus guarauna)	x	x	x
Crane Family			
Sandhill Crane, (Grus canadensis pratensis)	x	x	x
Plover Family			
Killdeer, (Charadrius vociferus)	x	x	x
Stilt Family			
Black-necked Stilt, (Himantopus mexicanus)	x	x	x
Pigeon and Dove Family			
Common Ground Dove, (Columbina passerina)	x	x	x
Mourning Dove, (Zenaida macroura)	x	x	x

Table C.4. Birds by County (continued).

Species	Counties		
	Seminole	Orange	Osceola
Cuckoo Family			
Yellow-billed Cuckoo, (Coccyzus americanus)	x	x	x
Barn-owl Family			
Common Barn Owl, (Tyto alba)	x	x	x
Typical Owl Family			
Burrowing Owl, (Athene cunicularia)		x	x
Great Horned Owl, (Bubo virginianus)	x	x	x
Eastern Screech Owl, (Otus asio)	x	x	x
Barred Owl, (Strix varia)	x	x	x
Nightjar Family			
Chuck-will's-widow, (Caprimulgus carolinensis)	x	x	x
Common Nighthawk, (Chordeiles minor)	x	x	x
Swift Family			
Chimney Swift, (Chaetura pelagica)	x	x	x
Hummingbird Family			
Ruby-throated Hummingbird, (Archilochus colubris)	x	x	x
Kingfisher Family			
Belted Kingfisher, (Ceryle alcyon)	x	x	
Woodpecker Family			
Common Flicker, (Colaptes auratus)	x	x	x
Pileated Woodpecker, (Dryocopus pileatus)	x	x	x
Red-bellied Woodpecker, (Melanerpes carloinus)	x	x	x
Red-headed Woodpecker, (Melanerpes erythocephalus)	x	x	x
Red-cockaded Woodpecker, (Picoidus borealis)	x	x	x
Downy Woodpecker, (Picoidus pubescens)	x	x	x
Hairy Woodpecker, (Picoides villosus)	x	x	x
Flycatcher Family			
Acadian Flycatcher, (Empidonax virescens)	x	x	x
Great Crested Flycatcher, (Myiarchus crinitus)	x	x	x
Eastern Kingbird, (Tyrannus tyrannus)	x	x	x
Swallow Family			
Purple Martin Swallow, (Progne subis)	x	x	x
Northern Rough-winged Swallow, (Stelgidopteryx serripennis)	x	x	x

Table C.4. Birds by County (continued).

Species	Counties		
	Seminole	Orange	Osceola
Jay and Crow Family			
Florida Scrub Jay, (Aphelocoma coerulescens coerulescens)	x	x	x
American Crow, (Corvus brachyrhynchos)	x	x	x
Fish Crow, (Corvus ossifragus)	x	x	x
Blue Jay, (Cyanocitta cristata)	x	x	x
Titmouse Family			
Tufted Titmouse, (Parus bicolor)	x	x	x
Carolina Chickadee, (Parus carolinensis)	x	x	x
Nuthatch Family			
Brown-headed Nuthatch, (Sitta pusilla)	x	x	x
Wren Family			
Carolina Wren, (Thryothorus ludovicianus)	x	x	x
Old World Warbler and Kinglet Family			
Blue-gray Gnatcatcher, (Polioptila caerulea)	x	x	x
Eastern Bluebird, (Sialia sialis)	x	x	x
Mimic Thrush Family			
Northern Mockingbird, (Mimus polyglottos)	x	x	x
Brown Thrasher, (Toxostoma rufum)	x	x	x
Shrike Family			
Loggerhead Shrike, (Lanius ludovicianus)	x	x	x
Vireo Family			
Yellow-throated Vireo, (Vireo flavifrons)	x	x	x
White-eyed Vireo, (Vireo griseus)	x	x	x
Red-eyed Vireo, (Vireo olivaceus)	x	x	x
Wood Warbler Subfamily			
Yellow-throated Warbler, (Dendroica dominica)	x	x	x
Palm Warbler, (Dendroica palmarum)	x	x	x
Pine Warbler, (Dendroica pinus)	x	x	x
Common Yellowthroat, (Geothylpis trichas)	x	x	x
Northern Parula Warbler, (Parula americana)	x	x	x
Prothonotary Warbler, (Protonotaria citrea)	x	x	
Hooded Warbler, (Wilsonia citrina)	x	x	x
Tanager Subfamily			
Summer Tanager, (Piranga rubra)	x	x	x

Table C.4. Birds by County (continued).

Species	Counties		
	Seminole	Orange	Osceola
Cardinal Subfamily			
Northern Cardinal, (Cardinalis cardinalis)	x	x	x
Blue Grosbeak, (Guiraca caerulea)	x	x	x
Painted Bunting, (Passerina ciris)	x	x	
Towhee and Sparrow Subfamily			
Bachman's Sparrow, (Aimophila aestivalis)	x	x	x
Rufous-sided Towhee, (Pipilo erythrophthalmus)	x	x	x
Blackbird and Oriole Subfamily			
Red-winged Blackbird, (Agelaius phoeniceus)	x	x	x
Orchard Oriole, (Icterus spurius)	x	x	
Brown-headed Cowbird, (Molothrus ater)	x	x	x
Boat-tailed Grackle, (Quiscalus major)	x	x	x
Common Grackle, (Quiscalus quiscula)	x	x	x
Eastern Meadowlark, (Sturnella magna)	x	x	x

Table C.5. Occurrence of MAMMALS in the Econlockhatchee River Basin by County.

Species	Counties		
	Seminole	Orange	Osceola
Opossum Family			
Opossum, (Didelphis virginiana)	x	x	x
Shrew Family			
Least Shrew, (Cryptotis parva)	x	x	x
Southeastern Shrew, (Sorex longirostris longirostris)	x	x	x
Mole Family			
Eastern Mole, (Scalopus aquaticus)	x	x	x
Twilight Bat Family			
Big Brown Bat, (Eptesicus fuscus)	x	x	x
Red Bat, (Lasiurus borealis)	x	x	x
Hoary Bat, (Lasiurus cinereus cinereus)		x	
Yellow Bat, (Lasiurus intermedius)	x	x	x
Evening Bat, (Nycticeius humeralis)	x	x	x
Eastern Pipstrelle Bat, (Pipistrellus subflavus)	x	x	x
Rafinesque's Big-eared Bat, (Plecotus rafinesquii)	x	x	x
Free-tailed Bat Family			
Brazilian Free-tailed Bat, (Tadarida brasiliensis)	x	x	x
Armadillo Family			
Nine-banded Armadillo, (Dasypus novemcinctus)	x	x	x
Rabbit Family			
Eastern Cottontail Rabbit, (Sylvilagus floridanus)	x	x	x
Marsh Rabbit, (Sylvilagus palustris)	x	x	x
Squirrel Family			
Southern Flying Squirrel, (Glaucomys volans)	x	x	x
Gray Squirrel, (Sciurus carolinensis)	x	x	x
Fox Squirrel, (Sciurus niger)	x	x	x
Sherman's Fox Squirrel, (Sciurus niger shermanii)	x	x	x
Pocket Gopher Family			
Southeastern Pocket Gopher, (Geomys floridana)	x	x	x
New World Rats, Mice, and Voles Family			
Round-tailed Muskrat, (Neofiber alleni)	x	x	x
Marsh Rice Rat, (Oryzomys palustris)	x	x	x
Florida Mouse, (Peromyscus floridanus)	x	x	x
Cotton Mouse, (Peromyscus gossypinus)	x	x	x
Hispid Cotton Rat, (Sigmodon hispidus)	x	x	x

Table C.5. Mammals by County (continued).

Species	Counties		
	Seminole	Orange	Osceola
Raccoon Family			
Raccoon, (Procyon lotor)	x	x	x
Weasel and Skunks Family			
River Otter, (Lutra canadensis)	x	x	x
Striped Skunk, (Mephitis mephitis)	x	x	x
Long-tailed Weasel, (Mustela frenata)	x	x	x
Eastern Spotted Skunk, (Spilogale putorius)	x	x	x
Foxes and Coyotes Family			
Gray Fox, (Urocyon cinereoargenteus)	x	x	x
Red Fox, (Vulpes vulpes)	x	x	x
Cat Family			
Bobcat, (Felis rufus)	x	x	x
Deer Family			
White-tailed Deer, (Odecoileus virginianus)	x	x	x
Pig Family			
Wild Boar, (Sus scrofa)	x	x	x

Table C.6. AMPHIBIAN use of habitats for feeding and nesting/breeding in the Econlockhatchee River Basin.

Species	Habitats						
	XS[1]	FW[2]	HH[3]	CS[4]	SH[5]	M&R[6]	EW[7]
Toad Family							
Oak Toad	f[8]	f		f	f	f	n[9]
Southern Toad	f	f	f	fn	fn	fn	n
Treefrog Family							
Florida Cricket Frog				fn	fn	fn	n
Green Treefrog		f	f	fn	fn	n	n
Southern Spring Peeper			f	n	n		n
Pinewoods Treefrog	f	f	f	f	f	f	n
Barking Treefrog	f			f	f	f	n
Squirrel Treefrog	f	f	f	f	f	f	n
Little Grass Frog		f	f	f	f		n
Florida Chorus Frog		f	f	fn	fn		n
Narrowmouth Toad Family							
E. Narrowmouth Toad	f	f	f	f	f		n
Spadefoot Toad Family							
Eastern Spadefoot Toad	f	f	f	f			n
True Frogs							
Florida Gopher Frog	f	f		f			n
Bullfrog				fn	fn	fn	
Pig Frog					fn	fn	
Southern Leopard Frog		f	f	fn	fn	fn	fn
Amphiuma Family							
Two-toed Amphiuma				fn	fn	fn	fn
Lungless Salamander Family							
Southern Dusky Salamander		f	f	fn	fn	fn	
Dwarf Salamander		f	f	fn	fn	fn	
Slimy Salamander		f	fn		fn		
Rusty Mud Salamander			f		fn		
Newt Family							
Striped Newt	f			f			fn
Peninsula Newt			f	fn	fn	fn	fn

Table C.6. Amphibians by habitat (continued).

Species	Habitats						
	XS	FW	HH	CS	SH	M&R	EW
Siren Family							
Narrow-striped Dwarf Siren				fn	fn	fn	fn
Eastern Lesser Siren				fn	fn	fn	fn
Greater Siren				fn	fn	fn	

[1] XS = Xeric Scrub

[2] FW = Flatwoods

[3] HH = Hardwood Hammock

[4] CS = Cypress Swamp

[5] SH = Swamp Hardwood

[6] M&R = Freshwater Marsh and River

[7] EW = Ephemeral Wetland

[8] f = use habitat to obtain food resources

[9] n = use habitat for nesting/breeding

Table C.7. **REPTILE** use of habitats for feeding and nesting/breeding in the Econlockhatchee River Basin.

Species	Habitats					
	XS[1]	FW[2]	HH[3]	CS[4]	SH[5]	M&R[6]
Alligator Family						
American Alligator			n[7]	f[8]n	fn	fn
Snapping Turtle Family						
Florida Snapping Turtle		n	n	f	f	f
Box and Water Turtle Family						
Florida Chicken Turtle	n	n	n	f	f	f
Peninsula Cooter	n	n	n	f	f	f
Florida Redbelly Turtle	n	n	n	f	f	f
Florida Box Turtle	fn	fn	fn			f
Mud and Musk Turtle Family						
Striped Mud Turtle	n	n	n	f	f	f
Florida Mud Turtle	n	n	n	f	f	f
Loggerhead Musk Turtle	n	n	n	f		f
Stinkpot	n	n	n	f	f	f
Tortoise Family						
Gopher Tortoise	fn	fn	fn			
Softshell Turtle Family						
Florida Softshell	n	n	n	f	f	
Worm Lizard Family						
Florida Worm Lizard	fn		fn			
Glass Lizard Family						
Eastern Slender Glass Lizard	fn		fn			
Iquanid Family						
Green Anole	fn	fn	fn	f	f	
Southern Fence Lizard	fn		fn			
Skink Family						
Peninsula Mole Skink	fn					
Southeastern Five-lined Skink	fn	fn	fn			
Broadhead Skink			fn		f	
Ground Skink	fn	fn	fn		f	
Whiptail Family						
Six-lined Racerunner	fn	fn	fn			

Table C.7. Reptiles by habitat (continued).

Species	Habitats					
	XS	FW	HH	CS	SH	M&R
Colubrid Family						
Florida Scarlet Snake	fn	fn		f	f	
Southern Black Racer	fn	fn	fn		f	
Southern Ringneck Snake		fn	fn	f	f	
Eastern Indigo Snake	fn	fn	fn		f	
Corn Snake	fn	fn	fn			
Yellow Rat Snake		fn	fn	f	f	
Eastern Mud Snake		n	n	f	f	f
Eastern Hognose Snake	fn	fn	fn			
Kingsnake	fn	fn	fn	f	f	
Scarlet Kingsnake	fn	fn	fn			
Eastern Coachwhip	fn	fn				
Green Water Snake				fn	fn	fn
Florida Water Snake						fn
Brown Water Snake				fn	fn	fn
Rough Green Snake	fn	fn	fn		f	
Florida Pine Snake	fn	fn				
Striped Crayfish Snake				fn	fn	fn
Pine Woods Snake	fn	fn				
South Florida Swamp Snake		n	n	f	f	f
North Florida Swamp Snake		n	n	f	f	f
Short-tailed Snake	fn	fn	fn			
Florida Brown Snake		fn	fn	f	f	f
Central Florida Crowned Snake	fn	fn	fn	f		
Peninsula Ribbon Snake		n	n	f	f	f
Eastern Garter Snake			fn	fn	fn	
Coral Snake Family						
Eastern Coral Snake	fn	fn	fn		f	

Table C.7. Reptiles by habitat (continued).

Species	Habitats					
	XS	FW	HH	CS	SH	M&R
Viper Family						
Florida Cottonmouth		n	n	f	f	f
Eastern Diamondback Rattlesnake	fn	fn	fn			
Dusky Pigmy Rattlesnake		fn		f	f	f

[1] XS = Xeric Scrub

[2] FW = Flatwoods

[3] HH = Hardwood Hammock

[4] CS = Cypress Swamp

[5] SH = Swamp Hardwood

[6] M&R = Freshwater Marsh and River

[7] n = use habitat for nesting/breeding

[8] f = use habitat to obtain food resources

Table C.8. **BIRD** use of habitats for feeding and nesting in the Econlockhatchee River Basin. Species that are present only during the non-breeding season are not included.

Species	Habitats						
	XS[1]	FW[2]	HH[3]	CS[4]	SH[5]	M&R[6]	EW[7]
Grebe Family							
Pied-bill Grebe						f[8]n[9]	
Cormorant Family							
Double-crested Cormorant				fn	fn	fn	
Darter Family							
Anhinga				fn	fn	fn	
Bittern and Heron Family							
Great Blue Heron		n	n	fn	fn	fn	f
Cattle Egret	f	fn	fn	n	n	n	f
Green-backed Heron				fn	fn	fn	
Great Egret		n	n	fn	fn	fn	f
Little Blue Heron		n	n	fn	fn	fn	f
Snowy Egret		n	n	fn	fn	fn	f
Tricolored Heron		n	n	fn	fn	fn	f
American Bittern						fn	
Eastern Least Bittern						fn	
Black-crowned Night Heron		n	n	fn	fn	fn	f
Yellow-crowned Night Heron		n	n	fn	fn	fn	f
Ibis and Spoonbill Family							
White Ibis		n	n	fn	fn	fn	f
Stork Family							
Wood Stork		n	n	fn	fn	f	f
Goose and Duck Family							
Wood Duck		n	n	fn	fn	f	f
Mottled Duck						fn	f
Mallard Duck						fn	f
Ring-necked Duck						fn	
Fulvous Whistling Duck						fn	
Vulture Family							
Turkey Vulture	fn	fn	fn				
Black Vulture	fn	fn	fn				

Table C.8. Birds by habitat (continued).

Species	Habitats						
	XS	FW	HH	CS	SH	M&R	EW
Kite, Eagle, and Hawk Family							
Cooper's Hawk	fn	fn	fn				
Short-tailed Hawk		fn	fn	n	n		
Red-tailed Hawk	fn	fn	fn				
Red-shouldered Hawk		f	f	fn	fn		
Broad-winged Hawk		fn	fn	fn	fn		
Northern Harrier						fn	
American Swallow-tailed Kite	fn	fn	fn	fn	fn	f	
Southern Bald Eagle	n	n	n	n	n	f	
Osprey		n	n	n	n	f	
Florida Everglade Kite						fn	
Caracara and Falcon Family							
Southeastern American Kestrel	fn	fn					
Crested Caracara		fn					
Turkey and Quail Family							
Northern Bobwhite	fn	fn	fn				
Wild Turkey	fn	fn	fn		f		
Rail, Gallinule, and Coot Family							
American Coot						fn	
Common Moorhen						fn	
Purple Gallinule						fn	
King Rail						fn	
Limpkin Family							
Limpkin				fn	fn	fn	
Crane Family							
Sandhill Crane	f	f				fn	
Plover Family							
Killdeer	fn	fn				f	
Stilt Family							
Black-necked Stilt						fn	
Pigeon and Dove Family							
Common Ground Dove	fn	fn	fn				
Mourning Dove	fn	fn	fn				

Table C.8. Birds by habitat (continued).

Species	Habitats						
	XS	FW	HH	CS	SH	M&R	EW
Cuckoo Family							
Yellow-billed Cuckoo	fn	fn	fn	fn	fn		
Barn-owl Family							
Common Barn Owl		fn	fn				
Typical Owl Family							
Burrowing Owl	fn	fn					
Great Horned Owl	fn	fn	fn		fn		
Eastern Screech Owl	fn	fn	fn	fn	fn		
Barred Owl		fn	fn	fn	fn		
Nightjar Family							
Chuck-will's-widow	fn	fn	fn				
Common Nighthawk	fn	fn	fn				
Swift Family							
Chimney Swift	fn	fn	fn	fn	fn		
Hummingbird Family							
Ruby-throated Hummingbird		fn	fn	fn	fn		
Kingfisher Family							
Belted Kingfisher	n	n	n	f		f	
Woodpecker Family							
Common Flicker	fn	fn	fn	f	f		
Pileated Woodpecker	f	f	f	fn	fn		
Red-bellied Woodpecker	fn	fn	fn	fn	fn		
Red-headed Woodpecker	fn	fn	fn				
Red-cockaded Woodpecker	fn	fn	f				
Downy Woodpecker	fn	fn	fn	fn	fn		
Hairy Woodpecker	fn	fn	fn	fn	fn		
Flycatcher Family							
Acadian Flycatcher			fn	fn	fn		
Great Crested Flycatcher	fn	fn	fn	fn	fn		
Eastern Kingbird	fn	fn					
Swallow Family							
Purple Martin Swallow	n	n	n	fn	fn	f	
Northern Rough-winged Swallow	n	n	n	f	f	f	

Table C.8. Birds by habitat (continued).

Species	Habitats						
	XS	FW	HH	CS	SH	M&R	EW
Jay and Crow Family							
Florida Scrub Jay	fn						
American Crow	fn	fn	fn				
Fish Crow		fn	fn			f	
Blue Jay	fn	fn	fn	fn	fn		
Titmouse Family							
Tufted Titmouse	fn	fn	fn	fn	fn		
Carolina Chickadee	fn	fn	fn	fn	fn		
Nuthatch Family							
Brown-headed Nuthatch		fn					
Wren Family							
Carolina Wren		fn	fn	fn	fn		
Old World Warbler and Kinglet Family							
Blue-gray Gnatcatcher		fn	fn	fn	fn		
Eastern Bluebird		fn	fn				
Mimic Thrush Family							
Northern Mockingbird	fn	fn	fn				
Brown Thrasher		fn	fn				
Shrike Family							
Loggerhead Shrike	fn	fn					
Vireo Family							
Yellow-throated Vireo			fn	fn	fn		
White-eyed Vireo	fn	fn	fn	fn	fn		
Red-eyed Vireo			fn		fn		
Wood Warbler Subfamily							
Yellow-throated Warbler		fn	fn				
Palm Warbler	fn	fn	fn	fn	fn	fn	
Pine Warbler	fn	fn					
Common Yellowthroat		fn	fn	fn		fn	
Northern Parula Warbler			fn		fn		
Prothonotary Warbler				fn	fn		
Hooded Warbler				fn	fn		

Table C.8. Birds by habitat (continued).

