Saint Andrew Bay

A look into one of Florida's most diverse watersheds

A Comprehensive report by Pamela Brown
University of Florida's Soil and Water Department
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Saint Andrew Bay Watershed: A look into one of Florida's most diverse watersheds

by

Pamela Brown

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ABSTRACT

Saint Andrew Bay Watershed: A look into one of Florida's most diverse watersheds

by Pamela Brown

Chairperson of the Supervisory Committee: Professor Alan Wright
Department of Soil
and Water Science

A major paper presented on the Saint Andrew Bay watershed from its geographical characteristics and historical significance to its major environmental concerns including conservation approaches, ecological restoration, and sustainable development.

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PREFACE

After moving to Panama City Beach, Florida in 2002, I fell in love with the natural beauty of the bay and the other coastal waters. Immediately, I set out to learn as much as I could about the local ecosystems, habitats, species, and the rich history of the area. I joined a local group effort to clean trash from the beaches and rivers banks. As I helped in these efforts, it brought back the memories of my youth and how determined I was to do my part in ridding our country of pollution after watching the Crying Indian public service advertisement (PSA.) Each weekend my family went out, collected trash along the roads, and recycled the hundred of bottles that we found weekly. The Crying Indian PSA that affected me the most was when the Crying Indian was canoeing through trash in the water and walking among the trash along the banks. Today, I am still doing my part to rid the country of pollution and protect our waters and I still feel as strong about the subject as I did as a youth. Unfortunately, most Americans have missed that message or simply do not care enough to do their part. Most Americans would rather blame businesses, industry, and government rather than face the truth that consumers' purchases drive the pollution. If we buy only the products that are sustainable and recyclable, then the businesses that pollute and waste resources would no longer have the consumers' money to support their destructive efforts. I believe it is time for another PSA that delivers as strong of a message as the Crying Indian of the 1970s to break the unemotional connection humans have towards our limited resources.

In the process of learning all about the area, I found out that Saint Andrew Bay Watershed was not only uniquely diverse, but a very fragile ecosystem. The watershed needs our protection from over utilization by many of the municipals

and industries in the watershed. Further research revealed just how delicate a balance the Saint Andrew Bay Watershed Basin has with the communities around it.

This report will focus on the Saint Andrew Bay Watershed, its resources, and its issues. Moreover, this report will share future plans for protecting this precious and diverse ecosystem from our human actions.

A Gulf Fritillary resting on a dune flower in Panama City Beach during their fall migration. Gulf Fritillaries are common butterflies in the area; however during the spring and fall migration their number increase approximately ten-fold. Photographed by Erika Brown.

Saint Andrew Bay

A couple taking a leisurely walk along the beach in Panama City Beach, Florida. Photographed by Pamela Brown.

INTRODUCTION

Even though more than 18,807,219 people live in Florida, how many people know that Florida has 7,800 lakes, 1,700 rivers and streams totaling 11,000 miles, 600 clearwater springs with 27 listed as first magnitude springs, and 2,276 miles of tidal shoreline (Schenker 2009 and FQF 2009.)

Florida is known for its tropical landscapes, cool breezes, palm trees, and beautiful endless beaches. However, there is so much more to Florida than that. Florida is mainly a peninsula with the Atlantic Ocean on the east coast and the Gulf of Mexico on the west coast. Florida is divided into four geographic land areas known as ecoregions: East Gulf Coastal Plain, Florida Peninsula, South Atlantic Coastal Plain, and Tropical Florida. The East Gulf Coastal Plain is the southwest portion of the peninsula and the northwest portion of the panhandle of Florida. It is characterized by flat to rolling landscapes with many rivers and streams. In addition, this area embraces the highest biodiversity of flora and fauna and it is home to more native species than any other analogous region in the United States (NWFLEC 2009.) The Florida Peninsula is the east portion of Florida and it is characterized by low and level landscapes. The Atlantic Coastal Plain is a land area in the northwest corner of the peninsula of Florida, and it is characterized by low rolling hills of red clay with hardwood and softwood forests and many lakes. The Tropical Florida is the southernmost portion of Florida where there is a tropical climate. The rest of Florida, the north and central portion, has a subtropical climate (Wikipedia 2009.)

Florida's overall size is 58,650 square miles with 54,252 square miles of land and 4,398 square miles of water (FQF 2009.) Surprisingly, Florida still has close to

Introduction

50,000 square miles of natural areas. Natural areas defined as ecosystems, which are forms of flatwoods, forests, marshes, prairies, swamps, and waterways, that occur in Florida with minimal human disturbances (Whitney et al 2004.) There are six land categories found in Florida: interior uplands, interior wetlands, interior waters, coastal uplands, coastal wetlands, and coastal waters. In addition, Florida has sixty-nine types of ecosystems. The diversity of Florida is due to its location in the southeastern region of the United States surrounded by water, and it's subtropical to tropical climate.

In addition to Florida's many lakes, rivers, streams, clearwater springs, and many miles of shoreline (Schenker 2009 and FQF 2009), there are fifty-two large watershed basins spreading across twenty-nine watershed groups in Florida as seen in *Figure 1* (FDEP 2009.) Watersheds are geographic areas where water flows across the landscape and drains into one common body of water. Water in a watershed basin comes from rainfall, stormwater run-off, groundwater discharge, and springwater discharge (FDEP 2009.) Watersheds are important in the development of our societies and providing water to fulfill the needs of the people who settle in the areas around them. Furthermore, issues of water resources in Florida have become important as their values to food security, economics, and social development are realized.

This report looks at the Saint Andrew Bay Watershed Basin and describes its geographical characteristics, its historical significance, and its influence on human history. Moreover, it will dive into the environmental issues of the watershed and discuss the conservation approaches and the ecological restorations that have occurred. Finally, we will look into the future plans for Saint Andrew Bay Watershed Basin and discuss sustainable solutions that are currently being investigated.

Figure 1. Major Identified Watersheds in Florida (FDEP 2009

A Photo of the upper view of an old Cypress tree and a photo of the water next to the old Cypress tree. Both photos show the biological diversity in tree species, and ground cover available in this ecosystem. Photographed by Pamela Brown.

C h a p t e r 1

THE BIG PICTURE: GEOGRAPHICAL CHARACTERISTICS

The Florida Panhandle has rich biodiversity with 57 distinct natural communities and it is home to more than 788 native vertebrates, including 131 amphibian and reptiles, more than 400 birds, more than 200 fish (freshwater and estuarine), and 57 mammals (NWFLEC 2009.)

PANHANDLE OF FLORIDA: GEOGRAPHY AND CLIMATE

Saint Andrew Bay Watershed basin is in the northwest portion of Florida known as the Panhandle of Florida. The Panhandle is part of the Florida plateau extension of the North American continent. Due to sea level fluctuation caused by the major climatic changes like the Ice Age and glacial melting, parts of the Panhandle of Florida were under water while higher elevations were islands. This fluctuation continued until the climate stabilized and the sea level declined enough for one permanent land mass to emerge during the Miocene epoch (23.3 to 5.3 million years ago.) The basement rock in the Panhandle is igneous rock and dates back to the Precambrian era. This means the youngest rock would be at least 542 million years old. The surface is twenty or more feet of Pliocene to Holocene siliciclastic sediment, that deposited during the sea level fluctuation when the area was emerging from under the sea (USGS 2009.) Siliciclastic rocks are noncarbonate sedimentary rocks of pre-existing rock fragments formed by inorganic processes that form quartz or other silicate minerals (Wikipedia 2009.)

