Purpose and Goals

The original plan, "A Look to the Future" was prepared in accordance with the then existing definition of "ecosystem" provided by the Florida Department of Environmental Protection. The form of that plan emulated the plans for the Indian River Lagoon and Tampa Bay Estuary that were written as part of the National Estuary Plan process financed by federal and state governments. This revision retains the general form of the original plan, but uses a different definition of ecosystem management than the original as explained below. The purpose of this revision is to provide a summary of the St. Andrew Bay ecosystem from an ecological point of view including the current status, threats to the ecosystem, and action plans to maintain, restore, and improve the current relationships of its components. It is written as an adjunct to the SWIM plan for the St. Andrew Bay drainage basin that was prepared by the Northwest Florida Water Management District (NWFWMD). The SWIM plan was prepared to fulfill the responsibilities of the NWFWMD to maintain surface and ground water quality. The SWIM plan drew quite heavily on "A Look to the Future" because the NWFWMD takes a holistic view of water quality management and recognizes the relationship between land and water.

The emphasis of the SWIM plan on surface and ground water quality prompted the preparation of this document. The emphasis of this revision is on other aspects of the ecosystem, although water quality remains an integral part of the plan. This document is directed at the maintenance and restoration of ecosystem functions by providing information about the ecosystem and recommending actions that will:

1. Reduce the fragmentation of the ecosystem by providing corridors of land and water between the fragments that are currently in public ownership.
2. Assess the status of the land in the ecosystem and increase the acreage in public ownership, in conservation easements, or other methods to preserve ecosystem functions.
3. Identify sensitive habitats for purchase by government or private organizations to increase the quantity of land preserved as natural habitats or restored to natural habitats.
4. Provide for the preservation and conservation of protected, endemic and/or rare species of plants and animals in the ecosystem.
5. Recommend actions to reduce the adverse impact of the increase in human population in the ecosystem.
6. Assure good quality of the surface water and their sediments in the ecosystem in conjunction with the SWIM plan by examining aspects that are not in the SWIM plan.
7. Assure good quality of the ground water in the ecosystem in conjunction with the SWIM plan through habitat preservation and conservation.
8. Examine particular areas of interest in the ecosystem for restoration or improvement of natural ecosystem functions on a long-term basis.
9. Increase the public and private awareness of the diversity and sensitive areas of our ecosystem.

Introduction

The St. Andrew Bay ecosystem serves as the environment for the people who choose to live here. The ecosystem provides us with air, water, land, and a desirable climate. It provides us with a variety of recreational opportunities, economic values, and commercial values. The fate of the ecosystem is the responsibility of those who live here and those who will immigrate here because of the desirable environment provided by the St. Andrew Bay ecosystem. This revision of "A Look to the Future" emphasizes the ecosystem as a whole, and the interrelationships of the components of the St. Andrew Bay ecosystem without the restriction of statutory responsibilities. This is an independent attempt to provide general information about the St. Andrew Bay ecosystem, establish the interrelationships between the major components of the ecosystem, and point to where additional information of a more detailed nature may be found. It is hoped that this will provide the citizens of the ecosystem with information useful in the process of planning for the future of their environment.

The attempt by government to manage land through an ecosystem approach has been, by and large, abandoned, altered, or the name changed. We do not know the reasons for the alteration of the ecosystem management approach, but it may be a result of attempting to define the ecosystem in political terms rather than adhering to the ecological definition. Or, it may have been realized that in order to manage an ecosystem, one must be willing to plan the use of the land and water to sustain ecosystem functions as well as provide for an increasing human population. Grumbine (1997) addressed the concept of ecosystem management and its history. In that article he states that "EM (ecosystem management) was perceived by many as a buzzword, a concept whose definition was slippery, imprecise". He provides four reasons for this statement that flow from his "politics of definition". He then discusses the ten dominant themes of ecosystem management. This discussion is interesting for the complexity that can be incorporated into ecosystem. Where does this plan fit in the ten dominant themes of ecosystem management? The authors believe that it fits best under "Ecological Integrity". We encourage the reader to answer that question by reading the article. The journal is in the library of the Florida Fish and Wildlife Conservation Commission and the National Marine Fisheries Service library, both in Panama City, Florida. Brunner and Clark (1997) followed with an article on practice-based ecosystem management. The underlying rationale for this approach is that a clear goal is necessary to select the best action alternatives for achieving it. It is hoped that the goals of this document are clear and that the completion of the action plans will achieve the purpose.

Land use planning at the local level of government appears to be the beginning step in the ecosystem management process. An inventory of the existing land and water in public ownership and the areas designated for preservation, conservation, or restoration to the natural biotic communities would be a beginning. It may be necessary to designate additional areas for preservation, conservation, and restoration to the natural condition and develop a fair method of doing so in order to maintain ecosystem functions. It may also be necessary to plan to link these areas to one another by establishing corridors of natural communities. These corridors will prevent the ecosystem from being fragmented into isolated units without functional relationships to one another. These are the major points addressed in this plan.