Species	XS	FW	HH	CS	SH	M&R	EW
	Habitats						
Tanager Subfamily							
Summer Tanager		fn	fn				
Cardinal Subfamily							
Northern Cardinal	fn	fn	fn	fn	fn		
Blue Grosbeak		fn	fn				
Painted Bunting		fn	fn				
Towhee and Sparrow Subfamily							
Bachman's Sparrow		fn					
Rufous-sided Towhee	fn	fn	fn				
Blackbird and Oriole Subfamily							
Red-winged Blackbird						fn	
Orchard Oriole		fn	fn				
Brown-headed Cowbird		fn	n	n	n		
Boat-tailed Grackle		fn			fn		
Common Grackle		fn	fn				
Eastern Meadowlark		fn					

[1] XS = Xeric Scrub

[2] FW = Flatwoods

[3] HH = Hardwood Hammock

[4] CS = Cypress Swamp

[5] SH = Swamp Hardwood

[6] M&R = Freshwater Marsh and River

[7] EW = Ephemeral Wetland

[8] f = use habitat to obtain food resources

[9] n = use habitat for nesting/breeding

Table C.9. MAMMAL use of habitats for feeding and nesting/breeding in the Econlockhatchee River Basin.

Species	Habitats						
	XS[1]	FW[2]	HH[3]	CS[4]	SH[5]	M&R[6]	
Opossum Family							
Opossum	f[7]n[8]	fn	fn	fn	fn	fn	
Shrew Family							
Least Shrew		fn				fn	
Southeastern Shrew			fn	fn	fn		
Mole Family							
Eastern Mole	fn	fn	fn				
Twilight Bat Family							
Big Brown Bat		fn	fn	fn	fn	f	
Red Bat			fn	fn	fn	f	
Hoary Bat			fn	fn	fn	f	
Yellow Bat			fn	fn	fn	f	
Evening Bat	fn	fn	fn	fn	fn	f	
Eastern Pipistrelle Bat		fn	fn	fn	fn	fn	f
Rafinesque's Big-eared Bat	fn	fn	fn	fn	fn	f	
Free-tailed Bat Family							
Brazilian Free-tailed Bat	fn	fn	fn	fn	fn	f	
Armadillo Family							
Nine-banded Armadillo	fn	fn	fn	f	f		
Rabbit Family							
Eastern Cottontail Rabbit		fn	fn				
Marsh Rabbit						fn	
Squirrel Family							
Southern Flying Squirrel	fn	fn	fn	fn	fn		
Gray Squirrel	fn	fn	fn	fn	fn		
Fox Squirrel	fn	fn					
Sherman's Fox Squirrel	fn	fn					
Pocket Gopher Family							
Southeastern Pocket Gopher	fn						
New World Rats, Mice, and Voles Family							
Round-tailed Muskrat						fn	
Marsh Rice Rat						fn	
Florida Mouse	fn	fn					
Cotton Mouse	fn	fn	fn				
Hispid Cotton Rat	fn	fn					

Table C.9. Mammals by habitat (continued).

Species	Habitats					
	XS	FW	HH	CS	SH	M&R
Raccoon Family						
Raccoon	fn	fn	fn	fn	fn	f
Weasel and Skunks Family						
River Otter				fn	fn	fn
Striped Skunk	fn	fn	fn			
Long-tailed Weasel	fn	fn	fn	f	fn	
Eastern Spotted Skunk	fn	fn	fn			
Foxes and Coyotes Family						
Gray Fox	fn	fn	fn	fn	fn	
Red Fox	fn	fn	fn			
Cat Family						
Bobcat	fn	fn	fn	f	f	
Deer Family						
White-tailed Deer	fn	fn	fn	f	f	
Pig Family						
Wild Boar	fn	fn	fn	f	f	f

[1] XS = Scrub or Sandhill

[2] FW = Flatwoods

[3] HH = Hardwood Hammock

[4] CS = Cypress Swamp

[5] SH = Swamp Hardwood

[6] M&R = Freshwater Marsh and Rivers

[7] f = use habitat to obtain food resources

[8] n = use habitat for nesting/breeding

Table C.10. Wildlife species' use of feeding and breeding zones (guilds) within the **XERIC SCRUB** habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Tree canopy	
		Cooper's Hawk
		American Swallow-tailed Kite
		Yellow-billed Cuckoo
		Blue Jay
		Eastern Kingbird
		Pine Warbler
		Evening Bat
		Eastern Pipistrelle Bat
		Refineque's Big-eared Bat
		Brazilian Free-tailed Bat
Tree canopy	Tree bole	
		Tufted Titmouse
		Chimney Swift
		Great Crested Flycatcher
Tree canopy	Ground surface	
		Chuck-will's-widow
		Common Nighthawk
		Northern Rough-winged Swallow
Tree bole	Tree bole	
		Red-bellied Woodpecker
		Red-headed Woodpecker
		Red-cockaded Woodpecker
		Downy Woodpecker
		Hairy Woodpecker
Tree bole	Breeds in other habitat	
		Squirrel Treefrog
		Pinewoods Treefrog
		Barking Treefrog
		Pileated Woodpecker
Shrubs or grasses	Tree bole	
		Carolina Chickadee
Shrubs or grasses	Shrubs or grasses	
		White-eyed Vireo
		Palm Warbler
Shrubs or grasses	Ground surface	
		Rough Green Snake
		Green Anole
		Southern Fence Lizard
Ground surface	Tree canopy	
		Loggerhead Shrike
		American Crow
		Mourning Dove
		Great horned Owl
		Red-tailed Hawk

Ground surface	Tree bole	
		Eastern Screech Owl
		Common Flicker
		Southeastern American Kestrel
		Southern Flying Squirrel
		Gray Squirrel
		Fox Squirrel
		Sherman's Fox Squirrel
		Opossum
		Raccoon
		Gray Fox
Ground surface	Shrubs or grasses	
		Florida Scrub Jay
		Northern Mockingbird
		Northern Cardinal
Ground surface	Ground surface	
		Florida Worm Lizard
		Peninsula Mole Skink
		Six-lined Racerunner
		Short-tailed Snake
		Central Florida Crowned Snake
		Killdeer
		Wild Turkey
		Burrowing owl
		Common Ground Dove
		Rufus-sided Towhee
		Northern Bobwhite
		Eastern Coral Snake
		Cotton Mouse
		Florida Mouse
		Hispid Cotton Rat
		Eastern Mole
		Eastern Slender Glass Lizard
		Ground Skink
		SE Five-lined Skink
		Gopher Tortoise
		SE Pocket Gopher
		Nine-banded Armadillo
		Eastern Hognose Snake
		Striped Skunk
		Long-tailed Weasel
		Scarlet Kingsnake
		Florida Scarlet Snake
		Southern Black Racer
		Eastern Coachwhip
		Corn Snake
		Florida Pine Snake
		Pine woods Snake
		Kingsnake
		Eastern Diamondback Rattlesnake
		Eastern Indigo Snake
		Florida Box Turtle
		Eastern Spotted Skunk
		Bobcat

		White-tailed Deer Wild Boar Red Fox
Ground surface	Breeds in other habitat	
		Oak Toad Southern Toad Florida Gopher Frog Eastern Narrowmouth Toad Eastern Spadefoot Toad Striped Newt Cattle Egret Turkey Vulture Black Vulture Sandhill Crane
Feeds in other habitat	Tree canopy	Southern Bald Eagle
Feeds in other habitat	Tree bole	Purple Martin Swallow
Feeds in other habitat	Ground surface	Florida Chicken Turtle Peninsula Cooter Florida Redbelly Turtle Striped Mud Turtle Florida Mud Turtle Loggerhead Musk Turtle Stinkpot Florida Softshell Turtle Belted Kingfisher

Table C.11. Wildlife species' use of feeding and breeding zones (guilds) within the **FLATWOODS** habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Tree canopy	
		Yellow-billed Cuckoo
		Orchard Oriole
		Summer Tanager
		American Swallow-tailed Kite
		Broad-winged Hawk
		Cooper's Hawk
		Yellow-throated Warbler
		Blue Jay
		Eastern Kingbird
		Pine Warbler
		Eastern Pipistrelle Bat
		Big Brown Bat
		Brazilian Free-tailed Bat
		Evening Bat
		Refinesque's Big-eared Bat
Tree canopy	Tree bole	
		Chimney Swift
		Tufted Titmouse
		Brown-headed nuthatch
		Great Crested Flycatcher
Tree canopy	Ground surface	
		Chuck-will's-widow
		Common Nighthawk
		Northern Rough-winged Swallow
Tree bole	Tree bole	
		Red-bellied Woodpecker
		Red-headed Woodpecker
		Red-cockaded Woodpecker
		Downy Woodpecker
		Hairy Woodpecker
Tree bole	Ground surface	
		Yellow Rat Snake
Tree bole	Breeds in other habitat	
		Green Treefrog
		Pinewoods Treefrog
		Squirrel Treefrog
		Pileated Woodpecker
Shrubs or grasses	Tree canopy	
		Blue-gray Gnatcatcher
Shrubs or grasses	Tree bole	
		Carolina Chickadee
		Carolina Wren
Shrubs or grasses	Shrubs or grasses	
		Blue Gosbeak

		Palm Warbler
		Painted Bunting
		White-eyed Vireo
		Ruby-throated Hummingbird
Shrubs or grasses	Ground surface	
		Common Yellowthroat
		Bachman's Sparrow
		Rough Green Snake
		Green Anole
Shrubs or grasses	Breeds in other habitat	
		Little Grass Frog
		Florida Chorus Frog
Ground surface	Tree canopy	
		Loggerhead Shrike
		Crested Caracara
		Short-tailed Hawk
		Barred Owl
		Boat-tailed Grackle
		Fish Crow
		Cattle Egret
		American Crow
		Common Grackle
		Mourning Dove
		Great horned Owl
		Red-tailed Hawk
Ground surface	Tree bole	
		Common Flicker
		Common Barn Owl
		Eastern Screech Owl
		Eastern Bluebird
		Southeastern American Kestrel
		Gray Squirrel
		Southern Flying Squirrel
		Fox Squirrel
		Sherman's Fox Squirrel
		Opossum
		Raccoon
		Gray Fox
Ground surface	Shrubs or grasses	
		Northern Mockingbird
		Brown Thrasher
		Brown-headed Cowbird
		Northern Cardinal
Ground surface	Ground surface	
		Six-lined Racerunner
		Short-tailed Snake
		Wild Turkey
		Black Vulture
		Turkey Vulture
		Common Ground Dove
		Rufus-sided Towhee
		Northern Bobwhite
		Eastern Coral Snake
		Central Florida Crowned Snake

		Florida Brown Snake
		Cotton Mouse
		Eastern Mole
		Ground Skink
		SE Five-lined Skink
		Gopher Tortoise
		Eastern Cottontail Rabbit
		Nine-banded Armadillo
		Eastern Hognose Snake
		Striped Skunk
		Long-tailed Weasel
		Scarlet Kingsnake
		Florida Scarlet Snake
		Southern Black Racer
		Southern Ringneck Snake
		Eastern Coachwhip
		Corn Snake
		Florida Pine Snake
		Pine woods Snake
		Kingsnake
		Dusky Pigmy Rattlesnake
		Eastern Diamondback Rattlesnake
		Eastern Indigo Snake
		Florida Box Turtle
		Killdeer
		Burrowing Owl
		Eastern Meadowlark
		Bobcat
		Least Shrew
		White-tailed Deer
		Florida Mouse
		Hispid Cotton Rat
		Eastern Spotted Skunk
		Wild Boar
		Red Fox
Ground surface	Breeds in other habitat	
		Oak Toad
		Southern Toad
		Eastern Narrowmouth Toad
		Eastern Spadefoot Toad
		Florida Gopher Frog
		Southern Leopard Frog
		Southern Dusky Salamander
		Dwarf Salamander
		Slimy Salamander
		Red-shouldered Hawk
		Sandhill Crane
Feeds in other habitat	Tree canopy	
		Great Blue Heron
		Great Egret
		Little Blue Heron
		Snowy Egret
		Tricolored Heron
		Black-crowned Night Heron

		Yellow-crowned Night Heron White Ibis Wood Stork Southern Bald Eagle Osprey
Feeds in other habitat	Tree bole	Wood Duck Purple Martin Swallow
Feeds in other habitat	Ground surface	Florida Snapping Turtle Florida Chicken Turtle Peninsula Cooter Florida Redbelly Turtle Striped Mud Turtle Florida Mud Turtle Loggerhead Musk Turtle Stinkpot Florida Softshell Turtle Eastern Mud Snake South Florida Swamp Snake North Florida Swamp Snake Peninsula Ribbon Snake Florida Cottonmouth Belted Kingfisher

Table C.12. Wildlife species' use of feeding and breeding zones (guilds) within the **HARDWOOD HAMMOCK** habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Tree canopy	
		Cooper's Hawk
		Broad-winged Hawk
		American Swallow-tailed Kite
		Summer Tanager
		Yellow-billed Cuckoo
		Orchard Oriole
		Yellow-throated Warbler
		Red-eyed Vireo
		Acadian Flycatcher
		Yellow-throated Vireo
		Blue Jay
		Northern Parula Warbler
		Eastern Pipistrelle Bat
		Big Brown Bat
		Brazilian Free-tailed Bat
		Evening Bat
		Hoary Bat
		Red Bat
		Refinewque's Big-eared Bat
		Yellow Bat
Tree canopy	Tree bole	
		Tufted Titmouse
		Chimney Swift
		Great Crested Flycatcher
Tree canopy	Ground surface	
		Chuck-will's-widow
		Common Nighthawk
		Northern Rough-winged Swallow
Tree bole	Tree bole	
		Red-bellied Woodpecker
		Red-headed Woodpecker
		Downy Woodpecker
		Hairy Woodpecker
Tree bole	Ground surface	
		Yellow Rat Snake
Tree bole	Breeds in other habitat	
		Green Treefrog
		Pinewoods Treefrog
		Squirrel Treefrog
		Pileated Woodpecker
		Red-cockaded Woodpecker
Shrubs or grasses	Tree canopy	
		Blue-gray Gnatcatcher
Shrubs or grasses	Tree bole	

		Carolina Chickadee
		Carolina Wren
Shrubs or grasses	Shrubs or grasses	
		Blue Gosbeak
		Palm Warbler
		Painted Bunting
		White-eyed Vireo
		Ruby-throated Hummingbird
Shrubs or grasses	Ground surface	
		Common Yellow-throat
		Rough Green Snake
		Green Anole
		Southern Fence Lizard
Shrubs or grasses	Breeds in other habitat	
		Southern Spring Peeper
		Little Grass Frog
		Florida Chorus Frog
Ground surface	Tree canopy	
		Short-tailed Hawk
		Fish Crow
		Cattle Egret
		American Crow
		Common Grackle
		Mourning Dove
		Great Horned Owl
		Red-tailed Hawk
Ground surface	Tree bole	
		Common Flicker
		Eastern Screech Owl
		Common Barn Owl
		Barred Owl
		Eastern Bluebird
		Southern Flying Squirrel
		Gray Squirrel
		Opossum
		Raccoon
		Gray Fox
Ground surface	Shrubs or grasses	
		Northern Mockingbird
		Brown Thrasher
		Northern Cardinal
Ground surface	Ground surface	
		Florida Worm Lizard
		Short-tailed Snake
		Eastern Slender Glass Lizard
		Broadhead Skink
		Six-lined Racerunner
		Wild Turkey
		Black Vulture
		Turkey Vulture
		Common Ground Dove
		Rufus-sided Towhee
		Northern Bobwhite
		Eastern Coral Snake

		Central Florida Crowned Snake
		Florida Brown Snake
		Cotton Mouse
		Eastern Mole
		Ground Skink
		Slimy Salamander
		SE Five-lined Skink
		Gopher Tortoise
		SE Shrew
		Eastern Cottontail Rabbit
		Nine-banded Armadillo
		Eastern Hognose Snake
		Striped Skunk
		Long-tailed Weasel
		Eastern Garter Snake
		Scarlet Kingsnake
		Southern Black Racer
		Southern Ringneck Snake
		Corn Snake
		Kingsnake
		Eastern Diamondback Rattlesnake
		Eastern Indigo Snake
		Florida Box Turtle
		Bobcat
		Eastern Spotted Skunk
		White-tailed Deer
		Wild Boar
		Red Fox
Ground surface	Breeds in other habitat	
		Southern Toad
		Eastern Narrowmouth Toad
		Eastern Spadefoot Toad
		Southern Leopard Frog
		Southern Dusky Salamander
		Dwarf Salamander
		Rusty Mud Salamander
		Peninsula Newt
		Red-shouldered Hawk
Feeds in other habitat	Tree canopy	
		Great Blue Heron
		Great Egret
		Little Blue Heron
		Snowy Egret
		Tricolored Heron
		Black-crowned Night Heron
		Yellow-crowned Night Heron
		White Ibis
		Wood Stork
		Southern Bald Eagle
		Osprey
Feeds in other habitat	Tree bole	
		Wood Duck
		Purple Martin Swallow
Feeds in other	Shrubs or grasses	

habitat		Brown-headed Cowbird
Feeds in other habitat	Ground surface	American Alligator Florida Snapping Turtle Florida Chicken Turtle Peninsula Cooter Florida Redbelly Turtle Striped Mud Turtle Florida Mud Turtle Loggerhead Musk Turtle Stinkpot Florida Softshell Turtle Eastern Mud Snake South Florida Swamp Snake North Florida Swamp Snake Peninsula Ribbon Snake Florida Cottonmouth Belted Kingfisher

Table C.13. Wildlife species' use of feeding and breeding zones (guilds) within the CYPRESS SWAMP habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Tree canopy	
		Acadian Flycatcher
		Broad-winged Hawk
		American Swallow-tailed Kite
		Blue Jay
		Yellow-billed Cuckoo
		Blue-gray Gnatcatcher
		Yellow-throated Vireo
		Big Brown Bat
		Red Bat
		Hoary Bat
		Yellow Bat
		Evening Bat
		Eastern Pipstrelle Bat
		Rafinesque's Big-eared Bat
		Brazilian Free-tailed Bat
Tree canopy	Tree bole	
		Chimney Swift
		Great Crested Flycatcher
		Purple Martin Swallow
		Tufted Titmouse
Tree canopy	Ground surface	
		Northern Rough-winged Swallow
Tree bole	Tree bole	
		Pileated Woodpecker
		Red-bellied Woodpecker
		Downy Woodpecker
		Hairy Woodpecker
Tree bole	Water column	
		Green Treefrog
Tree bole	Breeds in other habitat	
		Pinewoods Treefrog
		Barking Treefrog
		Squirrel Treefrog
Shrubs or grasses	Tree bole	
		Prothonotary Warbler
		Carolina Chickadee
		Carolina Wren
Shrubs or grasses	Shrubs or grasses	
		Hooded Warbler
		Ruby-throated Hummingbird
		White-eyed Vireo
		Palm Warbler
Shrubs or grasses	Ground surface	