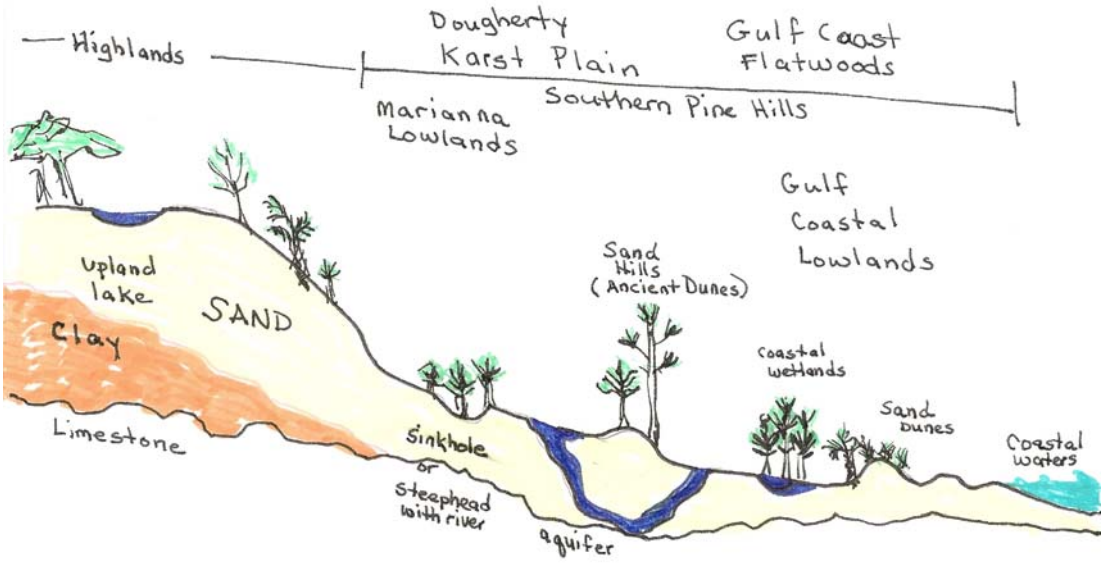
Geographical Characteristics

The Panhandle divides into three physiographic regions based on the origin and evolution of the landforms: Northern Highlands, Marianna Lowlands, and Gulf Coastal Lowlands. The Northern Highlands is a region of land where the highest elevation occurs including the town of Florala at 345 feet above sea level. The Marianna Lowlands is a region of land where there is karst topography sandwiched between the valleys of the Apalachicola, Chattahoochee, Chipola, and Choctawhatchee rivers. The karsts topography is a closed surface system with a water drainage basin over sandy soil. This region is part of the larger Dougherty Karst Plains and it has the highest number of dry caves in Florida with more than one hundred forty found. The Gulf Coastal Lowlands is the region of land formed beside the Gulf of Mexico where the lowest elevations occur. Typically, this region has poorly drained landscapes with numerous wetland areas. In addition, it contains barrier islands, coastal ridges, estuaries, lagoons, and "relict spits and bars with intervening coast-parallel valleys" (NWFLEC 2009.) The Gulf Coastal Lowlands region is a narrow strip up to 75 miles wide with its inland limits denoted by changes in topography including highlands, ridges, and scarps (Coultas and Hsieh, 1997.)

The climate in the Panhandle of Florida is subtropical due to the stabilizing effects of the Gulf of Mexico. The summers are humid and warm while the winters are mild to cool. As an average, the climate is mild with an average temperature of 68 degrees Fahrenheit; however, the day-to-day climate varies immensely. The Panhandle has stronger seasonal fluctuations and more rain than the Florida peninsula. The number of cold fronts that pass through the area from Pacific and Arctic origins causes the fluctuations. These cold fronts collide with the warmer air from the Gulf of Mexico and produce winter rain showers from December to April followed by the summer afternoon thunderstorms from

June to August. The summer thunderstorms and showers, caused by the collision of the moist air from both the Atlantic Ocean and the Gulf of Mexico, usually occur in the afternoon. The copious amounts of rain saturate the many creeks, lakes, springs, and wetlands. The average rainfall is 55"-60" per year. This plentiful supply of water in the hydrology cycle keeps temperature variations to a minimal. Periodically, tropical storms and hurricanes move through the area. On average, Florida experiences 0.76 tropical storms and hurricanes every 1.3 years (NOAA 2002.) The last hurricane to affect the Panhandle was Hurricane Katrina in August of 2005. Hurricane Katrina, classified as the sixth strongest recorded storm in the Atlantic region to hit the United States, cost over $100 billion in damages (Wikipedia 2009.)

Figure 2. Generalized Drawing of Topography & Elevations in the Panhandle



Three photographs showing the diversity of the communities in the Saint Andrew Bay Watershed. Photographs: Coastal Dunes (top left), Wetlands (bottom left), Coastal Grasslands affected by tide (right). Photographed by Pamela Brown.

Chapter 2

SIGNIFICANCE OF THE WATERSHED

Northwest Florida has five of the 27 first magnitude springs found in Florida including Gainer Springs, which discharges 114 million gallons per day of clear water into Saint Andrew Bay Watershed basin.

SAINT ANDREW BAY WATERSHED BASIN

Saint Andrew Bay Watershed (SABW) basin located midway in the northwest portion of Florida covers two of the three physiographic regions found in the Panhandle: the Marianna Lowlands and the Gulf Coastal Lowlands (Crowe et al. 2008; Richards 1997.) The northern and central part of the watershed is in the Marianna Lowlands region while the southern part of the watershed is in the Gulf Coastal Lowlands region. The Marianna Lowlands region divides into three subregions in the SABW: the northern part converses across the Sand Hills, the central part forms in the Sand Hill Lakes and Sinks characterized by the many sinkholes and sinkhole lakes, and the southern part covers the Flatwoods Forest.

The parent materials of the soils in the SABW consist of sand and clay particles that were transported by floodwaters from the Appalachian Mountains and deposited by seawaters as the ocean rose and fell during the Pleistocene Epoch. Sediments from the seas and uplands were deposited over the marine terraces. Nearly the entire watershed is underlain with Tampa formation overlying the Suwannee Limestone. The depth to the limestone can be over 200 feet in the southern part of the watershed. Many differences among the soils appear to

reflect the differences in parent materials and the time and interaction of the parent material with other geological factors.

The parent materials of the Marianna Lowlands are some of the oldest in Florida and have only been exposed recently in the last million years or so by erosion (Whitney et al 2004.) The Sand Hills are remnants of ancient pure white sand islands and dunes developed near primordial coastlines when the sea level was much higher. The Karst region is areas dominated by the underlying limestone reacting with water. The topography of this region consists of bluffs, depression marshes and ponds, caves, karst lakes, sinks, and tunnels. Bluffs are outcrops of limestone where the sand has been removed by natural processes. Depression marshes and ponds occur where the land subsides from erosion of the underlying materials including the limestone and little natural drainage occurs. Caves and tunnels form when pockets in the limestone remain after water spreading out through cracks and fissures dissolves the limestone away. Caves can be terrestrial (dry) or aquatic (underwater), and may interconnect with other caves through tunnels. Sinks form when the overlying sand hills cause the cave ceiling to collapse forming a deep conical hole. Depending on the water tables, the sink could be wet, dry, or some where in between. Wet sinks may connect to the underground aquifer and may even have springs flowing into them. Karst lakes occur when wet sinks fill with debris and disconnect from the aquifer.

The Sand Hills subregion, recognized by the longleaf pines and turkey oaks growing in thick residual sand soils, formed over higher marine terraces, while the Sand Hill Lakes and Sinks subregion, found west of the middle portion of Econfina Creek, formed when overlying sand hills collapsed over dissolved underlying limestone from the large amount of internally drained groundwater. This groundwater drains without showing any evidence of surface water vents. The southern part of he Sand Hills region covers the rolling and flat land situated