Who can undertake the task of land use planning with an expectation of success? The myriad state and federal agencies could attempt to do so, but the time necessary to accomplish the task would be prohibitive. It is the citizens of the ecosystem who must address land use planning and thereby maintain the natural ecosystem at some level of functionality. In the St. Andrew Bay ecosystem, there are a number of local organizations and citizens who can be of great value in this process. State and federal agencies can also be a part of the process, but it appears that the citizens, through their land use planning efforts, will drive the process to some sort of completion.

The Ecosystem and Ecosystem Management: A BEST & BEST, Inc. Perspective.

"A thing is right when it tends to preserve the integrity, stability, and the beauty of the biotic community. It is wrong when it tends otherwise." (Aldo Leopold)

The concept of the **ecosystem** is a fundamental unit of the science of ecology because it is the study of all the organisms (living things) in an ecosystem interacting with each other and with the physical and chemical properties (non-living things) of the environment to produce a self-sustaining unit. An ecosystem develops under the influence of the climate and the geological history of an area and is then acted upon by plants and animals. An ecologist's definition of an ecosystem is any area of nature in which the biotic (living) and abiotic (non-living) components interact to a form a clearly defined trophic (flow of energy) structure based upon the fixation of light energy, biodiversity, and biogeochemical cycles (see Odum, 1971). The only source of energy needed by the ecosystem is sunlight. Both the biotic and abiotic components of an ecosystem influence one another, and both are necessary for life on the planet. Ecosystem management, therefore, should be directed at maintaining and restoring the biodiversity, trophic structure, and biogeochemical cycles of the ecosystem in question.

BEST and BEST, Inc., by nature of their mission and goals statements as provided in the preface to this document, accept the ecological definition of ecosystem rather than attempt to redefine it. Federal, state, and local governmental agencies have attempted to place the concept of "ecosystem" into their environmental management plans at various times. However, these attempts were, more often than not, accompanied by a redefinition of the term ecosystem to fit the perceived responsibility or political framework of the time. This variety of definitions results in confusion among agencies and citizens and results in the absence of a unified approach to managing the ecosystem.

The **renewable resources** of an ecosystem are those living things that occupy the ecosystem. They are considered renewable because they will perpetuate themselves provided that the conditions necessary to their survival are present or maintained. **Species diversity** refers to the number of species (kinds of plants and animals) that occupy a given area such as an ecosystem or other defined unit of area. The species of animals and plants in an ecosystem are arranged as biotic communities. A **biotic community** is an assemblage of organisms that live in a physical habitat. The biotic communities of the St. Andrew Bay ecosystem are many and include seagrass beds, longleaf pine-wiregrass, etc. The six major community categories of the ecosystem are listed and subdivided into biotic communities in Appendix 1 and discussed in the biodiversity section below.

"When we try to pick anything by itself, we find it hitched to everything else in the Universe" John Muir (My First Summer in the Sierra, 1911, page 10)

Ecosystem management must embrace all the qualities of an ecosystem, because emphasis on one quality over the others is to lose sight of the ecosystem as a whole. An effective management plan that will assure the continuation of the functions of an ecosystem must be based on the knowledge of the biodiversity of the ecosystem and the physical and chemical characteristics of that ecosystem. Alteration of one component of the ecosystem in the absence of an understanding of the affects of that alteration on all of the other components of the ecosystem will risk change to the ecosystem. Often this change is small, but these changes must be viewed from the point of view of their cumulative affects that can act to so alter an ecosystem that it is no longer recognizable or sustainable.

BEST and BEST, Inc. realize that one must understand species diversity, biotic community structure, and the physical and chemical characteristics that determine the biotic communities that are present in an ecosystem in order to manage the ecosystem in a manner that will retain the functions of the ecosystem. They also realize that, within limits, the ecosystem can respond to alterations that are natural or man-made and restore itself if provided the opportunity to do so.

Once the above components of the ecosystem are reasonably understood, a reasonable approach to the management of the ecosystem can be developed. This approach should include actions to maintain existing natural functions, prevent alterations of natural characteristics, restore areas currently in an altered condition, prevent fragmentation, and correct the existing fragmentation of the ecosystem. **Fragmentation** of the ecosystem is the process of dividing the ecosystem into discreet, isolated units that can no longer function in relation to one another. Management of the ecosystem must be accomplished in conjunction with a rapidly increasing human population whose presence in the ecosystem results in alterations and fragmentation. This document was developed with that in mind.