		Common Yellowthroat
Shrubs or grasses	Water column	
		Southern Spring Peeper
		Florida Chorus Frog
Shrubs or grasses	Breeds in other habitat	
		Little Grass Frog
		Green Anole
Ground surface	Tree canopy	
		Red-shouldered Hawk
Ground surface	Tree bole	
		Barred Owl
		Eastern Screech Owl
		Opossum
		Southern Flying Squirrel
		Gray Squirrel
		Raccoon
		Gray Fox
Ground surface	Shrubs or grasses	
		Northern Cardinal
Ground surface	Ground surface	
		Eastern Garter Snake
		Southeastern Shrew
Ground surface	Water column	
		Southern Toad
		Florida Cricket Frog
		Bullfrog
		Southern Leopard Frog
		Southern Dusky Salamander
		Dwarf Salamander
		Peninsula Newt
Ground surface	Breeds in other habitat	
		Oak Toad
		Eastern Narrowmouth Toad
		Eastern Spadefoot Toad
		Florida Gopher Frog
		Stripped Newt
		Florida Scarlet Snake
		Southern Ringneck Snake
		Yellow Rat Snake
		Eastern Mud Snake
		Kingsnake
		South Florida Swamp Snake
		North Florida Swamp Snake
		Florida Brown Snake
		Central Florida Crowned Snake
		Peninsula Ribbon Snake
		Dusky Pigmy Rattlesnake
		Nine-banded Armadillo
		Long-tailed Weasel
		Bobcat
		White-tailed Deer
Water surface	Tree bole	
		Wood Duck

Water column	Tree canopy	
		Great Egret
		Snowy Egret
		White Ibis
		Little Blue Heron
		Great Blue Heron
		Tricolored Heron
		Black-crowned Night Heron
		Yellow-crowned Night Heron
		Wood Stork
Water column	Shrubs or grasses	
		Limpkin
		Green-backed Heron
		Anhinga
		Double-crested Cormorant
Water column	Ground surface	
		American Alligator
		Green Water Snake
		Brown Water Snake
		Striped Crayfish Snake
		River Otter
Water column	Water column	
		Two-toed Amphiuma
		Narrow-striped Dwarf Siren
		Eastern Lesser Siren
		Greater Siren
Water column	Breeds in other habitat	
		Florida Snapping Turtle
		Florida Chicken Turtle
		Peninsula Cooter
		Florida Redbelly Turtle
		Striped Mud Turtle
		Florida Mud Turtle
		Loggerhead Musk Turtle
		Stinkpot
		Florida Softshell
		Florida Cottonmouth
		Belted Kingfisher
Feeds in other habitat	Tree canopy	
		Cattle Egret
		Short-tailed Hawk
		Southern Bald Eagle
		Osprey
Feeds in other habitat	Tree bole	
		Common Flicker
Feeds in other habitat	Shrubs or grasses	
		Brown-headed Cowbird

Table C.14. Wildlife species' use of feeding and breeding zones (guilds) within the **SWAMP HARDWOODS** habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Tree canopy	
		Acadian Flycatcher
		Broad-winged Hawk
		American Swallow-tailed Kite
		Yellow-billed Cuckoo
		Northern Parula Warbler
		Red-eyed Vireo
		Blue-gray Gnatcatcher
		Yellow-throated Vireo
		Blue Jay
		Big Brown Bat
		Red Bat
		Hoary Bat
		Yellow Bat
		Evening Bat
		Eastern Pipstrelle Bat
		Rafinesque's Big-eared Bat
		Brazilian Free-tailed Bat
Tree canopy	Tree bole	
		Chimney Swift
		Great Crested Flycatcher
		Purple Martin Swallow
		Tufted Titmouse
Tree canopy	Ground surface	
		Northern Rough-winged Swallow
Tree bole	Tree bole	
		Pileated Woodpecker
		Red-bellied Woodpecker
		Downy Woodpecker
		Hairy Woodpecker
Tree bole	Water column	
		Green Treefrog
Tree bole	Breeds in other habitat	
		Pinewoods Treefrog
		Barking Treefrog
		Squirrel Treefrog
Shrubs or grasses	Tree bole	
		Prothonotary Warbler
		Carolina Chickadee
		Carolina Wren
Shrubs or grasses	Shrubs or grasses	
		Hooded Warbler
		Ruby-throated Hummingbird
		White-eyed Vireo

		Palm Warbler
Shrubs or grasses	Water column	
		Southern Spring Peeper
		Florida Chorus Frog
Shrubs or grasses	Breeds in other habitat	
		Little Grass Frog
		Green Anole
		Rough Green Snake
Ground surface	Tree canopy	
		Red-shouldered Hawk
		Great Horned Owl
		Boat-tailed Grackle
Ground surface	Tree bole	
		Barred Owl
		Eastern Screech Owl
		Opossum
		Southern Flying Squirrel
		Gray Squirrel
		Raccoon
		Gray Fox
Ground surface	Shrubs or grasses	
		Northern Cardinal
Ground surface	Ground surface	
		Eastern Garter Snake
		Southeastern Shrew
		Slimy Salamander
		Rusty Mud Salamander
Ground surface	Water column	
		Southern Toad
		Florida Cricket Frog
		Bullfrog
		Southern Leopard Frog
		Southern Dusky Salamander
		Dwarf Salamander
		Peninsula Newt
		Pig Frog
Ground surface	Breeds in other habitat	
		Oak Toad
		Eastern Narrowmouth Toad
		Broadhead Skink
		Ground Skink
		Florida Scarlet Snake
		Southern Black Racer
		Eastern Indigo Snake
		Southern Ringneck Snake
		Yellow Rat Snake
		Eastern Mud Snake
		Kingsnake
		South Florida Swamp Snake
		North Florida Swamp Snake
		Florida Brown Snake
		Peninsula Ribbon Snake
		Eastern Coral Snake
		Dusky Pigmy Rattlesnake

		Wild Turkey
		Nine-banded Armadillo
		Long-tailed Weasel
		Bobcat
		White-tailed Deer
		Wild Boar
Water surface	Tree bole	
		Wood Duck
Water column	Tree canopy	
		Great Egret
		Snowy Egret
		White Ibis
		Little Blue Heron
		Great Blue Heron
		Tricolored Heron
		Black-crowned Night Heron
		Yellow-crowned Night Heron
		Wood Stork
Water column	Shrubs or grasses	
		Limpkin
		Green-backed Heron
		Anhinga
		Double-crested Cormorant
Water column	Ground surface	
		American Alligator
		Green Water Snake
		Brown Water Snake
		Striped Crayfish Snake
		River Otter
Water column	Water column	
		Two-toed Amphiuma
		Narrow-striped Dwarf Siren
		Eastern Lesser Siren
		Greater Siren
Water column	Breeds in other habitat	
		Florida Snapping Turtle
		Florida Chicken Turtle
		Peninsula Cooter
		Florida Redbelly Turtle
		Striped Mud Turtle
		Florida Mud Turtle
		Stinkpot
		Florida Softshell
		Florida Cottonmouth
Feeds in other habitat	Tree canopy	
		Cattle Egret
		Short-tailed Hawk
		Southern Bald Eagle
		Osprey
Feeds in other habitat	Tree bole	Common Flicker
Feeds in other habitat	Shrubs or grasses	Brown-headed Cowbird

Table C.15. Wildlife species' use of feeding and breeding zones (guilds) within the **FRESHWATER MARSH AND RIVER** habitats in the Econlockhatchee River Basin.

Guilds		
Feeding Zone	Breeding Zone	Species
Tree canopy	Breeds in other habitat	
		American Swallow-tailed Kite
		Purple Martin Swallow
		Northern Rough-winged Swallow
		Big Brown Bat
		Red Bat
		Hoary Bat
		Yellow Bat
		Evening Bat
		Eastern Pipstrelle Bat
		Rafinesque's Big-eared Bat
		Brazilian Free-tailed Bat
Tree bole	Breeds in other habitat	
		Pinewoods Treefrog
		Barking Treefrog
		Squirrel Treefrog
Shrubs or grasses	Shrubs or grasses	
		Palm Warbler
		Red-winged Blackbird
Shrubs or grasses	Ground surface	
		Common Yellowthroat
Ground surface	Tree bole	
		Opossum
Ground surface	Ground surface	
		Least Shrew
		Florida Box Turtle
		Northern Harrier
		Marsh Rabbit
Ground surface	Water surface	
		Sandhill Crane
Ground surface	Water column	
		Southern Toad
		Florida Cricket Frog
		Bullfrog
		Southern Leopard Frog
		Southern Dusky Salamander
		Dwarf Salamander
		Peninsula Newt
		Pig Frog
Ground surface	Breeds in other habitat	
		Oak Toad
		Eastern Mud Snake
		South Florida Swamp Snake
		North Florida Swamp Snake

		Florida Brown Snake
		Peninsula Ribbon Snake
		Dusky Pigmy Rattlesnake
		Wild Boar
		Killdeer
		Fish Crow
		Raccoon
Water surface	Water surface	
		American Bittern
		Eastern Least Bittern
		American Coot
		Common Moorhen
		Purple Gallinule
		King Rail
		Round-tailed Muskrat
		Marsh Rice Rat
Water column	Tree canopy	
		Great Egret
		Snowy Egret
		White Ibis
		Little Blue Heron
		Great Blue Heron
		Tricolored Heron
		Black-crowned Night Heron
		Yellow-crowned Night Heron
		Florida Everglade Kite
Water column	Shrubs or grasses	
		Limpkin
		Green-backed Heron
		Doubel-crested Cormorant
		Anhinga
Water column	Ground surface	
		American Alligator
		Green Water Snake
		Brown Water Snake
		Florida Water Snake
		Striped Crayfish Snake
		River Otter
		Mottled Duck
		Mallard Duck
		Ring-necked Duck
		Fulvous Whistling Duck
		Black-necked Stilt
Water column	Water surface	
		Pied-billed Grebe
Water column	Water column	
		Two-toed Amphiuma
		Narrow-striped Dwarf Siren
		Eastern Lesser Siren
		Greater Siren
Water column	Breeds in other habitat	
		Florida Snapping Turtle
		Florida Chicken Turtle
		Peninsula Cooter

		Florida Redbelly Turtle Striped Mud Turtle Loggerhead Musk Turtle Florida Mud Turtle Stinkpot Florida Cottonmouth Wood Stork Wood Duck Southern Bald Eagle Osprey Belted Kingfisher
Water bottom	Ground surface	Limpkin
Feeds in other habitat	Tree canopy	Cattle Egret
Feeds in other habitat	Water Column	Green Treefrog

Table C.16. Spatial requirements reported for wildlife species that should occur almost exclusively in **WETLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual.

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Two-toed Amphiuma	50	habits very aquatic, needs enough adjacent land to provide good quality water	A 1
Narrow-striped Dwarf Siren	50	habits very aquatic, needs enough adjacent land to provide good quality water; endemic species	A 1
Eastern Lesser Siren	50	habits very aquatic, needs enough adjacent land to provide good quality water	A 1
Greater Siren	50	habits very aquatic, needs enough adjacent land to provide good quality water	A 1
Green Water Snake	50[3]	needs land for sunning and giving birth (linear home range in and adjacent to river: mean home range for 3 species in Nerodia genus = 5.7 ha)	R 1, R 2
Florida Water Snake	50	needs land for sunning and giving birth (linear home range in and adjacent to river: mean home range for 3 species in Nerodia genus = 5.7 ha); endemic species	R 1, R 2
Brown Water Snake	50	needs land for sunning and giving birth (linear home range in and adjacent to river: mean home range for 3 species in Nerodia genus = 5.7 ha)	R 1, R 2
Striped Crayfish Snake	50	needs land for sunning and laying eggs (similar to water snakes)	R 3
Florida Cottonmouth	50	needs land for sunning and giving birth (linear home range in and adjacent to river = 0.4 - 1.2 ha);	R 1
South Florida Swamp Snake	50	needs land for sunning and laying eggs (similar to water snakes) endemic species	R 4
North Florida Swamp Snake	50	needs land for sunning and laying eggs (similar to water snakes)	R 4
Eastern Mud Snake	50	needs land for sunning and laying eggs (similar to water snakes)	R 4
Pied-billed Grebe	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
American Bittern	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1

Table C.16. Spatial requirements reported for wildlife species that should occur almost exclusively in WETLAND habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Eastern Least Bittern	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
Florida Everglades Kite	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
American Coot	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
Common Moorhen	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
Purple Gallinule	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
King Rail	50	habitat requirements restricted to open water and littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
Red-winged Blackbird	50	habitat requirements restricted to littoral zones of marshes, needs enough adjacent land to provide good quality water	B 1
Black-necked Stilt	50	habitat requirements restricted to littoral zones and open shores of marshes, needs enough adjacent land to provide good quality water	B 1
Round-tailed Muskrat	50	habitat requirements restricted to littoral zones of marshes, needs enough adjacent land to provide good quality water; endemic species	M 1, M 2
Marsh Rice Rat	50	habitat requirements restricted to littoral zones of marshes, needs enough adjacent land to provide good quality water	M 1
Mallard Duck	50	very tolerant of humans	B 1
Double-crested Cormorant	50, 30-132	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting	B 2, B 3
Anhinga	50, 48-141	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting	B 2, B 3
River Otter	100	needs land for denning (linear home range in and adjacent to river = 1.7 - 3.6 miles of linear riparian habitat); imperiled species	M 3
Mottled Duck	120	minimum distance from humans tolerated while feeding	B 2
Florida Cricket Frog	180	adults forage in upland timber areas (similar to green treefrog which were found up to 180 feet from water); endemic species	A 1

Table C.16. Spatial requirements reported for wildlife species that should occur almost exclusively in WETLAND habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Limpkin	180, 39-165	similar to herons' tolerance to humans while feeding and nesting; listed species	B 1
Green-backed Heron	180, 39-165	similar to other herons' tolerance to humans while feeding and nesting	B 1
Ring-necked Duck	300	similar to wood duck	B 1
Fulvous Whistling Duck	300	similar to wood duck	B 1
Bullfrog	350	maximum distance found from permanent water	A 2
Pig Frog	350	similar to bullfrog	A 1
Hooded Warbler	450	minimum width of forested corridor bordered by development where species was found	B 4
Prothonotary Warbler	450	similar to hooded warbler	B 1
Marsh Rabbit	700	maximum distance found from shore	M 4

[1] Width needed values were determined by using spatial information reported in the literature including: home range (diameters were calculated), maximum distance a wetland species was found from the nearest water source, maximum distance a radio-tagged, wetland individual traveled from a water body to which it returned, minimum distance from humans tolerated, distance between captures of the same individual. If no spatial data were found for a species, width values for other species that are closely related, similar sized, found in comparable habitats, and categorized in similar guilds were used. Professional judgements also were needed to assure that the application of the literature data to determine a protection zone width was ecologically sound (e.g. alligators and otters have linear movement patterns that follow the river channel rather than circular home ranges that include extensive uplands).

[2] Information provided here includes: description of literature data or other explanation for "width needed" value; and an indication if species is endemic, imperiled, or listed.

[3] Highlighted numbers indicate that spatial data for a particular species were found in the literature.

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND and UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual.

Species	Width Needed (ft)[1]	Basis of Need[2]	References
American Alligator	50[3]	needs land for sunning and nesting (linear home range in and adjacent to river = 4.9 - 863.0 ha); listed species	R 5
Killdeer	50	needs undisturbed, open area for ground nest	B 1
Chimney Swift	50	very tolerant of humans	B 1
Purple Martin Swallow	50	very tolerant of humans	B 1
Northern Rough-wing Swallow	50	very tolerant of humans	M 6
Big Brown Bat	50	very tolerant of humans	M 5
Red Bat	50	very tolerant of humans	M 5
Hoary Bat	50	very tolerant of humans	M 5
Yellow Bat	50	very tolerant of humans	M 5
Evening Bat	50	very tolerant of humans	M 5
Eastern Pipistrelle Bat	50	very tolerant of humans	M 5
Rafinesque's Big-eared Bat	50	very tolerant of humans	M 5
Brazilian Free-tailed Bat	50	very tolerant of humans	M 5
Nine-banded Armadillo	50	very tolerant of humans	M 5
Rough Green Snake	51, 78	home range diameter (mean home range size = 0.019 ha, mean distance between captures of same marked individual = 78 feet); endemic species	R 1
Green Anole	51, 78	similar to rough green snake	R 6
Broadhead Skink	51, 78	similar to rough green snake	R 6
Ground Skink	51, 78	similar to rough green snake	R 6
Great Egret	60, 45-84	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting	B 2, B 3
Great Blue Heron	60, 48-144	similar to great egret, range of distances from humans tolerated while nesting	B 3
Cattle Egret	60, 33-63	similar to great egret, range of distances from humans tolerated while nesting	B 3
Osprey	60	very tolerant of humans	B 1
Ruby-throated Hummingbird	60	very tolerant of humans	B 1
Belted Kingfisher	60	very tolerant of humans	B 1

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND** and **UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Common Flicker	60	very tolerant of humans	B 1
Red-bellied Woodpecker	60	very tolerant of humans	B 1
Great Crested Flycatcher	60	very tolerant of humans	B 1
Fish Crow	60	very tolerant of humans	B 1
Northern Cardinal	60	very tolerant of humans	B 1
Brown-headed Cowbird	60	very tolerant of humans (thrives in open areas)	B 1
Boat-tailed Grackle	60	very tolerant of humans	B 1
Blue Jay	60	very tolerant of humans	B 1
Carolina Wren	60	very tolerant of humans	B 1
Gray Squirrel	60	very tolerant of humans	B 1
Raccoon	60	very tolerant of humans (linear home range adjacent to river, maximum length of home range = 1 mile)	M 6
Opossum	60	very tolerant of humans	M 5
Southern Flying Squirrel	60	tolerant of humans	M 5
Southeastern Shrew	60	tolerant of humans but not cats	M 5
Least Shrew	60	tolerant of humans but not cats	M 5
Florida Brown Snake	93, 177-591	diameter of home range, ranges of mean distances between captures of same marked individuals	R 1
Southern Ringneck Snake	93, 177-591	similar to Florida brown snake	R 4
Central Fl. Crowned Snake	93, 177-591	similar to Florida brown snake; endemic, imperiled species	R 4
Eastern Coral Snake	93, 177-591	similar to Florida brown snake	R 4
Southern Dusky Salamander	93, 177-591	similar to Florida brown snake	A 1
Dwarf Salamander	93, 177-591	similar to Florida brown snake	A 1
Slimy Salamander	93, 177-591	similar to Florida brown snake	A 1
Rusty Mud Salamander	93, 177-591	similar to Florida brown snake	A 1
Tufted Titmouse	166	diameter of smallest isolate forest patch in which species was found	B 5, B 6
Carolina Chickadee	166	similar to tufted titmouse	B 1
Red-eyed Vireo	180	minimum width of forested corridor bordered by development where species was found	B 4

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND** and **UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Green Treefrog	180	maximum distance found from water	A 3
Squirrel Treefrog	180	similar to green treefrog	A 1
Little Grass Frog	180	similar to green treefrog	A 1
Southern Toad	180	similar to green treefrog	A 1
Little Blue Heron	180, 39-63	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting; listed species	B 2, B 3
Black-crowned Night Heron	180, 51-69	similar to little blue heron, range of distances from humans tolerated while nesting	B 3
Yellow-crowned Night Heron	180, 51-69	similar to little blue heron and black-crowned night heron	B 1
Florida Chorus Frog	180	similar to green treefrog; endemic species	A 1
Common Yellowthroat	203-2,865	home range diameters (densities of 1.75 to 348 pair/100 ha reported)	B 7, B 8
Snowy Egret	240, 123-165	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting; listed species	B 2, B 3
Tricolored Heron	240, 75-141	similar to snowy egret, range of distances from humans tolerated while nesting; listed species	B 3
White Ibis	240, 38-120	minimum distance from humans tolerated while feeding, range of distances from humans tolerated while nesting	B 2, B 3
Wood Duck	300	minimum distance from humans tolerated while feeding	B 2
Penninsula Ribbon Snake	333	home range diameter	R 1
Southern Leopard Frog	350	similar to bullfrog	A 1
Dusky Pigmy Rattlesnake	368	home range diameter (home range = 0.98 ha)	R 1
Southern Black Racer	508-1,174, 336-525	range of home range diameters, ranges of mean distances between captures of same marked individuals	R 1
Acadian Flycatcher	300-600, 450	range of home range diameters, minimum width of forested corridor bordered by development where species was found	B 4
Downy Woodpecker	740	home range diameter	B 9
Hairy Woodpecker	740	similar to downy woodpecker	B 1
Yellow-billed Cuckoo	745	diameter of smallest isolated forest patch in which species was found	B 5