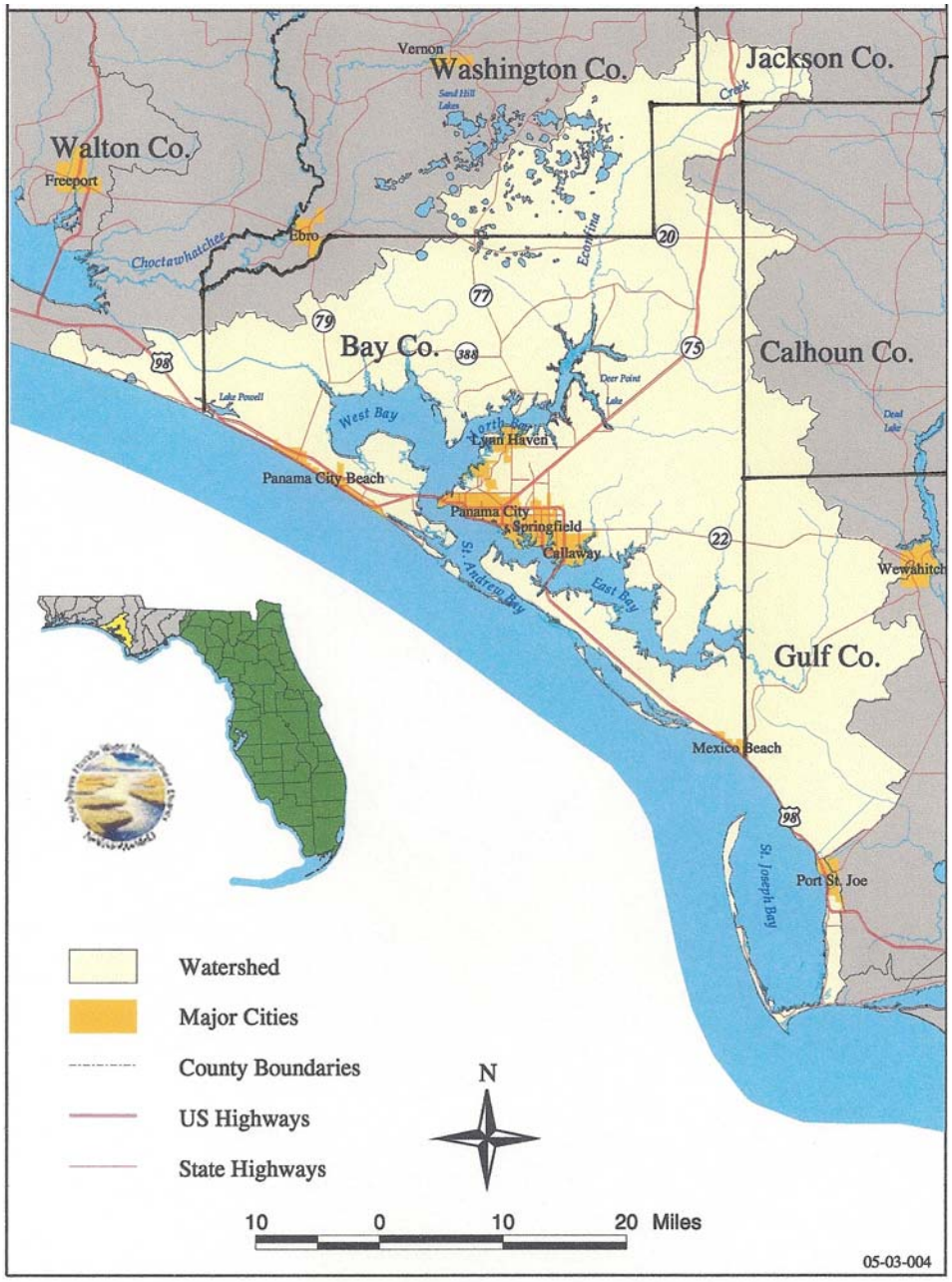
on low terraces of elevation less than seventy feet known as the Flatwoods Forest subregion. (Richards 1997.) The Sand Hills and Sand Hill Lakes and Sinks subregions have excessively well drained soils, while the Flatwoods Forest have moderately well drained to poorly drained soils with high water tables (Richards 1997.)

The Gulf Coastal Lowlands region in SABW is a narrow strip 25 miles wide and consists of beaches, estuaries, swamps, and tidal marshes. The ecosystems in this area are heavily influenced by salt spray, wave energy, and tidal patterns. The level and speed of erosion is based on the energy from the waves. Shorelines with high-energy waves will have steep slopes caused as the water carries away the fine sediments. In contrast, shorelines with low energy waves will have placid slopes embracing tidal marshes and swamps.

In regards to my home in the Gulf Coastal Lowlands region in Panama City Beach, the Soil Survey of Bay County map indicated Resota fine sand and Mandarin sand for my area with Kureb sand further south near the coast (Soil Conservation Service 1984.) However, when I surveyed the soil in 2008, I found layers strongly representing Kureb sand. In addition, recent geothermal well drilling at my house revealed pure white beach sand as deep as 250 feet.

As seen in *Figure 3*, the SABW basin extends across 749,663 acres of land encompassing six counties (Crowe et al. 2008; NWFWMD 2001.) It begins in the southwestern portion of Jackson County at the headwaters of the Econfina Creek (Richards 1997), and its range extends southwest through Bay, Washington, and Walton counties and southeast though Calhoun, and Gulf counties. The majority of the watershed, at sixty-one percent, crosses Bay County while the other thirty-nine percent is divided among Calhoun, Gulf,

Figure 3. Map of Saint Andrew Bay Watershed (NWFWMD 2009.)



Jackson, Walton, and Washington counties with 4%, 20%, 2%, 4%, and 9% respectively (Crowe et al. 2008; NWFWMD 2001.) All but one municipality located within the watershed are located in Bay County. Municipalities located within the SABW system are Callaway, Cedar Grove, Lynn Haven, Panama City (largest), Panama City Beach, Parker, and Springfield in Bay County, and Mexico Beach in Gulf County.

The SABW basin incorporates the watersheds of the Bayou George, Bear Creek, Burntmill Creek, Cedar Creek, Crooked Creek, Econfina Creek, Sandy Creek, Wetappo Creek, and their tributaries; Deer Point Lake; Lake Powell; Saint Andrew Bay Estuary system; and Saint Joseph Bay (NWFWMD 2001.) The major watersheds contributing to the system are Econfina Creek, Bear Creek, Deer Point Lake, and Saint Andrew Bay Estuary system (Crowe et al. 2008.)

ECONFINA CREEK

Econfina Creek is the largest creek in the SABW basin and the majority of the creek lies in the Sand Hills and Sand Hill Lakes subregions. It begins with its headwater in the southwestern portion of Jackson County and flows southwest through the northern tip of Bay County. Then it heads south through lower Washington county and crosses the county line back into Bay County before it discharges into the Deer Point Lake Reservoir located in the center of Bay County just eight miles north of Panama City. Econfina Creek has an average base flow rate, which is high for Florida as well as the Panhandle. Its base flow rate is 355 million gallons per day or 549 cubic feet per second. The base flow rate results from the high drainage of water in the deep sand hills that traverses internally through the porous limestone known as karst topography and discharges endlessly into the creek though clearwater springs flowing through the Floridan aquifer as seen in *Figure 4*. The result of the high groundwater flow is a

highly effective recharge area. Unfortunately, this recharge area does not filter groundwater for a long enough period of time to remove all the contaminates from entering the system from land use. Therefore, it is necessary to acquire surrounding recharge areas around the springs and lakes, in order to protect and conserve our freshwater resource supplies.

Figure 4. Photograph of Econfina Creek and Pitts Springs provided by Alice Guay with BEST.

Studies have shown there are 11 spring groups with more than 39 vents, including Gainer Spring, feeding Econfina Creek within a 4.75-mile segment along the middle portion of the creek. Gainer Spring is one of 27 first magnitude springs listed in Florida and one of five first magnitude springs listed in the Panhandle. First magnitude springs discharge more than 64.6 million gallons per day or more than 100 cubic feet per second (Richards 1997.) Gainer Spring discharges 114 million gallons per day, which is one-third of the Econfina Creek's total base flow rate. Another one-third comes from the other 10 spring groups.

Another important freshwater source is Bear Creek, the second largest creek in the SABW basin, which lies partially within the Sand Hills and Flatwoods Forest subregions. Its headwater begins in the northeastern portion of the SABW basin in Bay County and flows eighteen miles south to southwest until it discharges into the Deer Point Lake Reservoir (Crowe et al. 2008.) Bear Creek displays a slower base flow rate that is typical for creeks in the Panhandle. Its average base flow rate is 226 million gallons per day or 350 cubic feet per second (Richards 1997.) The base flow comes from groundwater moving through the soil from the higher elevation of the Sand Hills to the lower elevation of the Flatwoods Forest.

DEER POINT LAKE

Deer Point Lake (DPL), situated just eight miles north of Panama City, covers 4,572 acres. It was originally part of the upper North Bay, which developed over a succession of marine terraces and wave cut bluffs during the fluctuation of sea level (Richards 1997.) The majority of the DPL basin lies in the Marianna Lowlands subregion while the southern part lies in the Gulf Coastal Lowlands subregion. It is a man-made freshwater reservoir overlaying moderately well drained to excessively well drained soil (NWFWMD 2008.)