Part 1. Overview of the St. Andrew Bay Ecosystem

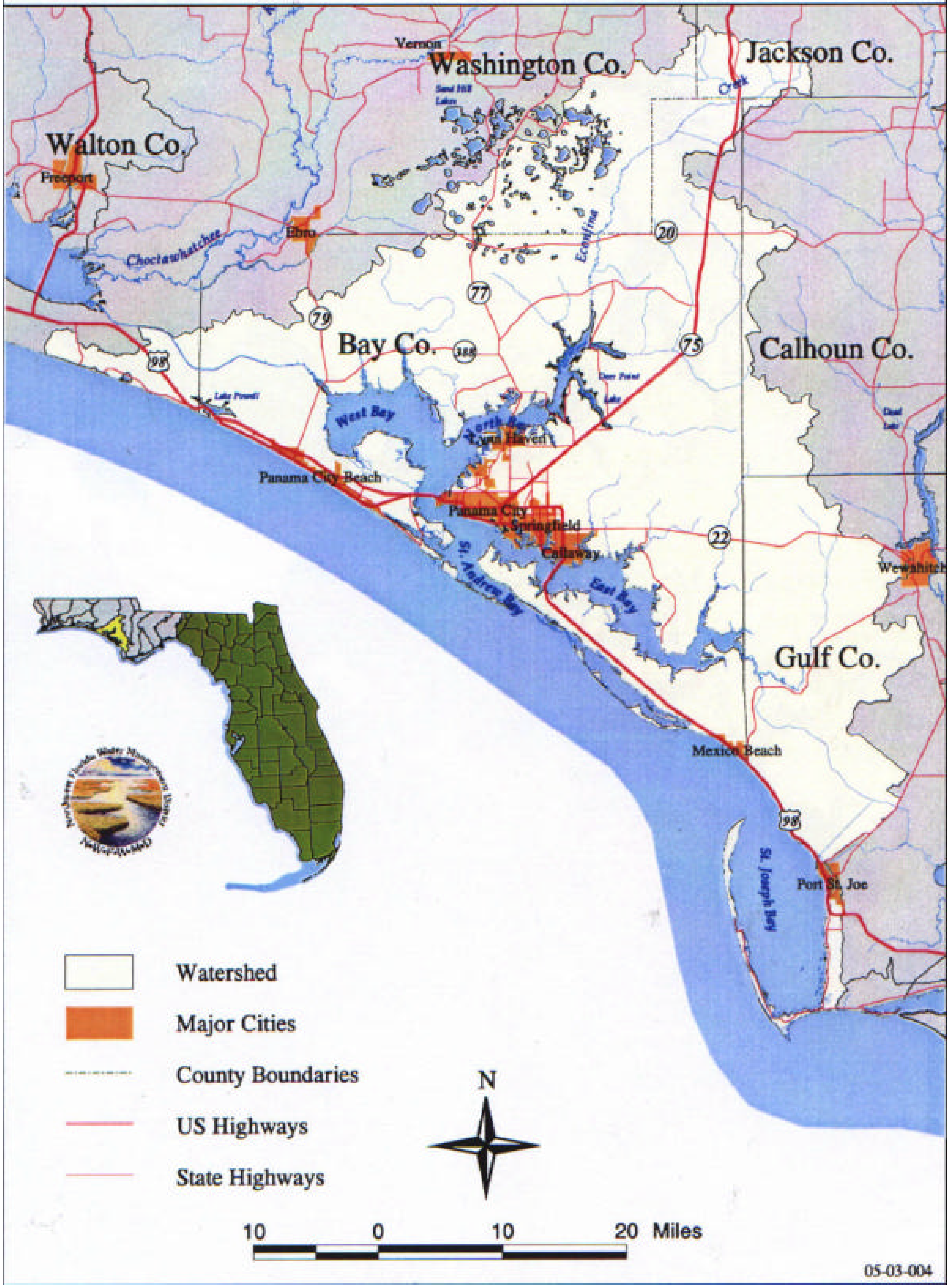
Introduction. Information regarding the St. Andrew Bay ecosystem is extensive. Shaffer (1993) compiled a bibliography of the research on St. Andrew Bay, its tributaries, and nearby coastal water, and the process of adding new information continues. The literature that is cited in this bibliography includes all levels of reports from contractors' reports to clients to government agency reports to manuscripts published in professional journals. This bibliography should be consulted by anyone interested in a particular aspect of the St. Andrew Bay ecosystem or the ecosystem in general. The bibliography and publication collection is located at the National Marine Fisheries Service Laboratory in Panama City Beach, Florida. For more information contact Ms. Rosalie Shaffer at that facility at 850/234-6541. An updated, searchable copy of this bibliography is available on the Internet at http://aoml.noaa.gov/general/lib/sadl.html. The SWIM plan (Thorpe et al., 2000) should also be consulted because it has an extensive list of publications and projects pertaining to the St. Andrew Bay ecosystem. Copies of the SWIM plan can be obtained from NWFWMD (850/539-5999).