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND and UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Yellow Rat Snake	1,155-1,297, 525-585	range of home range diameters, ranges of mean distances between captures of same marked individuals	R 1
Fl. Scarlet Snake	1,155-1,297, 525-585	similar to yellow rat snake; endemic species	R 4
Sandhill Crane	1,200	tends to nest away from roads and other development activity, only occurs in open prairies and marshes; endemic, imperiled, and listed species	B10
Northern Parula Warbler	1,183	diameter of smallest isolated forest patch in which species was found	B 6
Palm Warbler	1,183	similar to northern parula warbler	B 1
Blue-gray Gnatcatcher	1,183	similar to northern parula warbler	B 1
Yellow-throated Vireo	1,183	similar to northern parula warbler	B 1
White-eyed Vireo	1,183	similar to northern parula warbler	B 1
Striped Mud Turtle	1,350	maximum distance a radio-tagged individual traveled round-trip from shore to uplands (needs sandy soil for nesting); endemic species	R 7
Florida Snapping Turtle	1,350	similar to striped mud turtle; endemic species	R 6, R 8
Florida Chicken Turtle	1,350	similar to striped mud turtle; endemic species	R 6
Peninsula Cooter	1,350	similar to striped mud turtle; endemic species	R 6
Florida Redbelly Turtle	1,350	similar to striped mud turtle; endemic species	R 6
Florida Mud Turtle	1,350	similar to striped mud turtle; endemic species	R 6
Loggerhead Musk Turtle	1,350	similar to striped mud turtle	R 6
Stinkpot	1,350	similar to striped mud turtle	R 6
Florida Softshell	1,350	similar to striped mud turtle	R 6
Eastern Garter Snake	333-1,403, 513-636	range of home range diameters, range of mean distances between captures of same marked individiuals	R 1
Southern Bald Eagle	1,500	restricted activity zone around nest; imperiled and listed species	B11
Wood Stork	1,500	deserve as much protection as eagles; listed species	B12
Kingsnake	1,664, 780	similar to scarlet kingsnake	R 4
Red-shld. Hawk	1,177-2,346, 2,640-2978	range of diameters of smallest isolate forest patches in which species was found, range of home range diameters	B 5, B13
Short-tailed Hawk	1,177-2,346, 2,640-2978	similar to red-shouldered hawk	B 1
Broad-wng. Hawk	1,177-2,346, 2,640-2978	similar to red-shouldered hawk	B 1

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND and UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Am. Sw.-tail. Kite	1,177-2,346, 2,640-2978	similar to red-shouldered hawk; imperiled species	B 1
Barred Owl	3,455-7,153	range of home range diameters	B14, B15
Great Horned Owl	3,455-7,153	similar to barred owl but prefers more opened canopy	B 1
Eastern Screech Owl	3,455-7,153	similar to barred owl	B 1
Southern Spring Peeper	4,000	maximum distance found from breeding pond	A 4
Pinewoods Treefrog	4,000	similar to spring peeper	A 1
Barking Treefrog	4,000	similar to spring peeper	A 1
E. Narrowmouth Toad	4,000	similar to spring peeper	A 1
Eastern Spadefoot Toad	4,000	similar to spring peeper	A 1
Striped Newt	4,000	similar to spring peeper; endemic and imperiled species	A 1
Peninsula Newt	4,000	similar to spring peeper; endemic species	A 1
Pileated Woodpecker	3,098-5,763, 2,419	range of home range diameters, diameter of smallest isolate forest patch in which species was found	B16, B 6
Eastern Indigo Snake	4,654	home range diameter; imperiled and listed species	R 9
Long-tailed Weasel	5,280-10,560	range of home range diameters; endemic species	M 2
Florida Box Turtle	5,280	home range diameter	R 6
Bobcat	4,710-12,638	range of home range diameters	M 7
White-tailed Deer	5,959	home range diameter	M 5
Wild Boar	5,959	similar to white-tailed deer	M 5
Florida Gopher Frog	6,336	distance between captures of same marked individual; imperiled and listed species	A 5
Oak Toad	6,336	similar to gopher frog	A 1
Gray Fox	7,084-10,708	range of home range diameters	M 8
Wild Turkey	10,472	home range diameter	B17

Table C.17. Spatial requirements reported for wildlife species that should occur in both **WETLAND and UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

[1] Width needed values were determined by using spatial information reported in the literature including: home range (diameters were calculated), maximum distance a wetland species was found from the nearest water source, maximum distance a radio-tagged, wetland individual traveled from a water body to which it returned, minimum distance from humans tolerated, distance between captures of the same individual. If no spatial data were found for a species, width values for other species that are closely related, similar sized, found in comparable habitats, and categorized in similar guilds were used. Professional judgements also were needed to assure that the application of the literature data to determine a protection zone width was ecologically sound (e.g. alligators and otters have linear movement patterns that follow the river channel rather than circular home ranges that include extensive uplands).

[2] Information provided here includes: description of literature data or other explanation for "width needed" value; and an indication if species is endemic, imperiled, or listed.

[3] Highlighted numbers indicate that spatial data for a particular species were found in the literature.

Table C.18. Spatial requirements reported for wildlife species that should occur almost exclusively in UPLAND habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Southern Fence Lizard	51	similar to rough green snake	R 6
Peninsula Mole Skink	51	similar to rough green snake; endemic and imperiled species	R 6
Southeastern Five-lined Skink	51	similar to rough green snake	R 6
Sixlined Racerunner	51	similar to rough green snake	R 6
E. Slender Glass Lizard	51	similar to rough green snake	R 6
Eastern Kingbird	60	needs very little forest (edge species)	B 1
American Crow	60	needs very little forest (edge species)	B 1
Eastern Bluebird	60	needs very little forest (edge species)	B 1
Northern Mockingbird	60	needs very little forest (edge species)	B 1
Brown Thrasher	60	needs very little forest (edge species)	B 1
Loggerhead Shrike	60	needs very little forest (edge species)	B 1
Northern Bobwhite	60	needs very little forest (edge species)	B 1
Common Ground Dove	60	needs very little forest (edge species)	B 1
Mourning Dove	60	needs very little forest (edge species)	B 1
Blue Grosbeak	60	needs very little forest (edge species)	B 1
Painted Bunting	60	needs very little forest (edge species)	B 1
Orchard Oriole	60	needs very little forest (edge species)	B 1
Common Grackle	60	needs very little forest (edge species)	B 1
Cotton Mouse	71[3]	home range diameter	M 9
Eastern Mole	71	similar to cotton mouse	M 5
Florida Mouse	71	similar to cotton mouse; endemic and listed species	M 2
Hispid Cotton Rat	71	similar to cotton mouse	M 5
Pocket Gopher	71	similar to cotton mouse	M 5
Florida Worm Lizard	93, 177-591	similar to Florida brown snake; endemic species	R 6
Bachman's Sparrow	166	similar to tufted titmouse	B 1
Chuck-will's-widow	166	similar to tufted titmouse	B 1
Rufous-sided Towhee	166	similar to tufted titmouse	B 1
Scrub Jay	166	similar to tufted titmouse; endemic, imperiled, and listed species	B 1

Table C.18. Spatial requirements reported for wildlife species that should occur almost exclusively in **UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Eastern Meadowlark	166	similar to tufted titmouse, requires open fields	B 1
Brown-headed Nuthatch	166	similar to tufted titmouse in pine forests	B 1
Gopher Tortoise	247	home range diameter; imperiled and listed species	R10
Summer Tanager	>450	minimum width of forested corridor bordered by development where species was found	B 4
Turkey Vulture	500	needs undisturbed forested area for nesting	B 1
Black Vulture	500	needs undisturbed forested area for nesting	B 1
Eastern Cottontail Rabbit	527	home range diameter	M 5
Eastern Hognose Snake	732	distance between captures of same individual	R 1
Red-headed Woodpecker	890	home range diameter	B18
Fox Squirrel	1,053	home range diameter	M10
Sherman's Fox Squirrel	1,053	similar to fox squirrel; endemic, imperiled, and listed species	M 2
Yellow-throated Warbler	1,183	similar to northern parula warbler	B 1
Pine Warbler	1,183	similar to northern parula warbler	B 1
Florida Pine Snake	1,155-1,297, 525-585	similar to yellow rat snake; imperiled and listed species	R 4
Pine Woods Snake	1,155-1,297, 525-585	similar to yellow rat snake	R 4
Short-tailed Snake	1,155-1,297, 525-585	similar to yellow rat snake; endemic, imperiled, and listed species	R 4
Corn Snake	1,155-1,297, 525-585	similar to yellow rat snake	R 4
Scarlet Kingsnake	1,664, 780	home range diameter, distance bewteen captures of same marked individual	R 1
Eastern Coachwhip	1,686	home range diameter	R 1
SE American Kestrel	2,622-6,627	range of home range diameters; listed species	B19, B20, B21
Common Barn Owl	2,622-6,627	similar to kestrel	B 1
Burrowing Owl	2,622-6,627	similar to kestrel; imperiled and listed species	B 1
Cooper's Hawk	5,159	home range diameter	B22
Striped Skunk	5,280-10,560	similar to long-tailed weasel	M 5
Eastern Spotted Skunk	5,280-10,560	similar to long-tailed weasel	M 5
Red-tailed Hawk	10,560	home range diameter	B23

Table C.18. Spatial requirements reported for wildlife species that should occur almost exclusively in **UPLAND** habitats in the Econlockhatchee River Basin expressed as width of land (not water) needed by one individual (continued).

Species	Width Needed (ft)[1]	Basis of Need[2]	References
Crested Caracara	10,560	similar to red-tailed hawk, only in open prairies and flatwoods; imperiled and listed species	B 1
Northern Harrier	10,560	similar to red-tailed hawk, only in marshes	B 1
E. Diamondback Rattlesnake	2,756	home range diameter; imperiled species	R 1
Red-cockaded Woodpecker	3,960	recommended 3/4 mile protection zone by the USFWS; imperiled and listed species	B24
Red Fox	9,113-13,544	range of home range diameters	M 8

[1] Width needed values were determined by using spatial information reported in the literature including: home range (diameters were calculated), maximum distance a wetland species was found from the nearest water source, maximum distance a radio-tagged, wetland individual traveled from a water body to which it returned, minimum distance from humans tolerated, distance between captures of the same individual. If no spatial data were found for a species, width values for other species that are closely related, similar sized, found in comparable habitats, and categorized in similar guilds were used. Professional judgements also were needed to assure that the application of the literature data to determine a protection zone width was ecologically sound (e.g. alligators and otters have linear movement patterns that follow the river channel rather than circular home ranges that include extensive uplands).

[2] Information provided here includes: description of literature data or other explanation for "width needed" value; and an indication if species is endemic, imperiled, or listed.

[3] Highlighted numbers indicate that spatial data for a particular species were found in the literature.

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FEEDING ZONE

FEEDING ZONE \ BREEDING ZONE	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)				3		3	1 10		1 16
Tree Bole (TB)						1 5		4	1 9
Shrubs/ Grasses (S/G)				1 3	2	1			1 6
Ground Surface (GS)				13 41	1 3	2 10	5	3 10	19 69
Water Surface (WS)									
Water Column (WC)									
Water Bottom (WB)									
Feeds in other habitat				5 9		1	1 1		6 11
Totals				19 56	1 5	3 20	2 16	3 13	28 111

BREEDING ZONE

Figure C-1. Guild matrix with feeding and breeding zones for wildlife species that occur in XERIC SCRUB habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

FEEDING ZONE

FEEDING ZONE \ BREEDING ZONE	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)				3		4	1 15		1 22
Tree Bole (TB)				1		1 5		4	1 10
Shrubs/ Grasses (S/G)				1 4	5	2	1	1 2	2 14
Ground Surface (GS)				11 45	4	2 12	2 12	2 11	17 84
Water Surface (WS)									
Water Column (WC)									
Water Bottom (WB)									
Feeds in other habitat				7 15		2	5 11		12 28
Totals				19 68	9	3 25	8 39	3 17	33 158

BREEDING ZONE

Figure C-2. Guild matrix with feeding and breeding zones for wildlife species that occur in FLATWOODS habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

FEEDING ZONE

Feeding zone	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)				3		3	1 20		1 26
Tree Bole (TB)				1		4		1 5	1 10
Shrubs/ Grasses (S/G)				1 4	5	2	1	1 3	2 15
Ground Surface (GS)				8 40	3	10	1 8	1 9	9 70
Water Surface (WS)									
Water Column (WC)									
Water Bottom (WB)									
Feeds in other habitat				8 16	1	2	5 11		13 30
Totals				17 64	9	21	7 40	3 17	27 151

BREEDING ZONE

Figure C-3. Guild matrix with feeding and breeding zones for wildlife species that occur in **HARDWOOD HAMMOCK** habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

FEEDING ZONE

FEEDING ZONE \ BREEDING ZONE	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)				1		4	15 (1)		20 (1)
Tree Bole (TB)		1				4		3	8
Shrubs/ Grasses (S/G)		2 (1)		1	4	3		2	12 (1)
Ground Surface (GS)		7 (2)		2	1	7	1	21 (5)	39 (7)
Water Surface (WS)						1			1
Water Column (WC)		4 (1)		5 (2)	4 (1)		9 (4)	11 (6)	33 (14)
Water Bottom (WB)									
Feeds in other habitat					1	1	4 (2)		6 (2)
Totals		14 (4)		9 (2)	10 (1)	20	29 (7)	37 (11)	119 (25)

BREEDING ZONE

Figure C-4. Guild matrix with feeding and breeding zones for wildlife species that occur in CYPRESS SWAMP habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

FEEDING ZONE

Feeding zone \ Breeding zone	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)				1		4	1 17		1 22
Tree Bole (TB)		1				4		3	8
Shrubs/ Grasses (S/G)		1 2			4	3		1 3	2 12
Ground Surface (GS)		2 8		4	1	7	3	5 23	8 47
Water Surface (WS)						1			1
Water Column (WC)		1 4		2 5	1 3		4 10	6 9	14 31
Water Bottom (WB)									
Feeds in other habitat					1	1	2 4		2 6
Totals		4 15		2 10	1 9	20	7 34	12 38	26 126

BREEDING ZONE

Figure C-5. Guild matrix with feeding and breeding zones for wildlife species that occur in SWAMP HARDWOOD habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

FEEDING ZONE

Feeding zone	WB	WC	WS	GS	S/G	TB	TC	Breeds in other habitat	Total
Tree Canopy (TC)								1 11	1 11
Tree Bole (TB)								3	3
Shrubs/ Grasses (S/G)				1	2				3
Ground Surface (GS)		2 8	1 1	1 4		1		1 11	5 25
Water Surface (WS)			1 8						1 8
Water Column (WC)		1 4	1	3 11	1 4		4 9	8 14	17 43
Water Bottom (WB)									
Feeds in other habitat		1					1		2
Totals		3 13	2 10	4 16	1 6	1	4 10	10 39	24 95

BREEDING ZONE

Figure C-6. Guild matrix with feeding and breeding zones for wildlife species that occur in **FRESHWATER MARSH AND RIVER** habitats in the Econlockhatchee River Basin. The number of species using each feeding/breeding guild (center of square) and the number of species with ecological and legal statuses (endemic, imperiled, endangered, threatened, and special concern species; see Table 3.3.) in the guild (upper-right corner) are shown.

ECONLOCKHATCHEE RIVER BASIN NATURAL RESOURCES DEVELOPMENT AND PROTECTION PLAN

Chapter 4

HISTORICAL RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

Prepared for

St. Johns River Water Management District

October 1990

Chapter 4

HISTORICAL RESOURCES OF THE ECONLOCKHATCHEE RIVER BASIN

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INTRODUCTION

Issues

In this period of rapid development and change in our environment, society has become increasingly aware of the significance and fragility of the nation's historical resources. These resources, whether archaeological sites, historic structures, or historic sites, provide a direct link to our heritage. Unlike natural resources which, given time, can often be reproduced or reestablished, historical resources are non-renewable. Once archaeological sites or historic structures are destroyed, the information they contain relevant to our history or prehistory is irretrievably lost and the physical link to the past is significantly diminished. In order to mitigate this loss, the federal and state governments have established specific procedures for historical resource management. The Econlockhatchee Basin (Econ Basin) historical resources plan presented in this document is based on these established procedures.

Three basic properties are involved in historical resource management: archaeological sites, historic structures or architecture, and historic sites. Archaeological sites consist of artifacts and other associated remains or features which provide evidence of past human occupation or utilization of the property. Sites in Florida may include ceramics, lithic (stone) artifacts, bone, shell, human burials, postmolds, storage pits, wells, foundations, or mounds. The significance of such sites is determined based on the criteria for listing in the National Register of Historic Places (NRHP). Documentation of archaeological sites allows the scholar to interpret the activities which previously occurred on the site and thus understand the way other prehistoric or historic peoples used and occupied the land. The scientific value of an archaeological site lies in its context and the comparison of the material to that of similar sites. Disturbance or destruction of this context significantly reduces the value of the sites.

Historic structures reflect the nature of their builders and the communities within which they are located. They provide a sense of place and history for the community. Often they are associated with specific landscape features and archaeological remains. Structures may also provide guidance as to successful adaptations to specific environmental characteristics of an area, or innovative uses of materials. These structures contribute to our understanding of changing life styles, economic bases, technology, and raw material availability. When combined with historic archaeology and archival records, studies of these properties provide a glimpse of the lives of those who constructed and utilized the resources.

Historic sites commemorate important events in a region's past. Such sites may also conserve features of the natural environment. In addition, historic sites frequently contain archaeological remains associated with the events which occurred at that location.

Successful stewardship of our heritage requires the combined efforts of both the public and private realms. The public realm--government agencies and preservation organizations -- provide the legal framework, guidance, and, often funding for preservation efforts. However, the private realm must support and cooperate with the public realm in order to have a successful preservation program. Implementation of an historical resource management program often requires compromise, and sometimes innovative thinking from both groups.

Historical resource management consists of several basic steps:

1) Identification of the resources. This step is intended to locate and identify the nature of the historical resources within a given area. Generally identification requires a literature search and some form of field survey. The survey may be a simple windshield survey as often used for architectural resources, or it may be a more complex subsurface examination for archaeological resources.

2) Evaluation of the resources. This step involves assessing the significance of a resource and its potential eligibility for nomination to the NRHP. An evaluation normally requires the assistance of expert consultants such as archaeologists, historians, and/or architectural historians. Significance is based on an evaluation of the property's importance at a local, regional, or national level. Significance is based on a site's integrity, uniqueness, research potential, and relationship to historic persons or events.

3) Management of the resources. Management can take many forms, ranging from simple avoidance of a site during the development process, to in-depth study of a site, to active preservation and interpretation. The simplest form of management is avoidance. However, this is not always feasible or appropriate. In addition, the condition of a property may require active steps to protect it from deterioration. If avoidance is not selected, management may consist of maintaining a site, restoration or rehabilitation, interpretation, or, in a case of imminent development or destruction, salvage of the information from the site.

An effective resource management plan for the Econ Basin must address two goals: (1) it must protect the significant historical resources within the basin; and, (2) in protecting these resources, it must not unfairly or unreasonably restrict the rights of the landowners to use their property. It must be recognized that in some cases, the only way to attain both of these goals is through public acquisition of the property containing the significant resources.