Deer Point Lake basin receives on average 600 million gallons per day of freshwater from Bayou George, Bear Creek, Cedar Creek, Econfina Creek, and their tributaries. After the completion of the dam in 1961, the original brackish waters of North Bay trapped behind the dam flushed out over the fixed spillway into North Bay. Currently an average of 519 million gallons per day of freshwater spills over into North Bay (Ogren and Brusher 1977 sited by NWFWMD 2008.) The reservoir can completely recycle in just 21 days (NWFWMD 2008.)

Land Use in DPL basin is dominated by upland forest and wetlands (74%) with limited residential (4%) and recreational (5.7%) around the lake and some

agriculture (10%) areas just northeast of the city of Fountain. The water quality is classified as potable (Class I) water supplies from source to dam (SWQS 2009), and is protected by the Northwest Florida Water Management District (NWFWMD.) The water of Deer Point Lake, developed for commercial and potable water, currently is shared equally between the two uses (Richards 1997.) As a potable water source, DPL has become the primary drinking water source for most municipalities in Bay County (NWFWMD 2001.) The majority of the freshwater in the Saint Andrew Bay Watershed basin comes from streamflow that traverses through Deer Point Lake basin via Econfina Creek and Bear Creek with fifty-eight percent and thirty-six percent, respectively (Richards 1997.)

SAINT ANDREW BAY ESTUARY

Saint Andrew Bay Estuary (SABE) system, adjacent to Panama City, covers 69,190 acres and includes East Bay, North Bay, Saint Andrew Bay, and West Bay. SABE lies in the Gulf Coastal Lowlands subregion and is a unique estuary system with low freshwater inputs from creeks and DPL, and two passes that provide surface water connection to the Gulf of Mexico (NWFWMD 2008.) SABE inflows of 818 million gallons per day are very low compared to Apalachicola Bay, which has 12,669 million gallons per day draining from a 12,800,058-acre watershed (Crowe et al. 2008 and USGS 2009.) The SABE, defined to be a "relatively deep clearwater high salinity system" (Keppner and Keppner 2008 sited by Crowe et al. 2008), incorporates the interconnected waterbodies and surface water basins of Deer Point Lake, East Bay, Gulf of Mexico, North Bay, Saint Andrew Bay, Saint Joseph Bay, and West Bay (NWFWMD 2001.) The water quality is classified as "recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife" (Class III) for all areas of SABE with the exception of most areas of North Bay (NWFWMD 2009.) This is due to the SABE systems low freshwater inflows and high salinity. Moreover,

Saint Andrew Bay

SABE is not considered a true estuary and the only true estuary in the SABE system is in North Bay directly south of the DPL dam (Ogren and Brusher 1977 sited by NFMWD 2008) and worth mentioning in more detail later..

The SABE connects to the Gulf of Mexico via the eastern pass (East Pass) and western pass (West Pass) around Shell Island. The East Pass was the original natural passageway into SABE and provided the majority of the water exchange between the Gulf of Mexico and the SABE. Due to coastal hydrodynamic processes that caused shoaling, the East Pass slowly filled up with sediment and eventually closed in 1999(NWFWMD 2008.) In 2001, at a cost of two million dollars, a channel 300 feet wide and ten feet deep was dredged through the East Pass. Unfortunately, it did not take long for the channel to fill slowly back up with sediment, and in less than two years the pass was closed again. Although the East Pass helped flush the SABE and proved to be very beneficial while opened, it has been difficult getting the East Pass reopened. Many individuals and groups continue to pursue opening the East Pass (Hobson 2009.) It will be a while before all the necessary steps are completed and an application for a dredging permit filed (Hobson 2009.) The West Pass, a man-made passageway for navigation between the Gulf of Mexico and the SABE, was cut in 1934 and remains open to this day (NWFWMD 2001.)

North Bay is a shallow estuary system with a mean depth of six feet and a surface area of 6,700 acres. It extends from the DPL dam, where the majority of the freshwater hydrology interaction occurs, then flows south where it amalgamates with Saint Andrew Bay (NWFWMD 2008.)

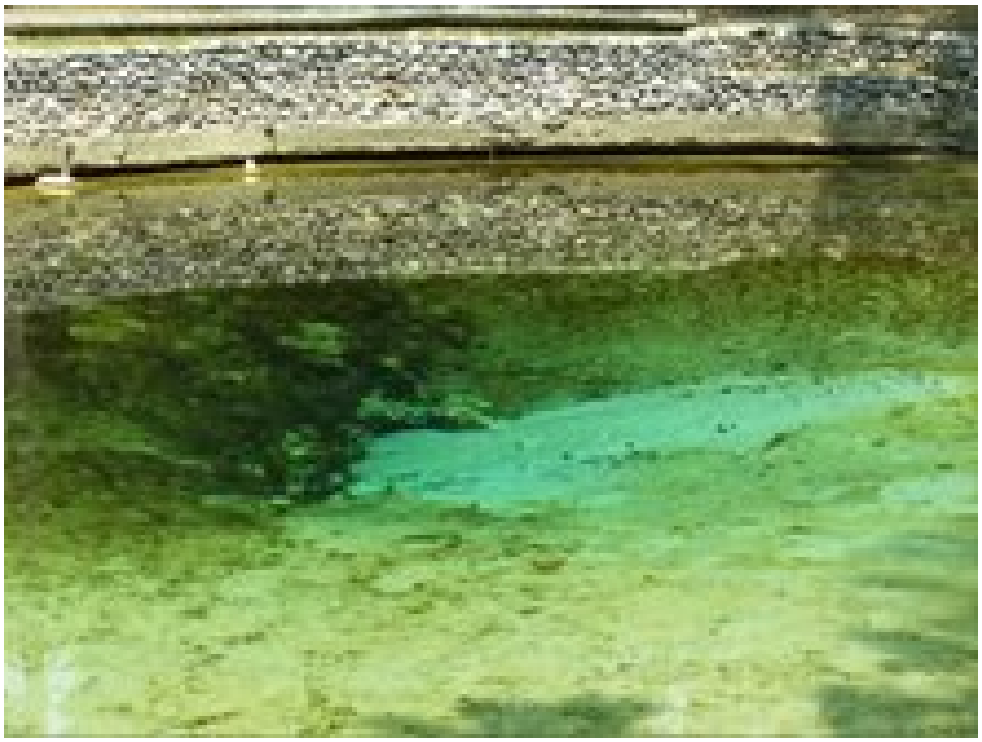
Land Use in North Bay is divided into the northern and southern zones. The northern zone consists mainly of upland forest and wetlands with a little residential, while the southern zone consists mainly of residential with some

commercial. The water quality is classified as shellfish propagation or harvesting (Class II) waterbody for all areas north of Highway 98 with the exceptions of alligator bayou and fanning bayou. Commercial harvesting is not allowed in any of the bayous.

The Gulf Intracoastal Waterway (GIWW), created in the 1950s for navigational purposes, flows from west to east. GIWW connects the SABE with the Choctawhatchee Bay west of West Bay at West Bay Creek. Then it flows through the SABE and exits east through East Bay at Wetappo Creek where it connects to the Saint Joseph Bay through the Gulf County Canal (NWFWMD 2001.)

Saint Joseph Bay is worth mentioning because it is the only embayment in the eastern Gulf of Mexico that lacks a major source of freshwater inflow. Saint Joseph Bay has a surface area of 42,826 acres and is located in the Gulf Coastal Lowlands region. It has the largest seagrass stock in the Florida Panhandle and its bay system is dominated by salt marshes and tidal flats that support approximately 3,643 species of birds, fish, shellfish, and other rare, protected, and endemic species (NWFWMD 2008.) In order to preserve this unique system, most of the bay was designated as an aquatic preserve in 1969 (NWFWMD 2001.)

Another smaller system worth mentioning is Lake Powell, which covers the southwest border of Bay County and the southeast border of Walton County. Lake Powell is a large interdunal lake with an 8,612-acre watershed and a lake surface area of 666 acres. The state of Florida has recognized Lake Powell as an "Outstanding Florida Water" (Keppner and Keppner 2000.)