The geology, physiography, and climatology of the St. Andrew Bay ecosystem have been described in a number of documents and publications. These documents and publications should be consulted for a more detailed description of the various characteristics of the system. The documents include Hydroqual, Inc. et al. (1993), Wolfe et al. (1988), Saloman et al. (1982), Brusher & Ogren (1976), Ogren & Brusher (1977) and the numerous publications by the NWFWMD pertaining to Deer Point Reservoir and the Deer Point Reservoir Watershed. The following is a general summary of the characteristics of the St. Andrew Bay ecosystem.

Geographical Boundaries of the Ecosystem. The definition of an ecosystem does not restrict the size of the system examined provided that the components and their interrelationships as stated in the definition are present. The SWIM plan used the U.S. Geological Survey Hydrologic Unit 03140101 to define the St. Andrew Bay drainage basin. This hydrologic unit includes St. Joseph Bay in Gulf County at the southeastern corner and Lake Powell at the southwestern corner of the hydrologic unit. Figure 1 is the entire St. Andrew Bay drainage basin including Lake Powell, Deer Point Reservoir, and St. Joseph Bay for reference purposes. The SWIM plan states that this hydrologic unit covers approximately 749,663 acres or 1171.5 square miles of land and water.

Beck et al. (2000) identified priority sites for conservation in the northern Gulf of Mexico ecoregion. Although no sites were identified in the St. Andrew Bay drainage basin as a priority site, they provided information pertaining to the St. Andrew Bay drainage basin. They determined the drainage basin to be 735,301 acres (1149 square miles) in size.

Figure 1 St. Andrew Bay Watershed



The St. Andrew Bay ecosystem is defined for management purposes in this document as the U.S. Geological Survey Hydrologic Unit 03140101 minus the Lake Powell subdrainage basin and the St. Joseph Bay subdrainage basin as shown on Figure 1. Using this definition for the purposes of this document, the St. Andrew Bay ecosystem covers approximately 707,560 acres or 1105.5 square miles. The St. Andrew Bay drainage basin consists of a number of subdrainage basins as depicted on the St. Andrew Bay drainage basin map produced by and available from the Florida Department of Community Affairs, Division of Community Planning in the year 2000. Those interested in subdivisions of the overall drainage basin should consult this or other maps.

The Lake Powell subdrainage basin is excluded from this plan because Keppner and Keppner (2000a) provided a comprehensive summary of the information pertaining to it. In addition, Lake Powell has been designated an Outstanding Florida Water, and this designation requires more stringent regulation of certain activities that may affect the ambient water quality of the lake than is used for other water bodies. The St. Joseph Bay subdrainage basin is within Gulf County and is connected to the overall St. Andrew Bay drainage basin by a narrow strip of land. The St. Joseph Bay subdrainage basin would be best considered on its own for management purposes and is excluded from this plan for that reason.

The Deer Point Reservoir subdrainage basin has been the subject of a separate SWIM plan developed by the NWFWMD. The SWIM plan for the Deer Point Reservoir and the Deer Point Reservoir subdrainage basin was developed in 1988 and revised in 1991. A copy of the plan is available from the NWFWMD. The development of the plan was a result of the importance of the Deer Point Reservoir and subdrainage basin as a source of drinking water and high quality industrial use water for Bay County. Little, if anything, can be added to the thorough assessment of this subdrainage basin by the NWFWMD in this plan. One should consult the NWFWMD for copies of the many excellent reports prepared for a variety of characteristics of this subdrainage basin and its management.

Political Boundaries of the Ecosystem. The St. Andrew Bay ecosystem is the only ecosystem within the Panhandle of Florida that contains an entire, major, estuarine system. In other words, all of the tidally influenced surface water of the St. Andrew Bay estuarine system is entirely within Bay County. State, city, and county boundaries are not drawn along drainage basin lines or ecosystem lines, so the St. Andrew Bay ecosystem encompasses all or part of six counties with Bay County being entirely within the boundaries of the ecosystem and accounting for about 69% (761 square miles) of the ecosystem. The other five counties contribute 35% (346 square miles) of the land and water to the ecosystem. The portion of the St. Andrew Bay ecosystem in each county is Gulf County about 15% (159 square miles), Washington County at 10% (117 square miles), Calhoun County at 4% (47 square miles), and Jackson County at 2% (23 square miles). However, the 4% of the ecosystem located in Walton County is excluded, as is a portion of the Gulf County contribution as stated above. The result is that Bay County accounts for over two thirds of the St. Andrew Bay ecosystem as defined here.

In summary, the boundaries of the ecosystem are drawn from an ecological perspective and include portions of six counties. Bay County is at the center of the ecosystem and accounts for over two thirds of the total land and water in the ecosystem including the entire St. Andrew Bay estuarine system. Therefore, Bay County will be the major political entity in determining the ultimate fate of the St. Andrew Bay ecosystem as a whole and the St. Andrew Bay estuarine system as a part of that whole. This places a large burden on the citizens of Bay County in planning for the increase in the growth of the human population while maintaining the functions of the ecosystem that provide many of the environmental characteristics that make the ecosystem so attractive to visitors and new residents.