Scope of the Study

The historical resource management plan for this phase of the Econ Basin project was designed to examine existing information on the area. Due to time and budget constraints, no fieldwork was attempted. The information utilized was obtained from the files of the Florida Division of Historical Resources (FDHR), the St. Johns River Water Management District, Rollins College, Piper Archaeology, P.K. Yonge Library of Florida History, the Map Library of the University of Florida, and the files of SouthArc, Inc.

In addition, informants were consulted concerning their knowledge of the area's resources. These informants included archaeologists from FDHR, the Florida Museum of Natural History, Rollins College, and Piper Archaeology. Other informants included Ken Bosserman of the Friends of the Econ and Brian Hickman of the Orange County Historical Museum.

The existing literature on the Econ Basin ranges from Florida Master Site File forms to general syntheses of the region's cultural history. This literature is reviewed in a later section of this document. Informants provided personal knowledge of the area's resources as well as input as to resource management needs for the region. Environmental information was utilized to make preliminary assessments of the potentially sensitive areas of the basin in terms of historical resources.

In order to thoroughly document and assess the historical resources of the Econ Basin, field survey is the primary need. The area is relatively little known or documented archaeologically and historically. All too often, the development which has occurred in the region has not included historical assessments. Therefore, not only are very few sites identified or assessed for significance, but it is also difficult to make valid predictions as to which portions of the basin might be sensitive in terms of historical resource potential.

Thorough examination of both historic and recent aerial photography might also be a major aid in identifying historical resources and areas of sensitivity. Correlation of photography with topographic and soils information, field survey results, and data on known sites would allow development of a reasonably accurate model for resource sensitivity within the basin. The Map Library of the University of Florida has complete aerial coverage of the basin, although stereoscopic coverage is limited. This coverage includes 1940, 1947, and 1957 aerials of Seminole County, 1947 and 1954 aerials of Orange County, and 1944, 1952, and 1954 aerials of Osceola County.

These recommendations are discussed in greater detail in the Management Alternatives section of this document.

Definition of Terms

The terms presented in this section are commonly used within the field of historical resource management (USMC 1986; Eubanks and Adams 1986; McGimsey n.d.). This list is not meant to be all inclusive, but will assist the reader in understanding the discussions in this document. The list is based on terminology established by the federal system of historical resource management as well as terms commonly used within the profession itself.

Aboriginal -- Generally refers to Native American or Indian occupations.

Advisory Council on Historic Preservation (ACHP) -- An independent federal agency tasked with formulating cultural resources protection policy and with commenting on federal agency undertakings which affect NRHP properties.

Archaeology -- The scientific discipline responsible for studying the social and cultural past through material remains, with the goal of ordering and describing the events of the past and explaining the meaning of these events.

Archaeological Assessment -- An evaluation of the archaeological resources present in an area, their scientific significance, and the cost of protecting or properly investigating them.

Archaeological Data -- Information embodied in material remains, artifacts, structures, refuse, etc., produced purposely or accidentally by human activity and the information embodied in the spatial relationships among such remains.

Archaeological Data Recovery -- The systematic removal of a portion or all of the scientific, prehistoric, historic and/or archaeological data that qualify a property for listing on the NRHP.

Archaeological Excavation -- The scientifically controlled recovery or salvage of a site designed to yield maximum information about the life of the inhabitants, their ways of solving human problems, and of adjusting to and modifying their natural environment. Such work should be programmed during final planning stages or at least during the early stage of project construction.

Archaeological Inventory -- A presentation and summation of the data presently known concerning an area. This is called by some agencies a records check. Only in very rare instances is present information sufficient to assess adequately the archaeological resources or to estimate the cost of mitigating the impact of a proposed project on those resources.

Artifact -- A material object made or modified in whole or in part by man. Among the most common artifacts on archaeological sites are fragments of broken pottery (sherds), or stone (lithic) tools, chips (debitage), projectile points, and similar lithic debris.

Consultation -- The act of seeking and considering the opinions and recommendations of appropriate parties about undertakings which might affect NRHP properties. Appropriate parties normally include the SHPO. Consultation is very formal and procedurally oriented; correct procedures are promulgated in federal law 36CFR800.

Criteria of Effect -- Standards promulgated by ACHP (in 36CFR800) and applied to determine whether an undertaking will affect any property on the NRHP. Effect is an action that results in a change, beneficial or adverse, in the quality or characteristics that qualify a property for inclusion in the NRHP. Adverse effect results in total or partial destruction or alteration of a NRHP property or eligible property. Adverse effect may also result if a property is isolated from its surrounding environment, if neglect of the property results in the deterioration or destruction of the property, and/or if the land occupied by the property is sold or transferred, and there are no provisions in the deed or transfer agreement to provide for the preservation, maintenance, or use of the property.

Criteria for Evaluation -- Criteria established in federal law 36CFR60 to be applied in determining whether a cultural resource is eligible for listing on the NRHP.

Cultural Resource -- Any building, district, site, structure, or object of historical, archaeological, architectural, engineering, or cultural significance.

Cultural Resource Professional -- An anthropologist, archaeologist, architectural historian, historical architect, or other professional with specialized training/experience in work required to comply with cultural resources legislation.

Cultural Resources Inventory -- A detailed descriptive listing of an area's cultural resources, including evaluations of significance according to NRHP criteria.

Cultural Resources Management Plan -- Includes inventory and categorization of an area's cultural resources, serving as a basis for on-going maintenance and protection from adverse effects of a planned undertaking. Also known as a Historical Resources Management Plan.

Cultural Resources Protection -- Not always the same as preservation, protection includes (1) routine maintenance and security, (2) consideration of effects any undertaking could have on cultural resources, and (3) formal documented consultation with the SHPO.

Cultural Resources Survey -- The systematic process of locating and identifying cultural resources so as to comply with the National Historic Preservation Act Amendments of 1980. There are two types of survey, the "reconnaissance" survey and the "detailed" or "intensive" survey.

Data Recovery -- Recovery prior to destruction of information contained in archaeological resources which are significant mainly for their value in scientific study.

Debitage -- Lithic debris resulting from the manufacture of stone tools.

Determination of Eligibility -- Decision as to whether or not a property meets the criteria of eligibility for listing in the NRHP as published in 36CFR60. Although agencies or persons cooperate with the SHPO in locating properties likely to meet the criteria, only the Keeper of the NRHP is empowered to make formal determinations of eligibility.

Division of Historical Resources (DHR or FDHR) -- Florida state agency responsible for administering state and federal regulations concerning cultural or historical resources. It is a division of the Florida Department of State and is directed by the SHPO.

Eligible Property -- Any district, site, building, structure, ruin, or object that meets the NRHP Criteria for Eligibility (36CFR60.6).

Environmentally Sensitive Area -- Any location containing endangered or protected plants, animals, or historical properties.

Evaluation -- The process of applying NRHP criteria of significance to apparently eligible resources and the categorizing of resources in preparation of a cultural resource management plan.

Feature -- An area in or on the ground where evidence of past human activities can be seen or detected. Among the most frequent features on archaeological sites are fire pits, storage pits, burial pits, hard-packed house floors, foundations, and postholes.

Historic District -- A geographically definable area which has a concentration of cultural/historical resources.

Historic Site -- A location where a significant event took place or where a significant cultural resource is now or used to be situated.

Intensive Archaeological Reconnaissance -- An on-the-ground surface survey and subsurface testing of an area sufficient to permit determination of the number and extent of the resources present, their scientific importance, and the time factors and cost of preserving them or otherwise mitigating any adverse effects on them. This level of investigation is most appropriate once a specific region or area to be affected has been determined or the choice has been narrowed to one of a few prime locations.

Keeper of the NRHP -- National Park Service official formally responsible for maintaining and publishing the list of cultural resources that meet NRHP criteria for eligibilty and for determining additions to or deletions from the NRHP.

Lithic -- Stone

Memorandum of Agreement (MOA) -- A written agreement among the agency, the SHPO, and the ACHP that stipulates how an undertaking will be carried out so as to avoid or mitigate adverse effects and otherwise to protect cultural resources.

Midden -- Archaeological refuse deposit.

Mitigation -- Planning activities or procedures that are intended to minimize the impact to cultural resources.

Mitigation by Excavation -- Archaeological excavation sufficient to recover data necessary to mitigate the adverse effect(s) of the proposed project on an archaeological site determined eligible for listing on the NRHP.

Multiple Resource Area -- A NRHP listing composed of individual properties or a combination of properties and districts within a specific geographical area. Within the Multiple Resource Area, only the lands occupied by each property and/or district are subject to the benefits and protections accorded by the National Historic Preservation Act.

National Historic Landmark -- A property designated by the Secretary of the Interior as having exceptional significance in the nation's history. National Historic Landmarks are automatically listed on the NRHP and subject to all preservation requirements.

National Register Criteria -- The criteria established in 36CFR60.6 by the Secretary of the Interior to evaluate properties for inclusion in the NRHP. Archaeological sites are generally considered if they have yielded, or may yield, information or data important for understanding the prehistory or history of the area.

National Register of Historic Places (NRHP) -- The federal government's official list, maintained by the Secretary of the Interior, of all sites, buildings, districts, structures, and objects of significance in American history, architecture, archaeology, engineering, and culture.

National Register Property -- Any cultural resource listed or eligible for listing on the NRHP.

Nomination -- Formal notification to the Keeper of the NRHP that a property appears to meet criteria of eligibility.

Paleobotanical Remains -- Plant remains in an archaeological context.

Prehistoric -- Prior to written history. Generally used in the U.S. to refer to occupations prior to European exploration and settlement.

Preliminary Archaeological Reconnaissance -- As defined in 36CFR66, a detailed on-the-ground surface examination of selected portions representing a statistical sample of the area to be affected, adequate to assess the general nature of the archaeological resources probably present, project this assessment to the entire area, assess the probable impact of a project, and estimate the cost of mitigating the impact. This level of investigation is appropriate to preliminary planning decisions.

Recordation or Documentation -- Drawings, photographs, and other formats permanently recording resources that must be destroyed or substantially altered.

Salvage Archaeology -- The systematic collection of surface and subsurface cultural remains by professional archaeologists from an area to be damaged or destroyed.

Section 106 Action -- Action to comply with Section 106 of the National Historic Preservation Act of 1966, which requires that an agency (1) consider effects of its undertakings on NRHP properties, and (2) afford the ACHP an opportunity to comment on undertakings that are likely to affect NRHP properties. This action applies to any federally funded, licensed, permitted, or assisted activity.

Sherd -- Fragment of ceramic or glass.

Significance -- Significance of cultural resources as evaluated in terms of NRHP criteria as provided in 36CFR60.

Site -- Any area or location occupied as a residence or utilized by humans a sufficient length of time to construct features, or deposit a number of artifacts.

State Historic Preservation Officer (SHPO) -- Official appointed by the governor of each state or U.S. territory, responsible for administering cultural resource programs.

Survey -- Initial assessment level for historical and archaeological sites; discovers and identifies sites within chronological and geographical framework; data usually not of sufficient detail to determine NRHP eligibility. Generally involves field inspection or reconnaissance level work.

Intensive survey includes subsurface testing. Windshield survey is a cursory examination of an area.

Technical Assistance -- A sharing by cultural resource specialists of their knowledge about cultural resource laws, regulations, guidelines, and instructions, their interpretation, and their practical application.

Testing -- Archaeological sampling or excavations sufficient to define the spatial extent, nature, and cultural significance of an archaeological site and determine NRHP eligibility. Sometimes referred to as secondary testing.

Zooarchaeological Remains -- Animal food remains in an archaeological context.

Common Abbreviations

ACHP	Advisory Council on Historic Preservation
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
CRM	Cultural Resource Management
DRI	Development of Regional Impact
EA/EIS	Environmental Assessment/Environmental Impact Statement
FAC	Florida Archaeological Council
FDHR	Florida Division of Historical Resources
HPP	Historic Preservation Plan
MOA	Memorandum of Agreement
NRHP	National Register of Historic Places
SCS	Soil Conservation Service
SHPO	State Historic Preservation Office
SOPA	Society for Professional Archeologists
USGS	U.S. Geological Survey

Review of Existing Literature

Archaeologists have divided Florida into a number of cultural regions based on differences in prehistoric archaeological site types and artifactual evidence. Seminole, Orange, and Osceola counties are considered to be part of the East and Central Lake District (Milanich and Fairbanks 1980). By comparison to other regions of the state, this district is relatively little known archaeologically and has received only limited attention from the profession. Although Milanich's and Fairbanks' synthesis of Florida archaeology includes this region, the majority of their discussion centers on the St. Johns River Basin and coastal portion of the district. Earlier works by John Goggin (1952) and Irving Rouse (1951) touch on the area but also focus on the major drainages of the St. Johns River Basin and the Indian River.

Actual archaeological research in the Econ Basin is also very limited. Although a number of early explorers, anthropologists and archaeologists visited the area and recorded sites on the St. Johns and Indian rivers, no information on the Econ Basin is available from these sources . These explorers included the Bartrams, Daniel G. Brinton of the University of Pennsylvania, Jeffries Wyman of Harvard, the engineer and cartographer J. Francis LeBaron, Cyrus Thomas of the Smithsonian, and Andrew E. Douglass of New York. The works of C.B. Moore provide the first documentation for the Econ Basin. Moore identified and excavated portions of the Palmer-Taylor Mound (8Se18), Tozzer Mound (8Se20), and Buzzards Roost or Heffer Mound (8Se21) during his late 19th century trips to Florida (Rouse 1951).

No further research was conducted in the Econ Basin until the winter of 1940-41, when the Excavators' Club of Cambridge Massachusetts dug at the Palmer-Taylor Mound site. Their research was completed in 1947 by the Anthropology Society of Harvard's Peabody Museum. The Excavators' Club also made surface collections at Cabin Mound (8Se19), the Tozzer Mound, and the Buzzards Roost Mound (Rouse 1951). This research documented the stratigraphy and contents of the excavated mound as well as the locations and artifacts of the other mounds.

During the past 20 years, environmental legislation at both the federal and state level has led to an increase in archaeological research throughout the nation. As a result there have been cultural resource surveys conducted in portions of the Econ Basin. Unfortunately, all too often development within the Basin has either not been at a level requiring consideration of the resource base, or the projects have been exempted from meeting the requirements.

Although there have been a number of Developments of Regional Impact (DRIs) within the vicinity of the Econ Basin, only a few have resulted in cultural resource surveys. These include the Huckleberry project in Orange County (Stewart et al. 1982), Hunters Creek in Orange County (Stewart and Weiss 1983; 1984; Stewart 1987), Primera in Seminole County (Stewart 1984a), the Central Florida Research Park in Orange County (Austin and Ballo 1987), and Martin Marietta Aerospace in Orange County (Austin and Ballo 1986).

Additional surveys in the region were completed for various public services, utility, and transportation projects, including the East Orlando 201 Plan (Swindell et al. 1977), Spring Hammock Park (Stewart and Dreves 1980), the Stanton Energy Center (Daniel and Gordon 1981), the Shingle

Creek Water Control Project (Stewart n.d.), the Tosohatchee State Preserve (Stewart 1982), the Duval-Poinsett 500 kV Transmission Line Right-of-Way (Hardin and Piper 1983), Tiger Creek Preserve (Stewart 1984b), the Upper St. Johns River Flood Control Project (Campbell et al. 1984), and the Orlando-Orange County Expressway Extension (White and Horvath 1985). In addition, knowledgeable area residents are aware of undocumented sites within the Basin (Bosserman 1989).

It must be noted, however, that many of these projects were limited in nature and that large portions of the study area remain unsurveyed. In 1985, Daniel proposed a model for hunter-gatherer settlement in central Florida based on the data from these surveys and research from the west coast of the state. If Daniels' model is correct, there should be significant early prehistoric sites in the central Florida upland areas. The model remains largely untested with the exception of Stewart's ongoing research at the Hunters Creek site (1987).

Description of Resource Characteristics

The following sections will present a regional cultural history applicable to the Econ Basin and then identify the presently known historical resources within the study area. A preliminary projection of areas which may contain historical resources is also presented. It must be cautioned that this projection is based on a very limited and incomplete data base, rather than systematic testing and documentation. Therefore, it can only be used at a very broad level of preliminary planning.

Regional Cultural History

Florida has been divided into a number of prehistoric cultural regions based on differences in the nature of the sites and artifacts within each region. The Econ Basin lies within the East and Central Lake Region defined by Milanich and Fairbanks (1980). Although their discussion of this region emphasizes the eastern area within the St. Johns River Basin and the coastal zone, the basic cultural sequence for the Central Lake area is believed to be similar to that to the east, based on the few excavations and sites identified within the area. In addition, the areas share similar environmental characteristics and their proximity and ready access via the many streams would facilitate diffusion of both cultural traits and people.

Paleo-Indian Period, 12,000-8,000 B.C.

The Paleo-Indians are generally described as migratory hunters of the now extinct megafauna such as the mammoth and giant ground sloth. During this period, Florida was much cooler and moister, with the shorelines extending many miles further out from the present coast as a result of lower sea levels. These Indians were believed to live in small bands or family groups which followed the migrations of the megafauna on which they depended. The majority of the known sites have been interpreted as "kill sites" located at springs or river crossings where the animals congregated. Sites are identified by the presence of the distinctive fluted, lanceolate projectile points such as the Clovis or Suwannee.

Recently Daniel (1985) has proposed a slightly different model for Paleo-Indian life. He bases his model on Binford's (1980) discussion of hunter-gatherer subsistence strategies. Using this discussion, Daniel postulates that Paleo-Indians fit the "collector" strategy which moves "goods to consumers with generally fewer residential moves" (Binford 1980:15). Collectors are responding to "a spatial or temporal incongruence of resources" (Daniel 1985:261) in which they move near a major resource and send special parties out to exploit other resources. Collectors may also store food for part of the year. Thus, collectors may have residential sites, extractive location sites, field camps, hunting stations, and caches. Daniel believes that Paleo-Indian occupation would have been tied to permanent water sources within territories oriented along east-west drainage basins. At the present time Daniel's model has not been tested in the East and Central Lake District due to a lack of known Paleo-Indian sites.

The nearest Paleo-Indian sites to the project area are located in Vero Beach, Melbourne, Marion County, and Warm Mineral Springs. No sites from this period are known in the immediate vicinity of the Econ Basin. If sites exist, it is probable that they would be located at stream crossings or in proximity to springs.

Archaic Period, 8,000-2,000 B.C.

The Archaic Indians have traditionally been described as hunter-gatherers who exploited a wider range of resources than their predecessors. They were believed to migrate seasonally, although they were thought to have been somewhat more sedentary than Paleo-Indians. Archaic Period sites are characterized by a wide range of tools made from stone, shell, bone, and wood. The lithics from this period appear to be more crudely made than the finely crafted Paleo-Indian points, however, they display a greater variety of forms. The distinctive projectile points for this period are large, stemmed types.

The environment during the Archaic Period had become much more like that of today, with warmer, drier conditions and a rise in sea level to near present heights. The megafauna of the Paleo-Indian period had either become extinct or shifted their range to the north, leaving fauna typical of present-day Florida. During this time, it appears that exploitation of freshwater shellfish became increasingly important, as indicated by the extensive shell middens associated with riverine and coastal sites of the period. The Mt. Taylor type shell midden sites of the Late Archaic are characterized by the presence of freshwater snails (*Viviparus georgianus*), apple snails (*Pomacea paludosa*), and bivalve molluscs (*Elliptio* spp.). Cemeteries and associated burial goods began to appear during the Late Archaic which indicates an increased emphasis on burial ceremonialism.

Daniel (1985) has also proposed a somewhat different model for Archaic Period occupation. Again, using Binford's analysis of hunter-gather subsistence strategies, he defines Archaic Indians as foragers who "move consumers to goods with frequent residential moves" (Binford 1980:15). Foragers are responding "to homogeneous or largely undifferentiated ecological areas of resources" (Daniel 1985:261). Foragers would have two types of sites, base camps and extractive locations. Further, Daniel suggests that Archaic Indians practiced a territorial occupation pattern along natural drainages. During the warm spring and summer months, the bands dispersed into small groups of foragers to exploit lacustrine and coastal resources. During the cooler fall and winter months, these groups coalesced into bands which shifted to a collector pattern of occupation in the uplands to exploit deer and nut resources.