Photographs of Econfina Creek and Pitts Springs.
Photographs provided by Alice Guay.

Chapter 3

LAND AND SPECIES DIVERSITY

The Panhandle is rich in biodiversity with six major ecosystems and fifty-seven different natural communities including bluffs, bogs, caves, coastal dunes and beaches, glades, lakes, hammock islands, sandhills, seepage, slopes, springs, steepheads, tidal salt marshes, uplands, seagrass and submerged vegetation, fresh and brackish wetlands, and soft and hard bottom waterbodies (NWFLEC 2009 and NWFWMD 2008).)

LAND USE COVERAGE

According to NWFWMD, Saint Andrew Bay watershed land use separates out to the percentages and acreage shown in *Table1*. The land use and coverage was determined by using the Florida Department of Transportation's Land Use, Cover, and Forms Classification System (NWFWMD 2008.) This table does not designate which upland forest and wetlands are used for silviculture. The majority of private lands were used for silviculture including lands owned by the largest landowner, St. Joe Company. In the past, St. Joe Company grew pine trees to harvest for pulpwood for the production of paper. When the company reorganized in 1985, it moved out of production land to a new real estate division called Southwood. It was not until the early 1990s that St. Joe Company started developing on a large scale with residential, and resort communities (SJC 2009.) Major public landowners include the Florida DACS Division of Forestry, Florida DEP Division of Recreation and Parks, Northwest Florida Water Management District, and the U.S .Department of Defense (NWFWMD 2001.) Although most of the existing urbanized areas are

the municipalities located adjacent to Saint Andrew Bay, urban growth in the form of new residential and commercial development around the West Bay sector has begun with the building of the new international airport in West Bay. The new airport will expand across 1,300 of the 4,000 acres donated by St. Joe Company. In addition, St. Joe donated a 9,609-acre West Bay Preservation Area and Conservation Easement. Great efforts to protect the West Bay and surrounding wetlands went into the planning of the airport and the surrounding land totaling 78,000-acres. Of that total, 41,000-acres including the preservation area were set aside and designated as conservation land, including thirty-three miles of bay shoreline and 44 miles of creek front. The U.S. Green Building Council will certify the new airport, built to higher standards than required by law, as a Leadership in Energy and Environmental Design (LEED) when completed in 2010.

Table 1. Generalized Land Use and Cover, St. Andrew Bay Watershed (Keppner and Keppner 2008)

Category	Acres	Percent
Agriculture	42,324.22	5.75
Barren Land	3,979.80	0.54
Commercial & Services	6,391.39	0.87
Industrial	2,871.36	0.39
Institutional	1,731.64	0.24
Recreational	10,109.31	1.37
Residential	38,011.75	5.16
Trans, Com, & Utilities	9,434.52	1.28
Upland Forests	500,151.51	67.95
Water	12,509.80	1.70
Wetlands	108,546.98	14.75
Total	**736,062.28**	**100.00**

HABITAT COMMUNITIES

Habitat communities are determined by the soil type, the underlying parent materials, and the hydropattern of the area. Saint Andrew Bay Watershed has a variety of habitat communities with a high amount of biodiversity. From an aerial view, the watershed appears to be dominated by pine sand hills, pine flatwoods, and wetlands communities with pine scrub forest dominating along the coastline of the Gulf of Mexico. However, a closer look reveals a vast region of many distinct communities intermingled together including steepheads, pine sand hills, pine flatwoods, temperate hardwood forest, springs, creeks, lakes and ponds, karst ponds, interior wetlands, coastal uplands, coastal wetlands, and coastal water (Whitney et al. 2004.)

STEEPHEADS

The word "steepheads" refers to ravines at the source of the headwaters (Whitney et al. 2004.) Steepheads in the Panhandle are deep ravines occurring in the uplands where waters coming up from springs or seepage cut into the sand hill from beneath it and the sand is carried away (NWFLEC 2009 and Whitney et al.2004.) Water flows through the steephead ravines at a steady rate all year long, regardless of the rainfall on the lands above them. Typically, the steephead ravine's walls slope at a 45-degree angle. Older steepheads have longer and deeper valley contours that can attain a depth of one hundred feet (Whitney et al. 2004.) The deeper elevation keeps the steephead cooler in the summer and promotes dense vegetation including sphagnum moss along the creek fronts and ancient species no longer available on the above land (NWFLEC 2009 and Whitney et al.2004.)

The only steephead region in the Saint Andrew Bay watershed occurs in the northern tip of Bay County and its bordering area in Washington County along the Econfina Creek and its tributaries. Gulches from the adjoining tributaries combined with the ravine of Econfina Creek can be easily seen from overhead as the pine flatwoods abruptly drop into the temperate hardwood forest in the steephead ravines. *Figure 5* is an aerial photograph showing the contrasting landscapes of the pine flatwoods and the lush green below. Note the steep white sandy walls of one of the tributary ravines in the middle of the photograph.

Figure 5. Aerial Photograph of Steephead Ravines along Econfina Creek (Google Maps 2009.)

PINE SAND HILLS

The pine sand hills community is an open canopy habitat where pines and wiregrass dominate the landscape with other ground covering plants over deep poor nutrient sand hills. This community relies on fire to suppress the hardwoods in the understory and stimulate plant reproduction (NWFLEC 2009and Whitney et al. 2004.) The scrub oaks in this community respond well to fire and appear healthier when frequently burned. Living among the trees and plants are numerous insects, birds, mammals, and reptiles including the fox squirrel, gopher turtle, and the endangered red-cockaded woodpecker. The red-cockaded woodpecker is used as an indicator species for old native sand hill communities, because it only drills a nesting cavity into live seventy plus year old native pine with heart rot (Whitney et al. 2004.)

PINE FLATWOODS

The pine flatwoods community is a flat open canopy habitat with fine sand soils with low organic matter typical of the coastal lowlands from which the community originated. Moreover, the flat topography induces a low run-off rate and a slow percolation rate to underlying soils. Fire and water availability determine the plant community in the flatwoods (NWFWMD 2001 and Whitney et al. 2004.) During the rainy season, water is abundant and flooding occurs; however, the rest of the year, the community suffers from drought. These extremes make it difficult for plants to flourish, and only those that adapt can survive to dominate the landscape. Thus, flatwoods vary from an open canopy dominated by grasses and herbs with scattered pines to dense canopy of pines with a dense understory. Among the pine flatwoods are areas of mixed hardwood, titi wetlands, bogs, swamps, and open-water communities growing near or in inundated depressions in the landscape. The major species are slash

pine (Pinus elliotti), long-leaf pine (Pinus palustris), wiregrass (Aristida spp.), saw palmetto (Serenoa repens), and a variety of species in the Ericaceae family (NWFWMD 2001.) The flatwoods community is important to biodiversity because it links other neighboring higher and lower elevated communities together (Whitney et al. 2004.) Unfortunately, the majority of pine flatwoods communities are used for silviculture (NWFWMD 2008.)

TEMPERATE HARDWOOD FORESTS

Temperate hardwood forests are multi-layered forest where different tree species compete for space and sunlight in the closed and shady canopy. Most temperate hardwood forests occur near abundant water including areas along side streams and areas near the bays and coast where fire fails (NWFWMD 2001 and Whitney et al. 2004.) There are three categories of temperate hardwood: hydric, xeric, and mesic (FNAI 2009.) According to Whitney et al., the hydric forest contains mainly cabbage palm (*Sabal palmetto*), red cedar (*Juniperus virginiana*), and swamp bay (*Persea palustris*.) Typically dry, the xeric forest consist of mainly the oak family, Quercacea and it is dominated by the live oak (*Quercus virginiana*) and laurel oak (*Quercus laurifolia*.) The mesic forests are the forests that fall in between the xeric and the hydric and contain many tree combinations including swamps known as bottomland forest. Other mesic forests are mixed forest, slope forest, upland forest, and Rockland hammocks, which are found only around limestone sinks (Whitney et al. 2004.) Temperate hardwood forests are valuable resources because they aid in stabilizing the climate and play a role in local rainfall patterns, while reducing pollution, run-off, and recharging the aquifer. Moreover, they are irreplaceable habitat communities as well as specie depositories (Keppner and Keppner 2008 and Whitney et al. 2004.) Temperate forests alongside Econfina Creek, purchased by NWFWMD, support interesting and protected species of plants and animals.