Abiotic (Non-living) Components of the Ecosystem

The abiotic components of the ecosystem include the landform, substrate (soil and sediment types), climate of the area, air quality, and the chemicals present in the water, sediment, and soil. The geology of the region, the geological history of the ecosystem, and the climate of the region set the stage for the evolution of the biotic (living) components of the ecosystem. The purpose of the following brief discussion of abiotic factors is to set the stage for addressing the information needed to assess the alterations of these factors in later sections of this plan. Wolfe et al. (1988) provided a detailed summary of the physiography, geology, and climate of the Florida Panhandle and specific areas such as the St. Andrew Bay estuarine system. Readers are encouraged to consult this work for a detailed understanding of the physical characteristics of this ecosystem.

Physiography and Geology. The landform of the St. Andrew Bay ecosystem has been greatly influenced by the rise and fall of sea level throughout geological history. The entire ecosystem has been inundated with seawater for varying periods of time. During the periods of inundation, seabed sediments were formed and were left behind as the sea level decreased. These sediments included the limestone and sand deposits that remained after the sea level decreased. The "sandhills" and karst area of the ecosystem were formed during the periodic rise and fall in sea level. These deposits formed the basic physical material for the development of the biotic portion of the ecosystem. Uplands, flatlands and lowlands are found in the ecosystem. The surface water bodies in the St. Andrew Bay ecosystem are also a result of the rise and fall of the sea level and the substrate left behind.

Substrate. The soils that develop in an ecosystem are a result of the parent material and sediments that have been transported, deposited, formed or exposed over the geological history of the area in conjunction with the quantity and quality of inorganic chemicals naturally present, slope, and the ability to hold moisture. The substrate plays an important role in determining the biotic communities that develop in an ecosystem. The biotic communities, in turn, act on the physical substrate to modify it. A look at a soils map of the ecosystem (Duffee et al., 1984) reveals that a significant number of different soil types have developed as a result of the interaction of the biota of the ecosystem with the substrate. Soils that are covered by, or saturated with, water are called sediments. They serve in the same manner as terrestrial soils to determine, in conjunction with the physical and chemical properties of the water column, the biotic communities present. Grain size and organic content of substrates are important characteristics in understanding the biota found in particular areas.

The water in surface water bodies serves as a physical substrate for aquatic biotic communities that develop in the water column. The quantity and quality of the physical and chemical characteristics of the water column influence the biotic community that is present in the open water. An obvious example is the quantity of salt in the water. The amount of salt in the water column determines the biotic communities that can develop. Only those organisms adapted to the quantity of salt in the water will be found there. The biotic communities, in turn, add substances to the water column and can affect other physical characteristics such as depth of sunlight penetration. The water column and the sediment of a water body also interact to exchange substances.

Climate. The climate sets limits on an ecosystem by establishing the basic conditions (normal and extreme) to which all the biota must be adapted if they are to survive in the ecosystem. The climatological limits to which the biotic component of the ecosystem must be adapted include seasonal temperature variations (length of growing season), rainfall amount, seasonal distribution of rainfall, and insolation (amount of sunlight). The frequency of thunderstorms affects the frequency of naturally occurring fire in the ecosystem, and the frequency of fire in an area acts as a determining factor in the development and maintenance of many biotic communities (Appendix 1). Flooding or period of inundation (normal and extreme) is also important to the development of natural communities and their maintenance. These natural events must be considered in the maintenance of the functional characteristics of the biotic communities within the ecosystem (Appendix 1).

Chemical Components. A number of studies have been conducted on the quantity and quality of the chemical and physical characteristics of the sediments of various surface water bodies in the St. Andrew Bay ecosystem. Included is the work by Brim (1998) and Payne (1997a & b, 1998, 2000). The quality and quantity of inorganic molecules present in the substrate or sediments are dependent on the parent material. The biotic communities that develop do so, in part, in response to the basic inorganic molecules present. Once established, the biota add organic chemical products of their metabolism to the substrate, and therefore, change the substrate providing different substrate conditions that support a different biota. This is an evolving process of interaction and change. An example is the development of a bog from an open water pond where the physical conditions are conducive to the bog. The open water area with its biotic community fills in with sediments and accumulations of organic material from the death of the biota until the open water is replaced by saturated soils. These saturated soils support a different biotic community that then further modifies the substrate until it is replaced by another biotic community.

The quantity and quality of the inorganic substances in the parent material determine the quantity and quality of the inorganic substances in the substrate. Those inorganic substances needed by the biota are cycled from the substrate through plants (photosynthesis or chemosynthesis) to the animals and back to the substrate upon the death and decomposition of the biota. Organic chemicals are produced primarily by the metabolism of the biota in the ecosystem, and these substances are added to the substrate and modify it chemically and physically. Of course, another source of organic chemicals to the ecosystem is the activities of humans and their ability to synthesize new organic molecules not found in the natural ecosystem.