Presently, with the exception of Stewart's ongoing research at Hunters Creek (1987), Daniel's model has not been tested in the East and Central Lake District.

Orange Period, 2,000-1,000 B.C.

The Orange Period represents the first appearance of ceramics in the southeast. These first ceramics were primarily slab construction and tempered with plant fibers. Decoration includes incising and punctation. Other than the ceramics, the artifact assemblages for this period are quite similar to the preceding Late Archaic/Mt. Taylor Period.

Subsistence patterns during this period show an increase in or shift towards exploitation of coastal resources, particularly the coquina (*Donax variabilis*) found in coastal lagoons. Sites are distinguished by extensive coquina shell middens containing fiber tempered ceramics.

Transitional Period, 1,000-500 B.C.

The Transitional Period marks the beginning of distinctive regional cultural groups in Florida. It also marks the change from slab construction fiber tempered ceramics to coil construction and sand tempering. The most common ceramic for this period in the East and Central Lake District is the chalky St. Johns Incised ware. It is believed that this period represents a gradual shift from a hunter-gatherer subsistence pattern to a more sedentary pattern which may have been based on exploitation of cultigens.

St. Johns I, 500 B.C.-A.D. 800

Daniel neatly summarizes the St. Johns Period as "a pottery using, mound building, semi-sedentary complex that probably utilized agriculture. The St. Johns Tradition is divided into two archaeological periods and several subperiods, and is noted for its chalky ware ceramics" (Daniel 1981:25). The presence of mound burial indicates an increasingly complex society, probably based on chiefdoms. It also implies a rather sedentary existance and larger populations to provide the necessary labor for such construction. The various subperiods are identified based on variations in the artifact assemblages and site characteristics.

The St. Johns I Period is subdivided into St. Johns I, Ia, and Ib. The St. Johns I subperiod (500 B.C.-A.D. 100) is characterized by the presence of plain and incised St. Johns ceramics in the village areas. However, burial mounds may contain Deptford pottery characteristic of cultural groups to the north and west. This implies an exchange of goods and perhaps ideas between the two groups. The Deptford wares represented in mounds include Deptford Linear Check Stamped, Deptford Bold Check Stamped, and Deptford Simple Stamped. The St. Johns type known as Dunns Creek Red is also present in burial mounds.

During the St. Johns Ia subperiod (A.D. 100-500) evidence of the Hopewellian-Yent complex characteristic of societies to the northwest begins to appear in burial mounds. This complex evidences increased burial ceremonialism with the presence of elbow pipes, cut mica, galena, shell gorgets, and copper ornaments, many of these trade goods from the north and central United States. Village pottery remains dominated by St. Johns Plain, but mounds contain Dunns Creek Red, Deptford, Swift Creek, and, during the latter part of the subperiod, Weeden Island types.

St. Johns Ib (A.D. 500-800) is marked by the appearance of Weeden Island influences from the west, although the village pottery remained St. Johns Plain. The total number of sites which can be identified with this subperiod represents an increase over previous subperiods suggesting a large population increase during this time.

St. Johns II, A.D. 800-1565

The St. Johns II Period is marked by the appearance of check stamped pottery. Like the previous period, St. Johns II has been divided into three subperiods based on changes in the artifact types.

St. Johns IIa (A.D. 800-1300) is marked by an increased use of burial mounds and the presence of the distinctive St. Johns Check Stamped pottery. Weeden Island pottery continues to appear in mounds and some mounds contain caches of ceramics.

St. Johns IIb (A.D. 1300-1513) sites begin to display Mississippian influences with the presence of Southeastern Ceremonial Cult copper items in the mounds. Although Check Stamped pottery dominates the sites, there are some Fort Walton and Safety Harbor ceramics represented, indicating contact with the west coast of Florida. Mounds became larger and more complex during this period, indicating an increasingly sedentary and stratified society. The Indians of this period were probably organized in hereditary chiefdoms and priesthoods.

St. Johns IIc (A.D. 1513-1565) is the final prehistoric stage in Florida during which European contact occurred. Although St. Johns Check Stamped ceramics and burial mounds are still present, European artifacts began to appear in the sites. The population of this period suffered severe reductions as a result of the introduction of European diseases.

In general, the St. Johns II period represents a continuance of the subsistence patterns of previous periods, with a heavy dependence on marine and estuarine resources, particularly coquina (*Donax variabilis*), oyster (*Crassostrea virginica*) and clam (*Mercenaria mercenaria*). Some shell middens along the coast were over 25 feet high, indicating the presence of large populations.

At the time of European contact, the Indians of the study area were described as the Freshwater (or Agua Dulce) and Acuera groups of the Timucuan people. These are probably the least known of the Timucuan groups due to limited contact with the early Spanish settlers. They were described as agriculturists who grew corn, beans, and tobacco, but also relied heavily on hunting, fishing, and gathering wild plant foods. Social organization was based on ranked clans headed by chiefs. Polygamy was common. The people were described as tall and often tatooed. Extensive rituals were practiced in association with warfare and burials.

St. Augustine Period, A.D. 1650-1750

European contact would result in the virtual destruction and elimination of the native Indians of Florida within a hundred-year period, primarily through the introduction of European diseases. Native ways of life were altered through the introduction of European goods and agricultural practices. The native religious practices were largely supplanted by the introduction of Catholicism through the Spanish mission system. Ceramics of the contact period also reflect European influences, particularly in their shapes. These ceramics are known as San Marcos types in eastern Florida.

The English raids of the early 18th century led to the final extermination of the Timucua and their culture. After 1715, the Spaniards encouraged Creek Indians from Georgia and Alabama to migrate to Florida, where they became known as the Seminole.

Historic Period, A.D. 1750 to present

After the decimation of the native Indians, the Creek Indians moved into northern Florida during the period described by Fairbanks (1978) as Colonization, 1716-1763. The Creeks in Florida appear to have abandoned the Creek town pattern with its central square in favor of a more dispersed pattern of separate farmsteads. This may reflect their increasing dependence on exploitation of the cattle herds introduced by the Spaniards. Seminole sites in north Florida are marked by the presence of Chattahoochee Brushed ceramics as well as European trade goods. Although the Seminole traded with the Spaniards, there was little additional contact and apparently no attempt to reintroduce the mission system.

Fairbanks (1978) characterizes the period from 1763 to 1790 as Separation. The British acquisition of Florida in 1763 led to a well-defined Indian policy which centered on increasing attempts to control the Indians. The Indians, in turn, extended their isolation from their homeland to an attempt at isolation from the British. This isolation was accompanied by increasing hostility towards the British. At the same time, the Seminole were harboring runaway slaves from Georgia and the Carolinas which promoted their distrust of white settlers as well as hostility on the part of those settlers. The British did establish a number of trading posts among the Seminole, thus increasing the presence of European goods on Indian sites.

The third Seminole period is characterized as Resistance and Removal, 1790-1840. This was the period of the First and Second Seminole Wars. After the Spaniards regained Florida, they allowed the British and Americans to continue to trade with the Seminoles. Perhaps as a result of increasing frontier tensions, Seminole sites became even more dispersed. After the Creek Indian War, large numbers of Indians migrated to Florida, increasing the Seminole population. At the same time, American settlers continued to move into the same areas, resulting in increased friction between the two groups. This led to the First Seminole War of 1818. Although this war was rather limited and brief, it did influence the cession of Florida to the United States in 1819. The 1823 Treaty of Moultrie Creek attempted to confine the Seminole to the area south of Ocala. This led to the Seminole presence in the Central Lakes area of Florida, but also to increased friction between the two groups.

The new Seminole reservation area did not offer the same resource base as the area previously occupied. At the same time, the increased friction between Indians and American settlers had resulted in reduced access to trade goods. In 1830, this friction erupted into the Second Seminole War. During this war, a number of military outposts and highways were established in Central Florida, including Fort Christmas, Fort Mellon, Fort Lane, Fort McNeil, Fort Gatlin, and Fort Taylor in the region of the St. Johns and Econ Basins (Davidson 1835-37). At least one battle occurred in the Econ Basin, at an Indian crossing on the river. Although the Indians were dispersed, the American army suffered losses, including a wound to its commander, Major General Jesup (Jesup 1838).

The end of the Second Seminole War brought the fourth stage of the Seminole Period, Withdrawal, 1840-1880 (Fairbanks 1978). At this time, the Seminole who remained in Florida withdrew into the reaches of the Everglades of South Florida, leaving north and central Florida open to American settlement. The Armed Occupation Act, offering homestead rights to settlers, led to an increased movement into the state. However, until the present time, the Econ Basin has remained lightly populated, with most of the area utilized for forestry and agriculture. Small settlements were established tied to the citrus, cattle, and logging industries.

With the growth of Orlando in the late 19th century, homesteading increased and large tracts of land were acquired for potential development. The largest landowner was Hamilton Disston, who owned thousands of acres after 1881. At this time, the communities of Maitland, Oviedo, and Sanford were also established (Wells 1977). The 1940s aerials show a pattern of small farmsteads in the better drained areas west of the St. Johns River flood basin. The farmsteads include row crops, pasture, and citrus. These farms continue up the river to Bithlo on the Econ and Delorme on the Little Econ. From there, land use shifts to selective logging and range land; this land use continues on to the south of the basin.

The recent growth and development of the Orlando area has led to increased pressure on the Econ Basin and its historical resources. With planned transportation expansions, it is almost certain that development will continue to spread to the east of Orlando.

Econlockhatchee River Basin Historical Resources

This discussion will address only those sites listed in the Florida Master Site File for the Econ Basin. While other sites certainly exist and may have been identified (Bosserman 1989), they are not currently documented at FDHR. Historic sites for which only archival information is available are not mapped. Figure 4-1 shows the locations of the known sites.

Seminole County

8Se18 -- Palmer-Taylor and Shapfeld Mounds. This site was homesteaded in the late 19th century and planted with grapefruit. The Palmer-Taylor house appears to have been located on the mound. The mound is located about 300 yards north of the Econ bank. The site was first identified by C. B. Moore in the 1890s, who excavated two pits in the mound. A later owner, John Clark Bills, excavated a large trench and other pits across portions of the site. In 1940-41, the Excavators Club placed a number of units in the Palmer-Taylor Mound as well as a test pit in the smaller Shapfeld Mound. The mound is a sand and shell structure which contains both animal and human remains. Ceramics include both Orange and St. Johns types, as well as the Belle Glade types characteristic of South Florida. Rouse (1951) described the site as dating to the Orange-Malabar sequence, which would correspond to Orange/St. Johns. The presence of St. Johns Check Stamped ceramics indicates a long period of repeated occupation for this site. Soils are described as "made land" and Delray fine sand in a hardwood hammock.

8Se19 -- Cabin Mound. This shell mound was located approximately 0.4 mile northwest of the Palmer-Taylor Mound. This site is also located on Delray fine sand in hardwood hammock.

Although a surface collection was made by the Excavators Club in 1940-41, no excavations were conducted due to the presence of the cabin on the mound as well as the active cultivation of the site. The site appears to be a low midden with animal bone and St. Johns ceramics. Rouse (1951) designated the site as dating to the Malabar II period which corresponds with St. Johns II.

8Se20 -- Tozzer Mound. This site lies approximately 0.5 mile west of the Palmer-Taylor Mound in the same soil and vegetation type environment. It is also a shell mound, first identified by Moore and later surface collected by the Excavators Club. It is a crescent-shaped midden approximately 200 feet long and 5 feet high. The site contains animal bone and St. Johns ceramics which date to the same period as the Cabin Mound site (Rouse 1951).

8Se21 -- Buzzards Roost or Heffer Mound. This midden lies south and east of the Palmer-Taylor Mound. It was identified by the Excavators Club in 1940 between the Econ and Puzzle Lake. The lake apparently comes up to the edge of the site during periods of high water. Moore also identified and excavated this mound. It is best described as a shell-heap hammock situated in a marsh. Surface collections recovered animal bone, St. Johns and Glades ceramics, and lithics. The occupation of this site appears to correspond to that of the Palmer-Taylor Mound, ranging from Orange to St. Johns II (Rouse 1951).

Orange County

8Or254 --Laughlin Hunting Lodge. This site consists of the remains of an early 20th century hunting lodge built by James Laughlin, Jr. of Pittsburgh, Pennsylvania (Deibler 1981). The lodge is located on the north side of a sandy oak ridge in the flatwoods.

8Or255 -- Econlockhatchee South 1. This site was located during the Stanton Energy Center survey in 1981. The site lies on a sand ridge in the flatwoods adjacent to a cypress swamp. The soils are Immokalee types. The site was identified by the location of one piece of lithic debitage (Daniel and Gordon 1981).

8Or256 -- Econlockhatchee South 2. This site was also located during the Stanton Energy Center survey. The site was also an isolated piece of lithic debitage found along a sand ridge road in the scrub oak portion of the property adjacent to the cypress swamp (Daniel and Gordon 1981). Soils at this site are Pomello sands.

8Or257 -- Econlockhatchee South 3. This site was found along a drainage ditch during the Stanton Energy Center survey. The site consisted of a collection of lithic debitage along the banks of a ditch south of a small cypress dome. The soil is Leon fine sand (Daniel and Gordon 1981).

8Or383 -- Econlockhatchee South 4. This site also lies within the Stanton Energy Center tract. It consists of a single broken projectile point, possibly a Newnan type found along a road in the pine flatwoods on Leon fine sand. The find probably dates to the Middle Archaic Period (5,000-3,000 B.C.) (Daniel and Gordon 1981).

8Or384 -- unnamed site. This site consists of another isolated broken projectile point found in the Stanton tract. It was located in the same area of flatwoods as 8Or383. The soil type is Leon fine sand. Daniel indicates that it may be a Middle Archaic Culbreath point (Daniel and Gordon 1981).

8Or479 -- Lake Telfer site. This site was identified during the Orlando-Orange County Expressway Extension survey. The site consists of 1 projectile point fragment and 1 piece of lithic debitage found on a ridge slope adjacent to a marsh (White and Horvath 1985). The site is on Blanton soils in an oak hammock.

8Or480 -- No information available.

8Or481 -- Green Bottle site. This site consists of a deposit of late 19th to early 20th century refuse and 1 piece of lithic debitage. The site is located on a ridge slope adjacent to Lake Telfer. The site lies on Blanton soil in an area of oaks with evidence of recent historic use. The site was located during the Expressway survey (White and Horvath 1985).

8Or482 -- Pawn Shop site. This is another historic refuse scatter identified adjacent to Lake Telfer during the Expressway survey. This site is located on Leon fine sand on relatively high ground. The site dates to the period between 1880 and 1930 (White and Horvath 1985).

8Or511 -- Aerospace 1 site. This site was located during the Martin Marietta DRI survey. The site is described as a lithic scatter located on a low rise adjacent to a cypress swamp (Austin 1986). The site lies on Leon fine sand in a flatwoods area between a creek and a bayhead.

8Or512 -- Aerospace 2 site. This site consists of a single lithic artifact found on a low rise adjacent to a cypress swamp. Like 8Or511 it lies on Leon fine sand in the flatwoods between the creek and bayhead. The site was also identified during the Martin Marietta survey (Austin 1986).

8Or514 -- Alafaya Trail site. This site was located during the Central Florida Research Park DRI survey. The site is described as a scatter of St. Johns Plain ceramics and lithics located on a ridge slope near an unnamed pond and Lake Rouse (Austin 1987). The site is located on St. Lucie soils in an area of well drained oaks adjacent to the lake.

In general, the located sites are either prominent mound sites in proximity to the St. Johns River Basin or small sites identified through surface inspection of roads. It appears that little or no systematic subsurface archaeological survey has been conducted within the Econ Basin. Analysis of the known sites indicate that they appear to occur in four situations or environments within the Basin; these areas would be considered high potential areas for historical resources:

1) **Flatwoods at the headwaters of the Basin.** Three types of flatwoods sites appear to occur. The first type of site is located on the ecotone between the extensive flatwoods areas and well-drained oak hammocks. These special use sites may not necessarily be closely associated with a water source; access to some other resource such as lithics may be the determining factor. The second type is located on relatively high ground at the point at which a creek begins to form a channel and drain a forested wetland. The third type is located at constrictions of forested wetlands with creeks, forming an easy crossing or access to water.

2) **Hills and lakes area in the mid-section of the River Basin.** Sites in this area are located on relatively high ground close to the water sources. Examples would be low hills or ridges with well-drained soils next to the water resource.

3) **Deep river channel area.** There is no site information available for the area where the river drops into a well-defined channel. However, based on experience with the resource potential in similar environments, there should be sites along this channel where there is relatively high ground which provides access to the river and is not frequently flooded.

4) **St. Johns River floodplain.** Sites have been located in this area are located on relatively high ground with an elevation of at least 10 feet or more. Although frequently found at the mouths of tributary rivers like the Econ, sites are also located along the St. Johns itself.

One source also indicates that site indicators include rapid rises in topography, reasonable distance to water, location of the upland or depositional side of the river, and the presence of live oaks (Bosserman 1989). Coupled with the presence of well-drained soils, these are probably reasonable site indicators.

Other areas of the Basin may be considered to have a medium potential for site location. This means that sites will be less likely to be found and may be smaller and fewer in number. These areas include sandhills not associated with a water source or steeper slopes (5% or more slope) along a creek or river. Areas ranging from 200 to 500 meters from a water source would also be considered medium potential, depending on other environmental factors such as soils and topography.

Areas of the Basin which are least likely to contain sites may be designated as low potential. However, this does not rule out the possibility of sites occurring in those areas. It merely means that based on present information, very few sites are anticipated. This would include gallberry/pine flatwood areas with no water sources or the low prairies. In general, the more poorly drained the soil, the less likely an area is to contain sites.

MANAGEMENT ALTERNATIVES

This section will present the general principles of historical or cultural resource management followed by guidance as to management of development impacts within the Econ Basin.

Principles of Historical Resource Management

Cultural resource management has three major sets of objectives: management, descriptive, and explanatory.

> Management objectives are those concerned with obtaining and evaluating sufficient data to determine the significance of sites and plan for their preservation directly, or indirectly. Descriptive objectives provide an empirical data base for future researchers to understand and re-evaluate the sites. Explanatory objectives place the sites in a chronological and cultural historical framework, and then take those empirical data and place them within current research paradigms or models (Eubanks and Adams 1986:14).

Management Objectives

Management of historical resources requires sufficient data to evaluate the sites within a given area and thus make an informed decision as to each site's fate. This can be an irrevocable decision, since a site which is not considered eligible for the NRHP is no longer subject to protection and can thus be destroyed or obliterated. On the other hand, it is not feasible to protect all sites adequately; therefore, it is necessary to make a choice as to which sites merit protection.

Unless the number and type of sites within an area are known, the historical resources cannot be adequately protected. Thus the first management objective is identification of the resources. This is generally accomplished through a combination of field survey and archival research. Archaeologists have divided the site identification and assessment program into three steps:

Phase I -- This step consists of a survey to locate the sites and make a preliminary evaluation of them. Phase I surveys provide managers with knowledge of the site's existence as well as information on its approximate size, depth, and cultural associations.

Phase II -- During this step sites which appear to be potentially eligible for the NRHP are evaluated as to their significance. This evaluation has very specific goals: (1) determination of the site size and configuration, including its extent, shape, artifact density, and variation within the site; (2)

definition of site depth and stratigraphy; (3) determination of the site's complexity, including the density and variation of features, and the number of cultural occupations represented; and, (4) identification of the site chronology and cultural associations, i.e., who lived there and when was it occupied. Based on this data, the site can be evaluated in terms of its potential to yield significant research information, as well as the extent and nature of potential impacts to the site.