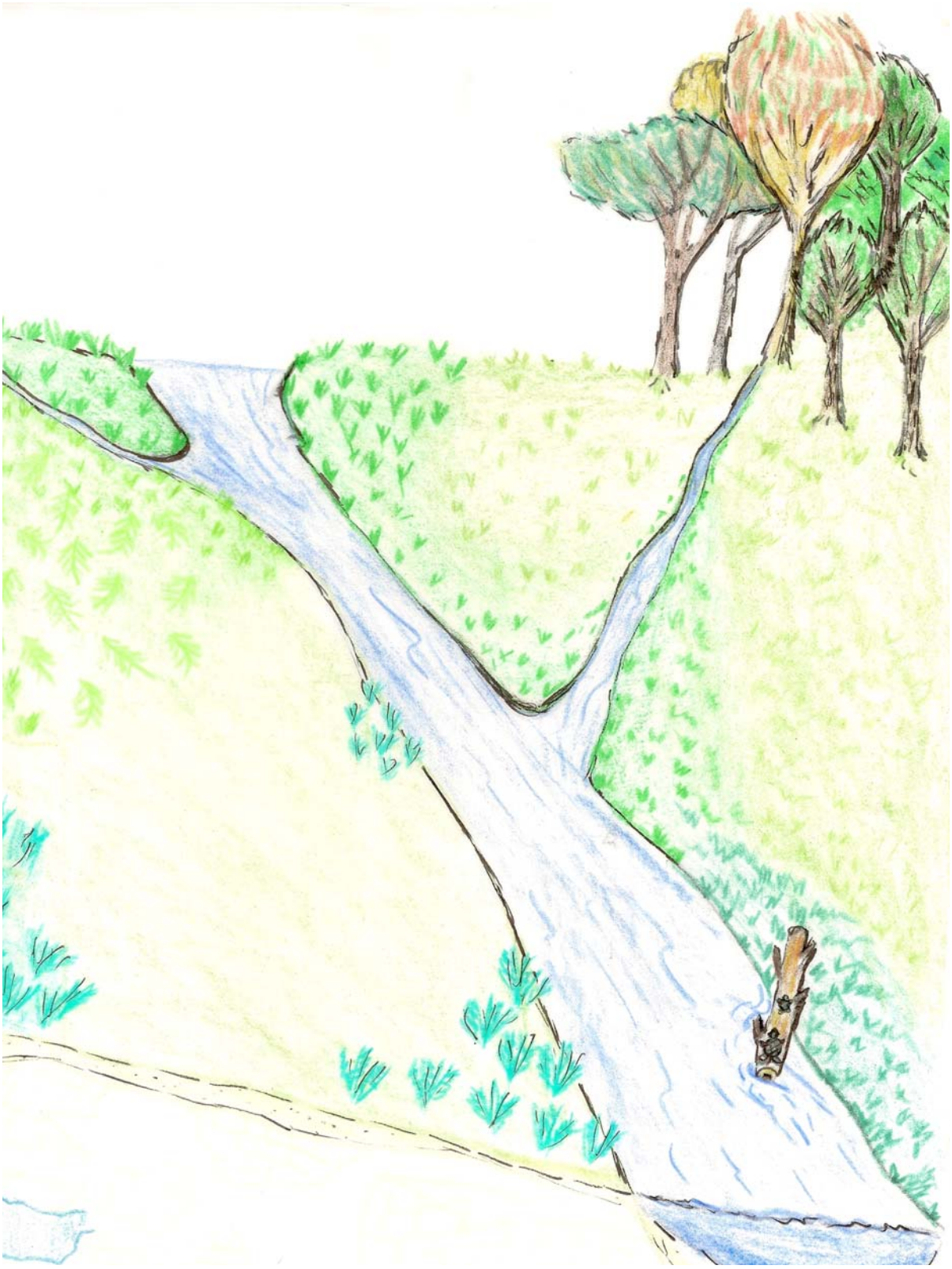
One beautiful example of the temperate hardwood forest can be seen in *Figure 4,* shown beforehand, where the pine flatlands abruptly stop and the tops of trees are visible at ground level (NWFWMD 2001.)

SPRINGS

Springs are groundwater streams that flow through weak points in the limestone. Where the weakest point meets the surface, springs vent out onto the surface as streams known as spring runs (Whitney et al. 2004.) Studies have shown that the number of springs increases in regions where the limestone layer is closer to the ground surface. This is especially true in northern Florida where the limestone is close to the ground surface as seen in the lower portion of *Figure 6*. The spring's water chemistry is determined by the residence time in the aquifer, the chemistry of the soil and aquifer layers, and the depth of the groundwater in the aquifer. Typically, larger springs have longer residence time and older water discharging from the springs. Spring flow is determined by the total amount of rainfall in a watershed and limestone porosity; however, a single rain event will not affect the flow rate. Only seasonal changes of drought or heavy rain can deter a spring's normal discharge rate. Moreover, the discharge rate determines the spring's classification from first to eighth magnitudes with first-magnitude being the highest volume per given time period. Saint Andrew Bay Watershed basin has 1 first-magnitude, 4 second-magnitude, and 6-third magnitude spring groups. These springs with their constant water flow, temperature, and chemistry provide unique habitats for many species (Whitney et al. 2004.)

Figure 6. Typical Habitat Communities in Saint Andrew Bay Watershed Drawn by Pamela Brown.

Land and Species Diversity



CREEKS AND RIVERS

According to Whitney et al., "All natural flowing freshwater systems are streams." Thus, streams, creeks, and rivers are one and the same because there are no standards for determination. Since the measurements of these lotic systems are subjective, the people who name it decide which one to use. In the Saint Andrew Bay watershed, creek is the term used for all lotic communities. Numerous creeks in the Saint Andrew Bay Watershed basin drain the land.

The major creek, Econfina Creek, is a spring-fed stream, a seepage stream, and a steephead stream depending on the segment of the creek. Most of the creek's surface water has a light tannin tint from fallen leaves and ground seepage. However, the water is crystal clear around the spring vents and a clear stream of spring water can be seen flowing down stream until the two waters merge as one. Due to changes in topography, streamflow rate, water and soil chemistry, and sunlight intensity, the creeks in the watershed have a variety of habitat communities as depicted in *Figure 5*. These communities provide food and shelter for numerous species of flora and fauna including some special species like the endangered Gulf Moccasin shell bi-valve mollusk (Mediondus pencillatus), endangered red-cockaded woodpecker, and reticulated flatwoods salamander (Ambystoma bishopi) (FNAI 2009 and Whitney et al. 2004.)

LAKES AND PONDS

Lakes and ponds are interior freshwater surface waterbodies that include a vast array of aquatic habitat communities. They are still water systems that encounter seasonal variations in depth and water temperature. Lakes go through periodical drying down, which allows the lake to cleanse itself of its dense muck bottoms. In fact, lakes need these drying periods. Without them, the lake communities become ill and die, as the oxygen levels get too low to

support life. Species in these communities have adapted to handle the variations in water level, sunlight penetration, and oxygen levels in the different environments. Typical zones for habitat communities in lakes are shoreline zones, light penetrating open-water zones, and dark open water zones. Emergent vegetation grows in the shoreline zone; while most submersed vegetation grow in the light penetrating open-water zone. In the dark open water zone, flora and fauna survive in the upper surface water where light can still penetrate, while bacteria and fungi live on the dark bottom feeding on fallen organic matter. Water quality is heavily dependant on the land use and human activities in and surrounding the lakes (Whitney et al. 2004.) Saint Andrew Bay watershed has sand hill lakes, sinkhole lakes, flatlands lakes, swamp lakes, and a coastal dune lake. Important lakes and ponds in the watershed are Deer Point Lake (reservoir lake), Lake Powell (coastal interdunal lake), and the many unnamed karst ponds (sinkhole lakes) found in the north central portion of the watershed (FNAI2009.)