The chemical characteristics of the substrate can be modified by human activities. Human activities can alter the balance of chemicals in the ecosystem by introduction of additional substances, alteration of the quantity of a substance, and the addition of toxic substances. Changes in the quantity and quality of the chemicals in the substrate of an ecosystem can result in changes in the biota present, and therefore, changes in the ecosystem.

Air. Air provides chemical substances necessary to the functioning of the ecosystem. Plants remove carbon dioxide from the air to use in photosynthesis to produce organic molecules. The process of photosynthesis releases oxygen to the air. Animals in their metabolic processes use the oxygen and return carbon dioxide to the air. Thus, one of the cycles is established between the biotic and abiotic components of the ecosystem. The quality of the air in an ecosystem can affect the biota present in the ecosystem. Natural events such as fire in the ecosystem can temporarily alter the air quality with little lasting effect on the biotic components of the ecosystem. However, the persistent addition of chemicals to the air from human activities can alter the air quality and adversely impact the biotic component of the ecosystem. An obvious example is acid rain and its effects on water chemistry and aquatic biotic communities and terrestrial communities in an ecosystem. Another example is the addition of mercury compounds to the ecosystem that can occur by burning certain fossil fuels in our industries.

Biotic (Living) Component of the Ecosystem

The biotic component of the ecosystem consists of the organisms that live in the ecosystem as a result of their being adapted to the abiotic conditions present in the area. The biotic component of the ecosystem uses the inorganic chemicals in the ecosystem to produce the organic substances necessary for life. Photosynthetic plants use the energy from the sun to convert inorganic chemicals to organic substances, and chemosynthetic microorganisms use the energy of bonds between atoms to do the same. The animals present in the ecosystem derive their energy by eating the plants and/or other animals present. Food chains and food webs (trophic structure) are established that lead from the variety of plants present to the variety of animals present in the ecosystem. Upon the death of the plants and animals, a group of organisms referred to as decomposers use the dead organic material as a source of energy. In doing so, they return the organic material to the abiotic part of the environment for reuse. Biogeochemical cycles (cycling of substances between the living and non-living) are thus established.

The description of the biotic part of the ecosystem can be accomplished from a number of viewpoints that attempt to bring order out of the diversity of organisms that occupy an ecosystem. For the purposes of this plan, we will use the concept of biotic communities and species diversity to summarize the biotic component of the St. Andrew Bay ecosystem. The rare, endemic, and protected species in the ecosystem will be examined separately. However, the reader should keep in mind the hierarchy of ecological study. A **species** is a group of organisms that breed and produce viable young, so one can study a species in relation to its environment. Species are arranged into populations. A **population** is a group of organisms of the same species that occupy a given area, so one can study a population in relation to its environment. Populations are arranged into **biotic communities** that are populations of different species interacting with one another and their environment. This ecosystem management plan is directed at the species and biotic community level of the ecological hierarchy.

Biotic Communities. The Florida Natural Areas Inventory (FNAI) defines a natural biotic community as a distinct and recurring assemblage of populations of plants, animals, fungi, and microorganisms naturally associated with each other and their physical environment (FNAI, 2000). It is within the biotic community that the energy flows are established through food chains and food webs and the biogeochemical cycles are established in relation to the abiotic component of ecosystem. FNAI has provided a hierarchy of biotic communities in which the community category is defined by the hydrology and vegetation. Each community category is divided into community groups that are defined by landform, substrate, and vegetation. Community groups are further subdivided into community types defined by landform and substrate, soil moisture, fire, climate and characteristic vegetation. Florida governmental agencies use the FNAI community hierarchy where biological evaluations or descriptions are needed to fulfill their responsibilities. For that reason, the FNAI hierarchy is used here.

FNAI (2000) defines 70 natural community types that constitute the original, natural biological associations of Florida. In addition, FNAI (2000) has provided a ranking system for these natural community types based on their degree of imperilment in Florida. FNAI kindly provided the authors with a list of 27 community types and their rankings that are present in Bay County alone. Three additional community types present in Bay County that are not listed by FNAI have been added. The 30 community types that occur in Bay County represents 43% of the total number of communities listed for the State of Florida. Eighteen of the natural community types of the 30 in our ecosystem are listed as imperiled (S1, S2, or S3) by FNAI (Appendix 1). These community types are considered sensitive habitats for the purposes of this plan. An additional three types of communities are present in the other counties included in the St. Andrew Bay ecosystem. Appendix 1 contains the list of biotic communities from ecosystem, their definition, and ranking.

The St. Andrew Bay ecosystem is a diverse mosaic of natural community types that demonstrates a complex interrelationship of these communities with one another and with their physical and chemical environment. The maintenance of these interrelationships, in conjunction with the rapidly increasing human population and its need to alter communities, is a task that requires careful thought.