Phase III -- This step involves mitigation of adverse affects to a site which is deemed eligible for the NRHP. Archaeological mitigation generally involves data recovery or excavation. The goal is to recover that information which makes the site significant and eligible for the NRHP. Data recovery should be problem-oriented in order to provide an empirical data base for future researchers. The basic objective is the recovery of sufficient data to provide an analog for the site after it has been destroyed. This is done through detailed documentation of the mitigation process.

Descriptive Objectives

Descriptive objectives provide the record of the research and of the data recovered. Based on this record of the research design, methodology, and results, the reader should obtain a clear understanding of how and why the research was accomplished. Site reports must not only provide a permanent record of the data recovery, but must also attempt to explain and interpret that data within a scholarly framework.

Explanatory Objectives

Archaeologists must go beyond mere description and present their data in two other ways: (1) comparison with data from adjacent sites and regions, and (2) explanation in terms which will present a view of life in that locality through time. In order to explain the sites, it is necessary to address certain historical objectives which may take the form of research questions:

1) Who lived at the site?
2) When did each represented group occupy the site?
3) Where did they live in terms of the environmental features?
4) What are the physical remains at the site?
5) How did people live at this site?
6) Why did people live as they did at this site?
7) How can the changes or continuity of lifestyle at this site be explained?

These general research questions can be further refined into hypotheses which can be tested with the data available from the site. Such hypotheses generally fall into three broad topics: settlement, subsistence, and technology. An example of this type of hypothesis for the Central Florida District would be Daniel's model for Paleo-Indian/Archaic settlement patterns described earlier in this document (Daniel 1985).

Once all three objectives have been met for an area, then the cultural or historical management plan can be considered to have been successfully implemented. It should be noted that while the previous discussion primarily addresses archaeological resources, a similar process would be required for architectural or historical sites.

Management of Development Impacts

The FDHR has provided the following excellent discussion concerning interfacing development with historical resource management:

> Inherent in the philosophy underlying Florida's historic preservation program is the belief that an environment in which elements of our prehistoric and historic heritage blend harmoniously with new land uses and construction is the best in which to live and work. At the same time, this philosophy recognizes that pure preservation of every historic property is unrealistic and not in the public interest.
>
> Thus, federal and state historic preservation procedures do not insist on preservation in every case. The solution resulting from the historic preservation compliance review process can range from purest preservation to unmitigated loss of a property, depending upon its significance, location, size and physical characteristics. However, an agency's or project developer's decision about how to treat historic properties MUST have resulted from meaningful consideration of cultural and historic values, and the options available to preserve them. In short, the compliance review process ensures that historic preservation is weighed along with costs and other factors in determining the projected tangible and intangible benefits of the completed project.
>
> Another factor which must be considered is timing. Consideration of historic properties must occur very early in the project planning stage so that preservation concerns can receive open, positive, and balanced consideration as the project is planned. Early project review also permits modification of project plans, if necessary, to accomodate preservation or the scheduling of data recovery to mitigate project impacts while they are relatively easy to accomplish. This reduces the potential for conflict and delay, and has positive economic benefits (FDHR 1988:11).

In summary, what FDHR is saying is that historical resource management and development can coexist, but careful planning at an early stage is necessary for successful coexistance. When a development project is first under consideration or in the planning stage, a survey should be undertaken to determine whether there are any historical resources within the development area, and, if so, what the impacts of the development will be on those resources. Once the resources are located, they can then be evaluated and intelligent decisions can be made as to their management. Management may take the form of avoidance, protection, documentation, rehabilitation, or data recovery depending upon the nature and significance of the resource. If a resource is not considered to be significant, development can proceed without further consideration.

SUMMARY AND RECOMMENDATIONS

The historical resources of the Econ Basin are poorly documented by comparison with other areas of the state. Only 17 sites have been recorded within the entire study area, and only four of these are significant sites. The major reason for this lack of information is the limited amount and level of survey which has been completed within the Basin. The majority of the recorded surveys consist primarily of surface inspections along roads, ditches, and streams. Little systematic subsurface testing has been completed. As a result of this lack of basic data and lack of data collected in a consistent manner, it is extremely difficult to make valid predictions as to the potential for historical resources within a given area of the Basin. These recommendations, therefore, are based on this limited level of information.

First, it is recommended that consideration be given to implementing a project to develop a better predictive model for historical resource location within the Basin. Such a project would require additional archival research, aerial photography interpretation, coordination of environmental/map data, and limited subsurface sampling of all represented environmental zones within the basin. A model development project for the Basin could probably be completed for approximately $20,000 to $30,000.

Second, it is recommended that future development within the basin be required to complete cultural resource assessments according to state guidelines (FDHR 1988). Methodologies for all assessments should be comparable so that the data could be used to refine the model of the Basin. However, the level of effort for the assessments could be stratified based on the presently known potential for resource location. Stratification can be tied to the preservation and conservation zones recommended by this management plan as follows:

1) <u>Areas designated as Preservation Zone</u> (the Econ and its associated wetlands). Since no impacts will be permitted in this zone, no cultural resource assessment should be necessary. It should be noted, however, that this zone contains the most significant known resources in the Basin, the mound sites at the junction with the St. Johns. Therefore, this is probably the most sensitive archaeological zone.

2) <u>Areas designated as Conservation Zone</u> (within the 100 year-floodplain). This zone contains portions of the high potential historical resource areas based on the existing information for the Basin. Cultural resource assessments should be required prior to any ground disturbance in this zone, including development of forested wetland water retention areas. This assessment should include subsurface testing at intervals not greater than 30 meters, as well as extensive surface inspection.

3) <u>All other portions of the Basin</u>. Cultural resource assessments in all other portions of the Basin should be stratified based on the presently known potential for historical resources as described earlier in this document under the title Econlockhatchee River Basin Historical Resources. Those areas considered to have a high potential for locating resources should be assessed with subsurface testing at an interval no greater than 30 meters, as well as extensive surface inspection. Areas of medium potential should be subsurface tested at a greater interval, perhaps 50 or 60 meters, as well as surface

inspected. All other areas should be surface inspected with subsurface testing on a judgmental basis. All assessments should include archival research, aerial photography interpretation, and evaluation of topographic and soils maps. The exception to this recommendation would be areas of known extensive ground disturbance such as heavily developed zones, or land which has been deeply excavated for ditches, sand mines, or drainage basins. If this disturbance is well documented, no assessment should be necessary.

It should be stressed that if new information is obtained which alters the presently known pattern for site location within the Basin (i.e., if sites are identified in areas not now considered to have a high potential), then the recommended assessment stratification should be changed to correspond with this information. In other words, new high potential areas should be delineated and the corresponding methodologies implemented.

If archaeological sites are located, management should also follow state guidelines (FDHR 1988). The initial step is normally to determine whether the site is significant and eligible for the NRHP. If a site is significant, preservation is typically the preferred management alternative. However, if preservation is not feasible, mitigation of impacts in the form of data recovery can be implemented. The one exception to this would be a site containing human remains (such as a burial mound). Under present state laws concerning human remains, preservation is probably the least costly and certainly the simplest alternative. Sites containing human remains can be excavated if absolutely essential to implement proposed development. Such excavation would require very close coordination with the State Archaeologist and possibly the Governor's Council on Indian Affairs.

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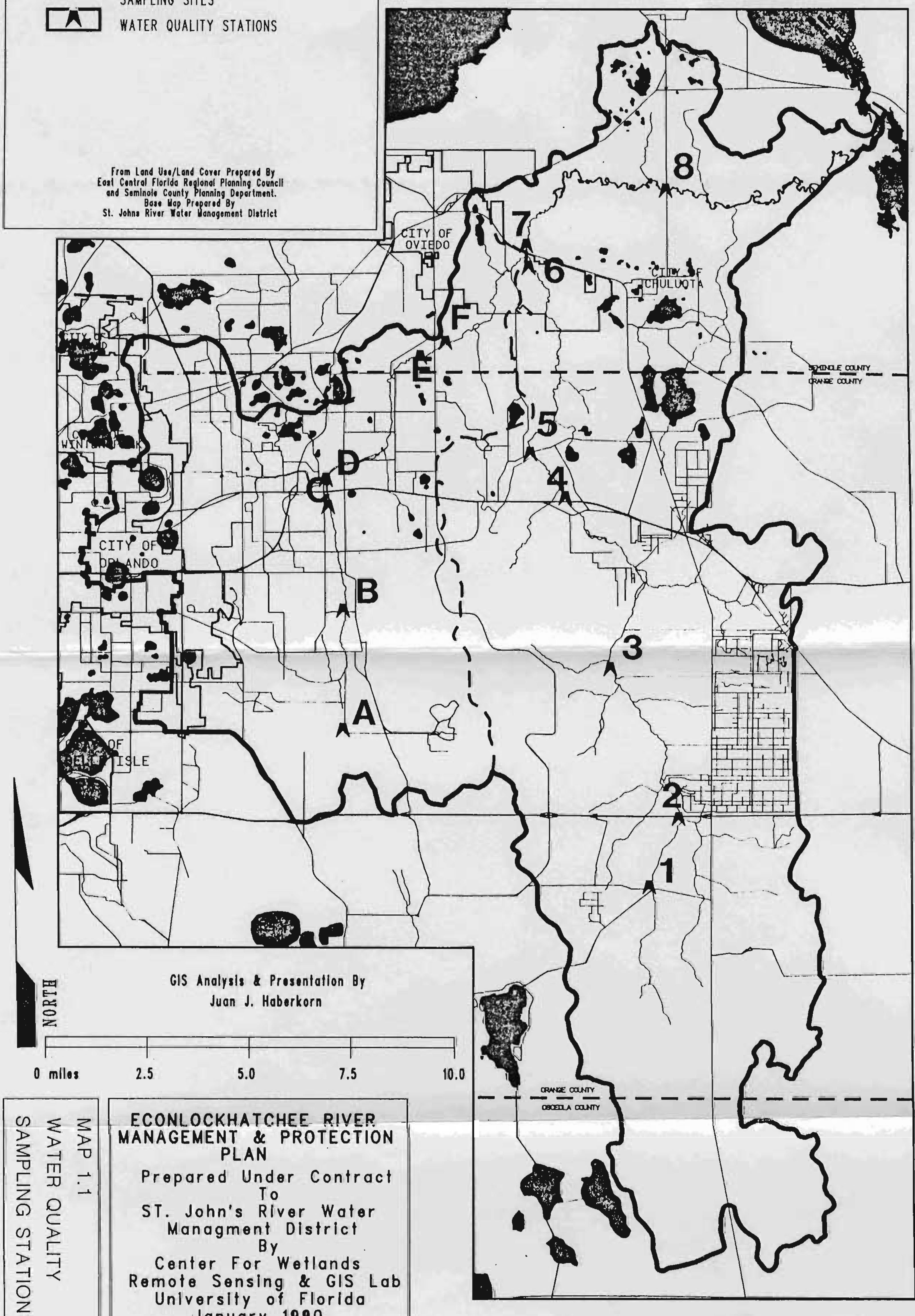
MAP LEGEND:

SAMPLING SITES
WATER QUALITY STATIONS

From Land Use/Land Cover Prepared By East Central Florida Regional Planning Council and Seminole County Planning Department. Base Map Prepared By St. Johns River Water Management District



GIS Analysis & Presentation By
Juan J. Haberkorn

MAP 1.1
WATER QUALITY
SAMPLING STATIONS

ECONLOCKHATCHEE RIVER MANAGEMENT & PROTECTION PLAN

Prepared Under Contract
To
ST. John's River Water Managment District
By
Center For Wetlands
Remote Sensing & GIS Lab
University of Florida
January 1990

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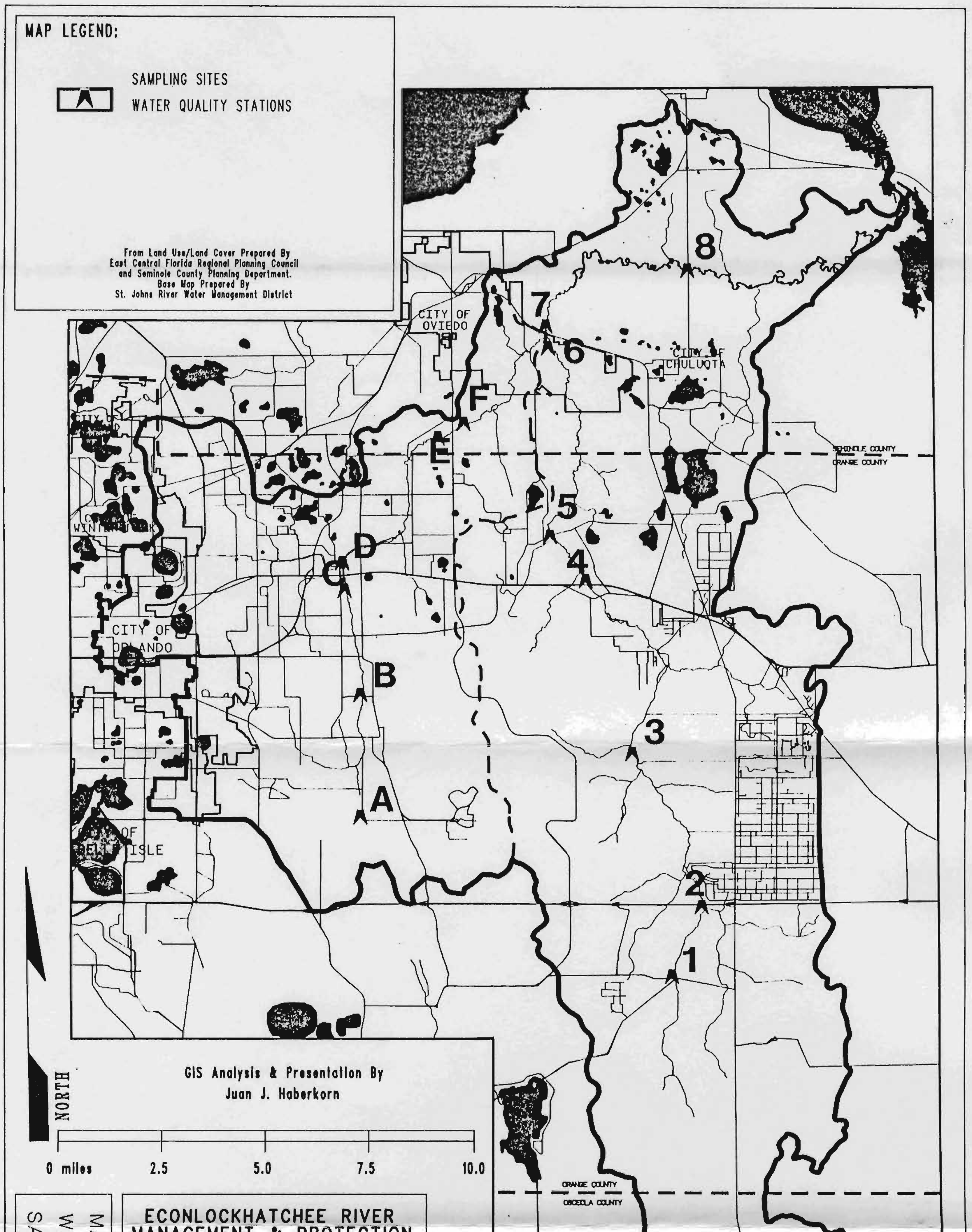

MAP 1.1
WATER QUALITY
SAMPLING STATIONS

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MANAGEMENT & PROTECTION
PLAN

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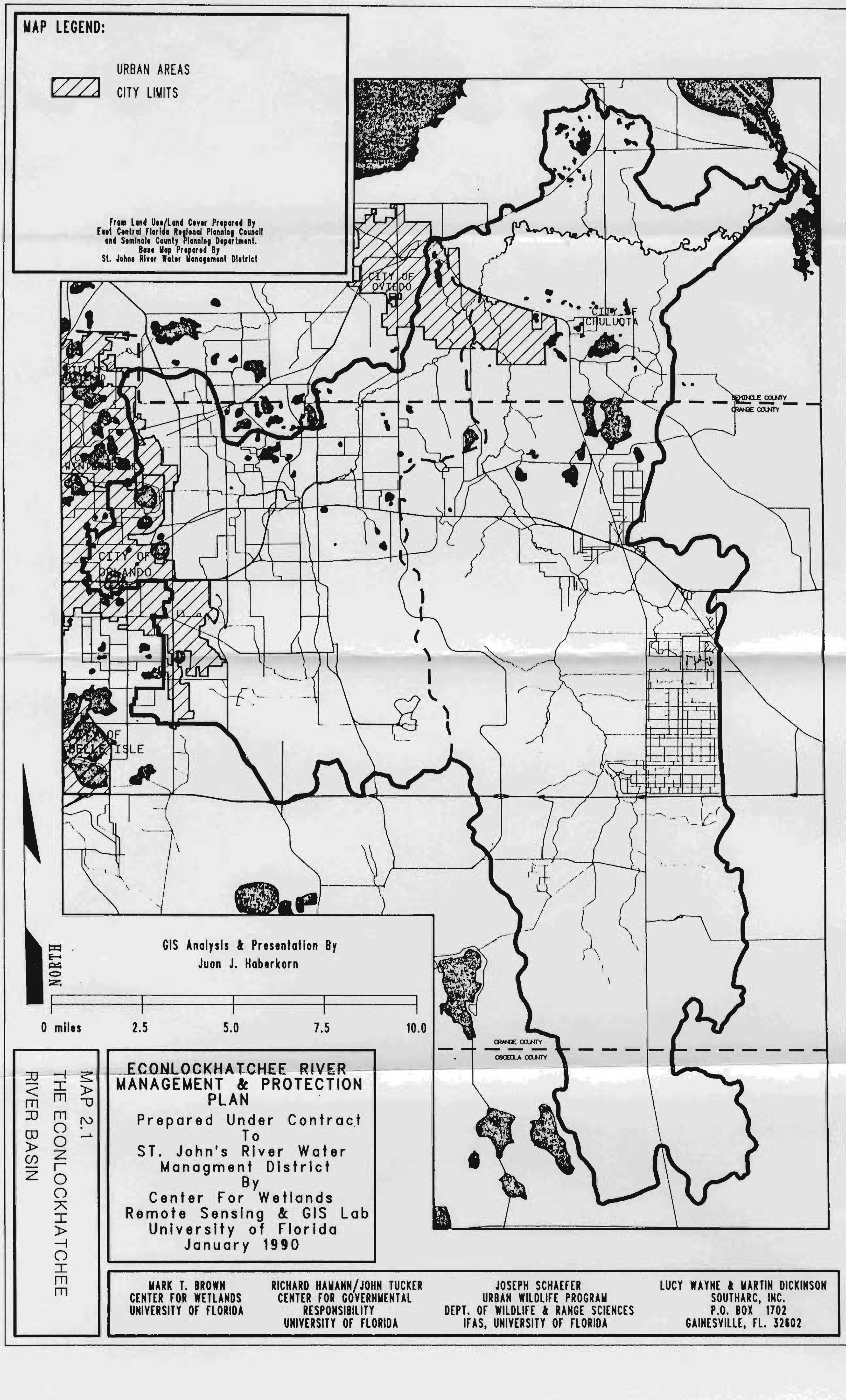
MAP LEGEND:
URBAN AREAS
CITY LIMITS
From Land Use/Land Cover Prepared By
East Central Florida Regional Planning Council
and Seminole County Planning Department.
Base Map Prepared By
St. Johns River Water Management District
CITY OF OVIEDO
CITY OF CHULUOTA
SEMINOLE COUNTY
ORANGE COUNTY
CITY OF ORLANDO
CITY OF BELLE ISLE
ORANGE COUNTY
OSCEOLA COUNTY
NORTH
GIS Analysis & Presentation By
Juan J. Haberkorn
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MAP 2.1
THE ECONLOCKHATCHEE
RIVER BASIN
ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION
PLAN
Prepared Under Contract
To
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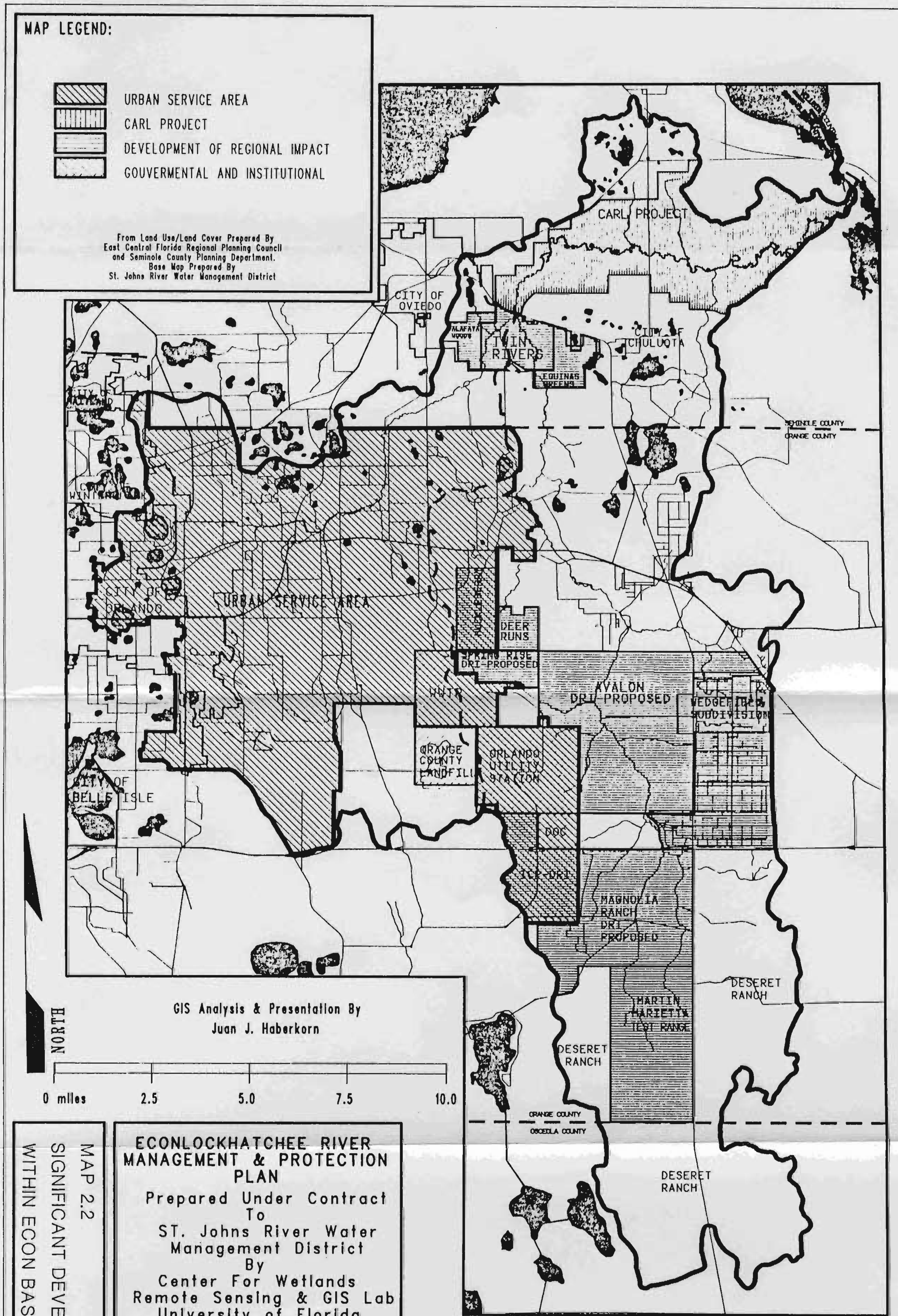