KARST PONDS

Karst Ponds are sinkholes where the water table is at the ground surface. Although a karst pond may look like an ordinary placid pond, the water is far from being still. Since karst ponds are feed by groundwater moving downwards through the watershed, the water in the pond is constantly interacting with the groundwater and recharging the water in underlying aquifer. This interaction keeps the water cool and alkaline, and at the same time keeps the water level constant. According to NWFWMD, the karst ponds in the northern part of Bay County and the southern part of Washington County are the "most ogliotrophic in the nation." Moreover, the water is low in pH, low in nutrients, low in calcium hardness, and it is clean and clear (NWFWMD 2001.)

Lush vegetation occupies the immediate area outside the sandy shoreline. This lush habitat supports a community full of rare and endangered species of plants and animals including a diverse community of benthic macroinvertebrates (NWFWMD 2001.) According to Keppner and Keppner, one exceptionally rare plant, found in this local region of karst ponds and nowhere else in the world, is the Smoothbark St. John's wort (*Hypericum lissophloeus*.) Some other plants found with the Smoothbark St. John's wort and other similar habitats in Florida are the Crystal Lake Whitlow wort (*Paranychia chartacea*), the Kral's yellow-eyed grass (*Xyris longisepala*), the Panhandle meadowbeauty (*Rhexia salicifolia*), the Quillwort yellow-eyed grass (*Xyris isoetifolia*) similar to the Kral's species, and the Threadleaf sundew (*Drosera filiformis*.) The change in land use to residential around the karst ponds places the Smoothbark St. John's wort in peril of extinction due to human activities and clearing vegetation around shoreline of the karst ponds (FNAI 2009.)

INTERIOR WETLANDS

Wetlands are areas with standing water for some period during the growing season. Wetlands of variable size are found between uplands and deep waterbodies, and they are influenced by hydropatterns, physiochemical environment, adaptation of biota, and human activities (Mitsch and Gosselink 2000.) Hydropattern, used to describe the hydrology of an area, includes five components: depth, duration, flow, frequency, and timing. The hydropattern helps determine the type of wetland for a given area.

Interior wetlands are comprised of bogs, freshwater marshes, and swamps. The Saint Andrew Bay watershed consists mainly of fresh water marshes and swamps with the occasional bog. Freshwater marshes fringe the shallow waters of lakes and ponds. Marshes in the watershed are comprised of beakrush

marshes, cattail marshes, and sawgrass marshes. Swamps in the watershed, consisting mainly of trees, include bayhead swamps, cypress swamps, titi swamps, and tupelo riverine swamps (NWFWMD 2008.) Bogs are mainly seepage wetlands that have dominating vegetation consisting of grasses and sedges. However, among the grasses and sedges are some rare or unusual species of bladderwort, butterworts, pitcher plants, and sundews (NWFWMD 2001.) Wetlands play a crucial role in the Saint Andrew Bay watershed by providing flood control, improving water quality, and providing habitat for wetland adapted species. (Misch and Gosselink 2000.)

COASTAL UPLANDS, WETLANDS, AND WATERS

Coastal uplands, wetlands, and waters are three regions of habitat communities along the Gulf of Mexico that are directly affected by salt spray, deposition, erosion, and salt water. Coastal uplands or pine scrub uplands occur in regions above the high tide where the quartz sand is well drained and it is only affected by changes in the deposition of sand and salt spray (FNAI 2009 and Whitney et al.2004.) The only water this region receives is from the occasional rainstorm (Odum et al. 1998 and Whitney et al. 2004.) According to NWFWMD, the trees dominating in this region are the sand pine (*Pinus clausa*), sand live oak (*Quercus geminate*), and myrtle oak (*Quercus myrtifolia*), while the dominating shrub is the Florida rosemary (*Ceratiola ericoides*) occurring in dry areas and the Lyonia spp. occurring in wetter areas.

Coastal wetlands and beaches are the shorelines directly affected by wave energy, tidal patterns, and salt water. Whether the shoreline will be a white quartz sand beach or a coastal wetland depends on the intensity of the wave energy. The wave energy potential arises from the degree of slope of the land as the land enters the Gulf. Smaller slopes and flat lands create less wave

energy than steep slopes. The bays in the watershed are low energy shorelines with coastal wetlands including salt marshes and submerged seagrass beds; however, there are a few sand beaches where wave action is too high for marshes and seagrasses to establish. Seagrass beds are important biotic communities that provide shelter, food, and nurseries for marine species (Odum et al 1998 and Whitney et al. 1998.) Clear shallow waters in the Saint Andrew Bay Estuary system and Saint Joesph Bay are dominated by shoal grass (*Halodula* wrightii) and turtle grass (*Thalassia testudinum*) with some manatee grass (*Syringodium filifome*) occurring in slightly deeper water (NWFWMD 2001.) In contrast, the region directly in contact with the water of the Gulf of Mexico is a high-energy shoreline with white sandy beaches. Although the beaches appear sterile, they are full of microsopic communities among the sand grains. Moreover, the driftline debris, which is carried onto shore by wave actions, supports its own habitat communities (Odum et al. 1998 and Whitney et al. 2004.) The Quartz white beaches extend the entire length of the watershed from the western boundary in Walton County to the eastern boundary in Gulf County. Most of the beach region in Bay County is predominantly developed (Keppner and Keppner 2008.)

Coastal waters, areas of open water including soft and hard bottoms, have many habitat communities throughout the different layers of the water similar to lake zones aforementioned. Submerged vegetation grows in light penetrating open water with habitat communities at the surface water, vegetation zone, and the soft organic matter bottom. In deeper dark open water zones, habitat communities of flora and fauna exist at the surface layer, while bacteria and fungi live in microscopic communities on the dark bottom. Estuaries, areas where freshwater and saltwater mix, support another group of habitat communities. The main habitats, comprised of plankton and benthic communities including oyster reefs, support a diverse group of flora and fauna.

The only true estuary in the Saint Andrew Bay Estuarine system is in North Bay at the spill over dam. This area with brackish waters supports the only commercially valuable oyster reef in the watershed. Other areas in East Bay, North Bay, and West Bay support oyster reefs in brackish waters where freshwater inflows from creeks and tributaries exist. Oyster reefs provide hard bottom habitat communities including diverse communities of sessile and portative organisms (NWFWMD 2001.) *Table 2* shows a comparison of species diversity between the United States (in general for estuaries), Indian River Lagoon (considered one of the most diverse and important estuaries in Florida), and Saint Andrew Bay Estuarine System. In addition, it shows that the total species count of 2913 reported in Saint Andrew Bay Estuarine System outnumber the total species count of 2529 reported in the Indian River Lagoon Estuarine System, thus emphasizing the importance of Saint Andrew Bay Estuarine System to the watershed and surrounding communities.

Table 2. Number of species reported from Saint Andrew Bay Estuary, United States, and Indian River Lagoon for comparison (Keppner 2002.)

Group	Species from St. Andrew Bay	Species from U.S.*	Species from Indian River Lagoon
Microalgae	278	?	250
Macroalgae	28	?	142
Fungi	8	34,000	0
Lichens	1	3,800	0
Vascular Plants	149	15,869	147
Protozoa	109	?	175
Porifera	15	375	14
Coelenterata	47	1620	31
Ctenophora	3	45	2
Platyhelminthes	5	6000	5

Table 2. A continued comparison of species diversity showing Saint Andrew Bay Estuarine System with more species than Indian River Lagoon (Keppner 2002.)