Biodiversity. Biodiversity, in its simplest form, is the number of different kinds (species) of organisms that occupy a given area. It can be viewed as the naming of all of the species that occupy the Earth and a determination of their distribution patterns on Earth. It can also involve the study of the ecological relationships between organisms, their genetics and their evolution. Species diversity refers to the number of different kinds of organisms (species) that occupy a given area such as an ecosystem, biotic community (community type), or a plot in your backyard. It is not an easy task to determine the species diversity of even a small area in your backyard. This is a result of the myriad species of arthropods, nematodes, protozoa, bacteria, algae and other groups of organisms that may be present in addition to those that are more easily seen and recognized. Methods have been developed by The Nature Conservancy, the Heritage Programs of the states (FNAI is a state Heritage Program), and other organizations to track species diversity and make sense out of the concept of biodiversity in general. Our concern here is the species diversity of the St. Andrew Bay ecosystem.

Stein et al. (2000) addressed the biodiversity of the United States and identified six areas of significant biodiversity in the nation that they referred to as "hotspots." This book is recommended reading for anyone interested in biodiversity and ecosystem management. One of the six "hotspots" is centered over the Apalachicola River basin with the St. Andrew Bay ecosystem included to the west of the epicenter. One of the criteria used to identify the "hotspots" was the number of rare and/or endemic species present in the area. The St. Andrew Bay ecosystem supports a number of populations of rare and endemic species, a few of which are known only from small areas of this ecosystem and nowhere else on Earth. "A Look to the Future" contained the lists of the species so far reported from the ecosystem and will not be reproduced in this revision. Those interested in the complete listings can refer to the original document. However, those lists must be viewed as minimal because not all groups of organisms were included. The lists do attempt to incorporate species from all the counties in the ecosystem. The following discussion centers on Bay County because this area is entirely within the ecosystem, and various lists of species have been compiled for the county.

The species diversity of the St. Andrew Bay ecosystem has been partly addressed through literature surveys and field surveys of various groups of organisms living in the ecosystem. Emphasis has been placed on the species known from the St. Andrew Bay estuarine part of the ecosystem and on the vascular plants of Bay County. Although lists of species of organisms of various groups are available for the other five counties that make up a part of the ecosystem, the specific locations for the species within a given county are not provided. Therefore, it is not possible to determine which species occur in the part of the county within the St. Andrew Bay ecosystem and which species do not occur without locating the original record or specimen for each species. Therefore, the following summary of species diversity is restricted to the Bay County portion of the ecosystem. Those interested in the complete picture could request information for the other counties from FNAI and plot their element occurrence records on a map.

Keppner (1996) attempted to catalogue the species known from the St. Andrew Bay estuarine system based solely on reports from the literature. This effort resulted in the listing of 1649 species of invertebrates, 398 species of vertebrates, and 350 species of plants from the estuary. Only 25 species were vascular plants, and the remaining 325 species were species of algae and diatoms. This was obviously not a representative number of species of plants for the estuary or the county. However, the list of species directly associated with the estuary totaled 2397. If less stringent criteria for listing had been used, the number would increase to about 2530.

Keppner and Keppner (1997) provided a list of the vascular plants of Bay County. This list was compiled from the list of vascular plants for Bay County given by Wunderlin et al. (1996) and specimens present in collections of vascular plants in the herbaria for St. Andrews State Recreation Area, Camp Helen State Recreation Area, and in the authors' collection. The list contained 1146 species in 474 genera in 137 families including non-native species. Additional collecting of vascular plants in Bay County continued, and Keppner and Keppner (2001a) provided a recent list of the vascular plants known from Bay County based on the above mentioned collections and additional collections in the county. The list of vascular plants from Bay County now contains about 1271 species in 512 genera in 151 families including non-native species. Clewell (1985) listed 2359 species in 810 genera, in 181 families of vascular plants for the Panhandle counties of Florida (Suwanee River westward to Pensacola Bay). The Bay County portion of the St. Andrew Bay ecosystem alone supports 54% of the species, 63% of the genera, and 83% of the families reported from the Panhandle by Clewell (1985). Wunderlin (1998) stated that the State of Florida supports 3834 species in 1306 genera, in 227 families of vascular plants. The Bay County portion of the St. Andrew Bay ecosystem alone supports 33% of the species, 39% of the genera, and 66.5% of the families reported by Wunderlin (1998).

Recent publications by a number of workers have been located that would increase the species diversity of the ecosystem appreciably through addition of freshwater invertebrates and freshwater species of algae. With the known additions, one can conclude that the St. Andrew Bay ecosystem has significant species diversity. If one adds the number of vascular plants now known from the ecosystem to the number of estuarine animals and non-vascular plants known from the ecosystem, the total for this restricted summary is 3643 species. To that number could be added, at very least, the species of crayfish and Lepidoptera from the ecosystem that are in the authors' collections, reports of freshwater algae from DEP reports, records of occurrence from FNAI, and the freshwater aquatic invertebrates in Payne (1997 a & b, 1998, 2000). A search of the records at various educational institutions could easily increase the total number of species many times.