MAP 2.2
SIGNIFICANT DEVELOPMENTS WITHIN ECON BASIN

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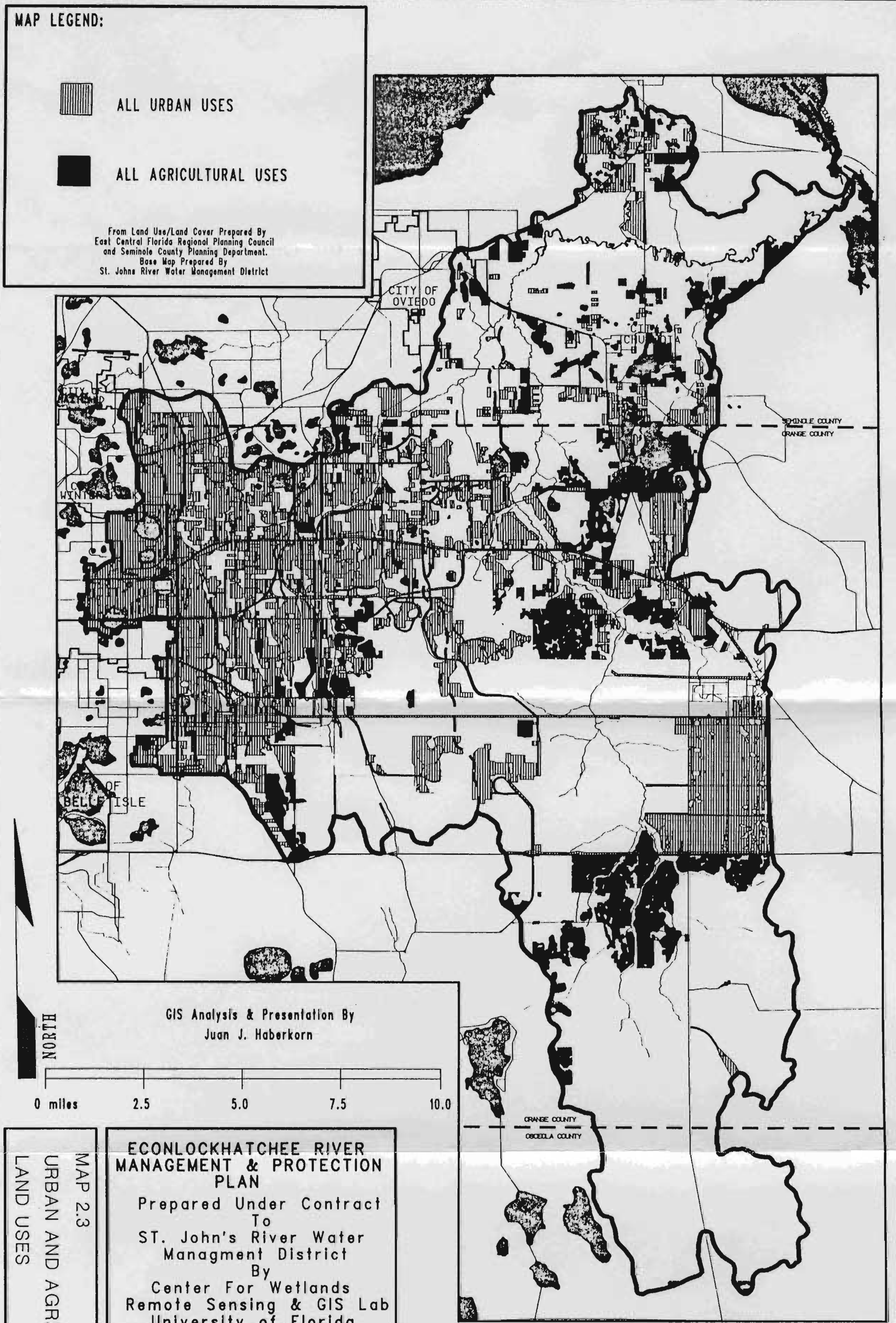

MAP 2.3
URBAN AND AGRICULTURAL
LAND USES

ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION
PLAN

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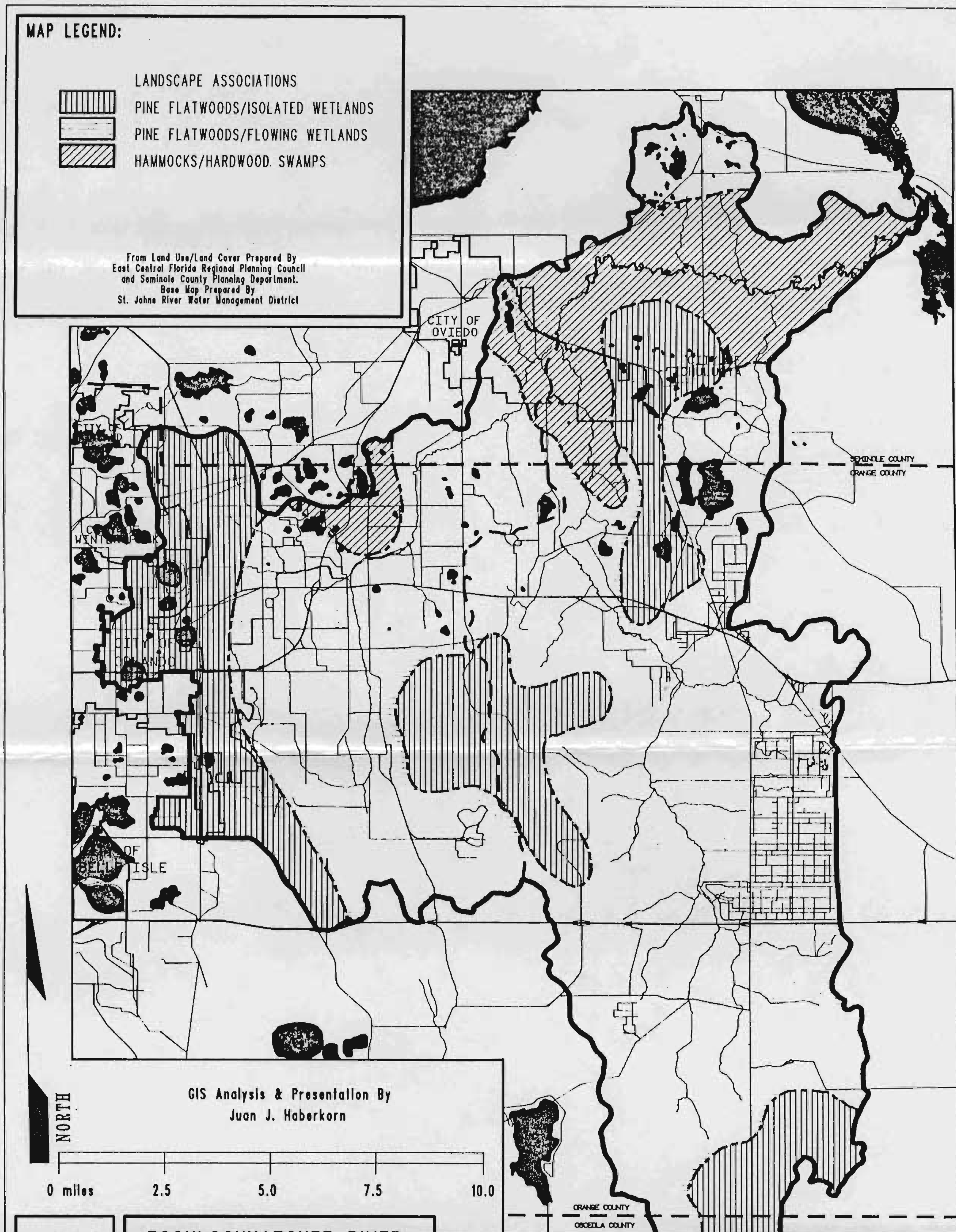

MAP 2.4
ECON LANDSCAPE ASSOCIATIONS

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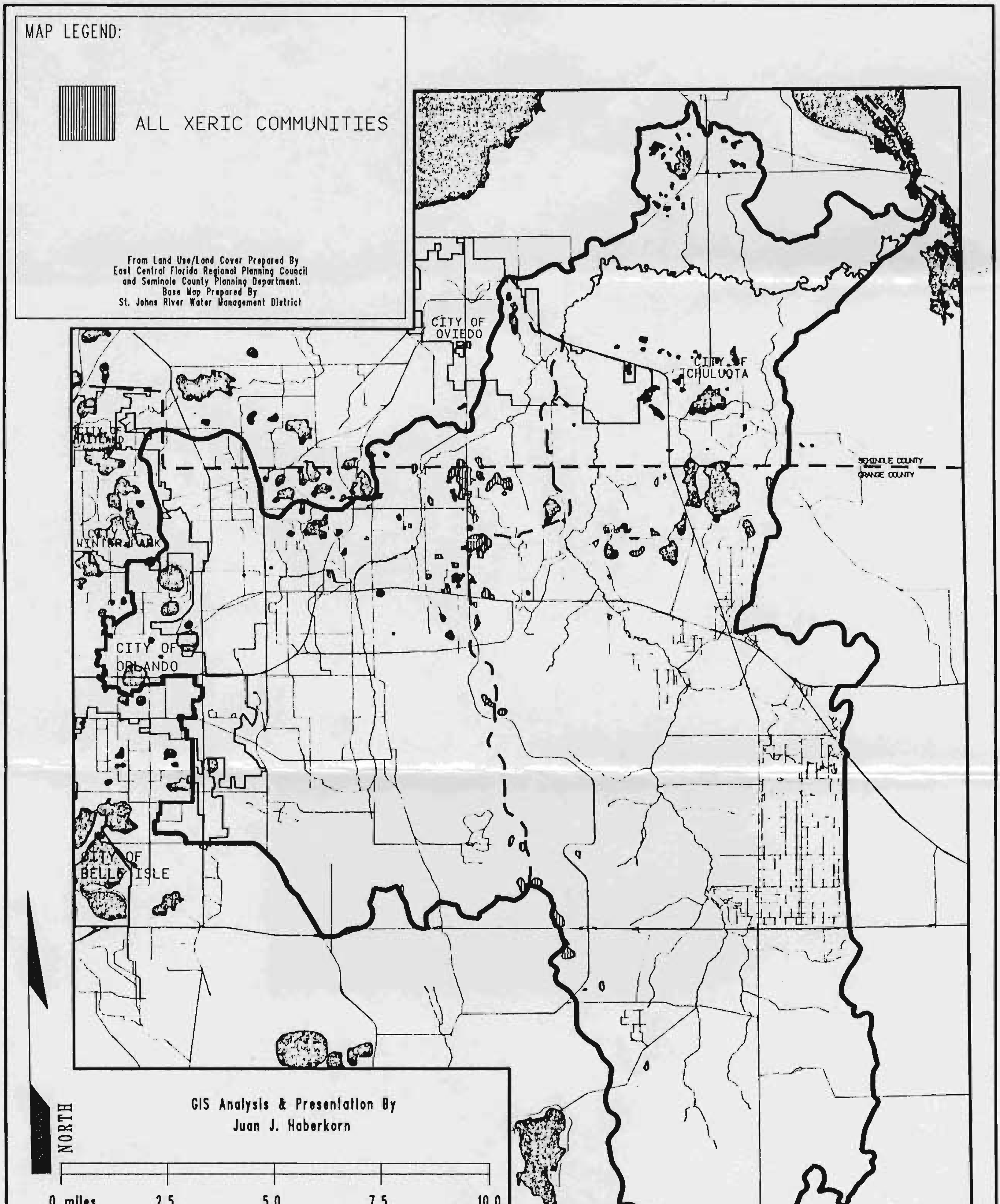

MAP 2.5
XERIC COMMUNITY LOCATIONS

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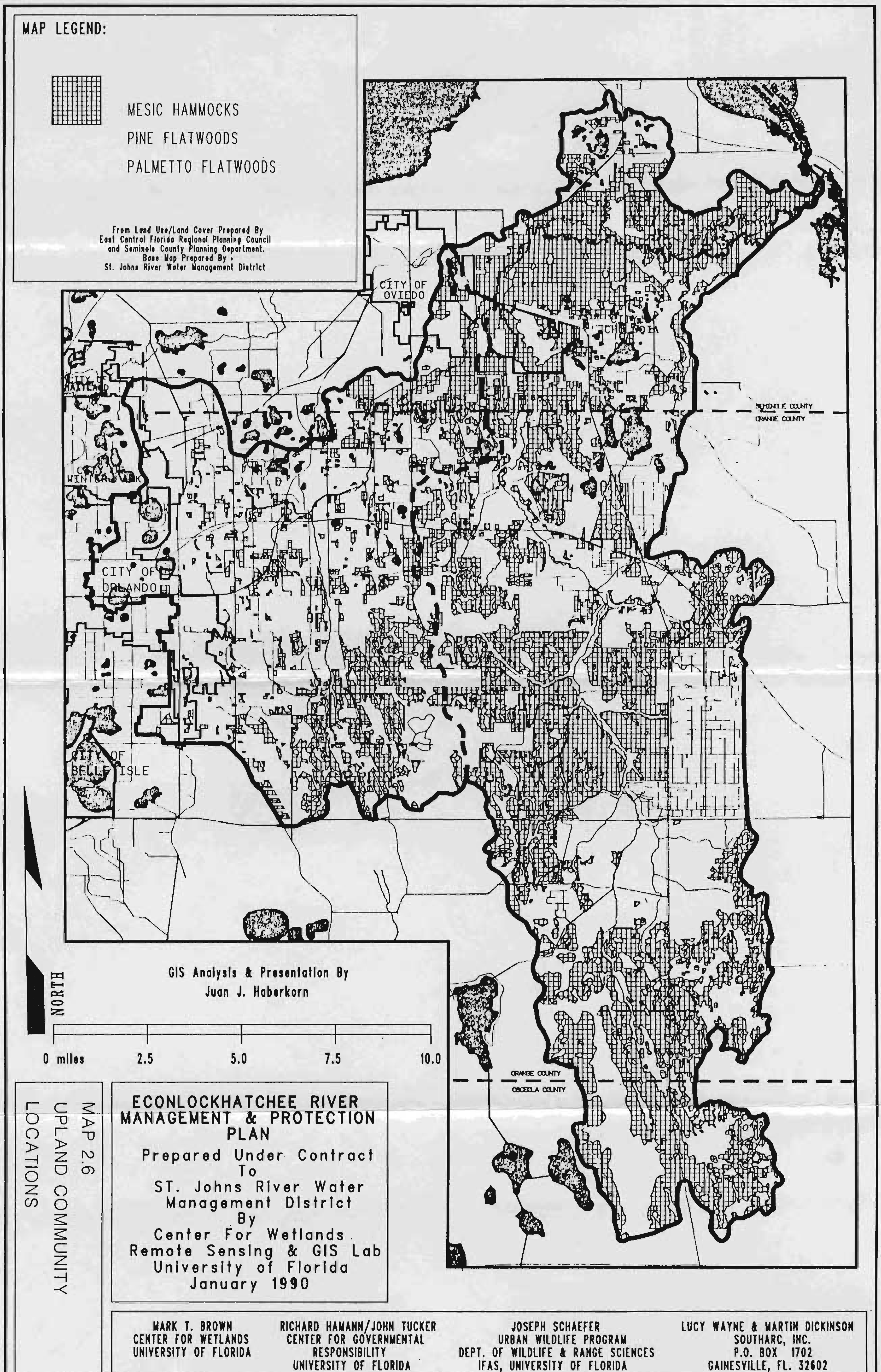
MAP LEGEND:
MESIC HAMMOCKS
PINE FLATWOODS
PALMETTO FLATWOODS
From Land Use/Land Cover Prepared By
East Central Florida Regional Planning Council
and Seminole County Planning Department.
Base Map Prepared By
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CITY OF ORLANDO
CITY OF BELLE ISLE
SEMINOLE COUNTY
ORANGE COUNTY
ORANGE COUNTY
OSCEOLA COUNTY
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MAP 2.6
UPLAND COMMUNITY
LOCATIONS
ECONLOCKHATCHEE RIVER
MANAGEMENT & PROTECTION
PLAN
Prepared Under Contract
To
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