The Indian River Lagoon was once considered to be the most species-diverse estuary in North America. Swain et al. (1994) published a list of the species reported from the Indian River Lagoon drainage basin of the east coast of Florida that contained 2493 species. The St. Andrew Bay ecosystem is one half the size of the Indian River Lagoon drainage basin, and supports 3643 reported species. This makes the St. Andrew Bay ecosystem one of the most, if not *the* most, diverse estuary in North America if the original statements from the Indian River estuary supporters are correct. Regardless, the species diversity of the St. Andrew Bay ecosystem is impressive, and all levels of government should take notice of this fact.

In summary, diversity at the biotic community level and species level of the St. Andrew Bay ecosystem is quite high and depends on the maintenance of the natural habitats within the ecosystem. The maintenance of that biodiversity will be a challenge to those tasked with planning the development of the ecosystem as the human population increases.

Rare, Endemic, and Protected Species. The St. Andrew Bay ecosystem provides habitat for a significant number of rare, endemic, protected and/or tracked species of organisms. The **rare** species in the St. Andrew Bay ecosystem are those species that are present in limited numbers or of limited distribution (Panhandle or Florida) but are not yet protected or are secure as a result of their abundance on public land. These rare, unprotected endemic species also exist in the St. Andrew Bay ecosystem and in adjacent ecosystems. An example is *Hypericum exile* Adams that is endemic to the central and western areas of the Panhandle including the St. Andrew Bay ecosystem. **Endemic** species are those that are restricted to a geographical area such as Bay County, the St. Andrew Bay ecosystem or any other finite geographical area. We will examine those species that are endemic to the St. Andrew Bay ecosystem and those that extend into an adjacent ecosystem. **Protected** species are those species that are listed as threatened or endangered by the State of Florida under state statute and/or the federal government under the Endangered Species Act. Species tracked by FNAI include most of the formally protected species as well as those of interest to FNAI because of their rarity.

The U.S. Fish and Wildlife Service administers the federal Endangered Species Act and lists the species protected under that act. The Florida Department of Agriculture and Consumer Affairs, Division of Plant Industry, Bureau of Entomology, Nematology, and Plant Pathology – Botany Section publishes a list of the protected plants of Florida (Coile, 2000). The Florida Fish and Wildlife Conservation Commission is responsible for the listing of state protected animals in Florida (Wood, 1996). Appendix 2 provides the lists of species mentioned above as provided by FNAI (Chafin, Pers. Comm.) for Bay County and records in Coile (2000) and Wood (1996) for Bay County. Appendix 2 also contains a list of the protected and tracked species for the ecosystem that was provided by FNAI for this report. Again, Bay County is chosen for a detailed examination because of the extent of the ecosystem located in Bay County. Bay County provides habitat for 39 species of protected and/or tracked vertebrates, 4 species of invertebrates, and 55 species of vascular plants. The ecosystem contains 60 species of vertebrates and invertebrates and 130 species of vascular plants.

The St. Andrew Bay ecosystem supports an endemic species of crayfish that is found nowhere else on Earth except in a small area of Bay County. The Panama City Crayfish, *Procambarus* (*Leconticambarus*) *econfinae*, is the subject of a survey supported by a grant from the U.S. Fish and Wildlife Service to BEST, Inc. Keppner and Keppner (in prep.) will provide a report of the results of that survey by June 30, 2001. Northern Bay County and southern Washington County provide the only known habitat for a species of vascular plant found nowhere else on Earth. The plant is smoothbark St. John's-wort, *Hypericum lissophloeus*, which inhabits the margins of the karst ponds in the St. Andrew Bay ecosystem and part of the adjacent Choctawhatchee River drainage basin. Keppner and Keppner (2001b) provided a summary of the reported information and their observations pertaining to this species. Associated with this endemic species of plant are a number of other species of vascular plants that are protected under state and federal statutes or are rare or endemic to the Panhandle. The continued existence of the protected, endemic and/or rare species of plants and animals supported by the St. Andrew Bay ecosystem should be considered seriously in any plan for the management of the ecosystem.

Summary. The St. Andrew Bay ecosystem is a complex and highly diverse system of interrelated physical, chemical, and biological components that provide value for the citizens of the ecosystem. The physical and chemical components and their distribution and variation throughout the ecosystem has provided for a diversity of habitats with their attendant microhabitats. This provides for significant species and biotic community diversity in the St. Andrew Bay ecosystem. Included in this species diversity are a number of quite rare and endemic species that should be addressed as part of the plan to maintain the function and diversity of the St. Andrew Bay ecosystem.