Rotifera	2	700	0
Gastrotricha	1	100	0
Kinorhyncha	1	20	3
Priapulida	0	3	0
Nematomorpha	1	3	0
Nematoda	278	5300	0
Nemertinea	9	253	1
Entoprocta	0	28	37
Tartigrada	0	200	2
Chaetognatha	6	25	6
Phoronida	2	9	4
Ectoprocta	9	934	36
Brachiopoda	1	10	1
Mollusca	340	7500	428
Annelida	378	3360	145
Sipunculida	4	45	18
Echiura	0	30	1
Arthropoda	593	115638	360
Echinodermata	28	1110	31
Hemichordata	1	26	1
Urochordata	19	285	31
Pisces	309	saltwater = ?	398
Amphibia	4	231	4
Reptilia	14	283	20
Aves	225	768	202
Mammalia	35	416	34
TOTAL SPECIES	**2913**		**2529**
*from Stein et al.[110]			

In addition to the estuarine system in the coastal waters, the rocks at the jetties, cement from pilings, and the original Hathaway bridge that was torn down and left, become invaluable artificial substrate. Although infrequent, artificial substrates offer refuge and attract invertebrates and valuable recreational and commercial fish. According to NWFWMD, ninety to ninety-five percent of recreationally and commercially valuable Gulf of Mexico species of fish depend on an estuarine environment for at least part of their life cycles. Some recreationally and commercially important species of fish, including creville jack (*Caranx hippos*), dolphin fish (*Coryphaena hippurus*), king and Spanish mackerel (*Scomberomorus* spp.), and penaeid shrimp (*Penaeus* spp.), commonly appear in the Saint Andrew Bay watershed (Keppner et al 2008, and NWFWMD 2001)

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Vessel of earthenware, height of 4.1 inches, found in mound near Crooked Island (Moore 1918.)

Vessel of earthenware, 9.1inches n diameter, found in mound near Crooked Island (Moore 1918.)

Vessel of earthenware, height 6.25 inches, found in mound near Davis Point (Moore 1918.)

Vessel of earthenware, height 6 inches, found in mound near Crooked Island (Moore 1918.)

Vessel of earthenware, height 8 inches, found in mound near Burnt Mill Creek (Moore 1918.)

Chapter 4

HUMAN INFLUENCES

The first humans, known as Paleoindians, came into Florida near the end of the Ice Age over 12,000 years ago They were hunters and gatherers that migrated south with the large game animals like the mammoth, giant sloth, bison, bear, and saber-toothed cats. It was a time of cooler climates when the sea level was 200 feet lower than today, and Florida's land mass was twice it's current size (Gornitz 2007 and Milanich 1998.) Over time as the climate grew warmer, the sea level rose and the total land mass reduced to its current size around 5,000 years ago. All the while, the Native American population continued to grow and adapt to their new lands. By 4,000 years ago, the flora and fauna had changed with the climate and almost of the large game animals were extinct (Milanich 1998 and Odum et al. 2000.) The Native Americans lived near water and fished rivers, estuaries, bays, and the Gulf of Mexico (Milanich 1998.)

EARLY HISTORY

In Saint Andrew Bay watershed, fossils of camel, mammoths, mastodon, and saber-toothed cats have been found in upland spring runs and creeks. Artifacts have been found dating back to 13,000 years ago when the Gulf of Mexico was fifteen miles further south and the bays were dry with deep valleys created by creeks running through them (Houpt 2007.) An archeological site in the Oaks by the Bay Park on West Tenth Street is believed to belong to one of the Weeden Island Native American tribes. Accretions of discarded shells and bones known as middens or mounds were found around an occupation site. The occupational site was used for gathering scallops, fish, and oysters to feed the tribe (Houpt

2007.) According to Moore, pottery, tools, and ornamental decorations made of limestone and shell were found at the mound sites. Archeological digs in the early 1900s, revealed over eight mound sites in the Saint Andrew Bay watershed on the coastal and pine hammocks where Native Americans ceremonially buried, and sometimes cremated their dead (Moore 1918.) These sites give clues to the local Native Americans that occupied the area from 13,000 years ago until 500 years ago.

As the Ice Age ended and the climate grew warmer, Native Americans had to adapt to survive. Hunting gave way to gathering and agriculture as large game disappeared, and new plants and animal species migrated into the area with the climate change. Over thousands of years, Native Americans endured and evolved in response to the changes in climate, resources, and technology including ceremonial burial mounds created from 5,000 to about 2,500 years ago. In the Late Archaic period around 1000 B.C., the Native American's knowledge of plants and animals was extensive. They knew when plants would produce berries, and the trees would produce fruits or nuts. They knew the migration period of animals and their breeding seasons. By 700 B.C., the Early Woodland period began as the Native American created larger burials sites than in earlier periods and began making pottery for cooking or ceremonial offerings to protect the dead. The Middle Woodland period noted changes in the hierarchical political order of villages with great ceremonies and larger burial mounds for important figures in the village. The Native Americans lived in large settlements of hundreds of individuals and built permanent homes. A large native trading route began, which helped decrease economic instability from low crop yields or extreme weather conditions. The bow and arrow emerged in this time period as hunting for game grew more difficult and larger numbers were needed to feed a village. By the beginning of the Late Woodland period around 300 A.D., the Native Americans became skilled fishermen, hunters, and farmers of native plants

including tree orchards. However, their village sizes decreased dramatically to no more than fifty individuals and they stopped building large elaborate burial mounds. Weather changes and population demands played a huge role in the cultural impoverishment during this period. As the Mississippian period began in 700 A.D., the Native American's culture evolved once again. During this period, the tribes were dominated by the Coles Creek traditions. Burial mounds evolved into impressive ceremonial temples on mounds. The tribes lived in permanent settlements along major waterways to encourage trade. Corn became the dominant food source and wooden hoes with stone blades were invented to ease crop tilling. Tribes defended the crops and settlements from other tribes or outsiders.

In Saint Andrew Bay, the Weeden Island Culture tribes along the bay adapted subsistence strategies of other tribes and by 900 A.D. evolved into the Mississippian culture tribes who lied on the rivers and creeks (Houpt 2007.)

Chatot (a.k.a Choctaw) and Yucci (a.k.a. Euchee) are two distinctly different Native American tribes that lived in the SABW when the Spanish explorers came to the area in the 1500s. The Chatot were of Muskogee family descent and spoke in a muskhogean dialect. Some culture traditions were to artificially flatten their heads and clean all the meat off the bones of their dead before placing the bones of the deceased in the bone house. The Chatot were farmers that could defend themselves when attacked. In contrast, the Yucci spoke a language all their own. They were mound builders who built their homes half subterrained. They surrounded their villages with Palisade walls of wooden stakes. They were conservationists who practiced control burns, hunted based on hunting season, and grew crops including corn and squash. They were very frugal, and tried to balance their existence with the environment.

The rich culture of the local Chatot and Yucci tribes would come to an end with their encounter with Panfilo de Narvaez's Spanish expedition in the early 1500s. The expedition originally landed in Tampa Bay in 1528 and marched north in search of gold. Travelling across land was extremely difficult due to the thick underbrush. After losing contact with their ship, they travelled north until they reached the Apalachicola River in 1529. They stopped there and built boats to travel down the river and back to the Gulf of Mexico, and eventually reach Mexico by sailing along the coast. While camped out on the Apalachicola River, the expedition stole bushels of corn from one of the local Apalachicola River Indian tribes. In retaliation, the Native Americans started to attack small groups of the expedition and kill them. In an attempt to stop the killings, Narvaez ordered the Chief's capture and Narvaez held him as a prisoner to ward off further attacks. Eventually the expedition finished the boats and sailed south to the Gulf of Mexico with the Chief still held as prisoner, and after a week following the Florida coast west towards Mexico, the expedition came to Saint Andrew Bay. According to Cabeza de Vaca, the treasurer of the expedition, the Native Americans lived in palm-thatched lodges along the inlet of the bay. The lodge had many jars of water and fish, and the women wore short skirts of palm filament. De Vaca claimed the Native Americans greeted them in canoes without bow or arrows; however, later that night while they slept, the Native Americans attacked the expedition with bows and arrows. The men retreated to their boats and managed to escape with injuries (West 1922.) Soon after this encounter, the Chatot became extinct and the Yucci relocated north and west of the area. Other accounts indicate that De Narvaez's men infected the tribes with dysentery (Houpt 2007.) Due to the fighting between the English, the Spanish, and the Native Americans over land in the Panhandle of Florida, not many dared to settle down in this hostile environment. Saint Andrew Bay would remain quiet with a

couple of Spanish fishermen living along the bay as noted by Thomas Robinson's account in 1754 (West 1922.)

EARLY SETTLERS ON THE BAY

Juan Ponce de Leon named Florida in 1513. The Spanish explored and surveyed the coast of Florida. Panfilo de Narvaez explored the area in 1529 (West, 1922 and Wikipedia..) Settlers from Spain came in 1559 (West, 1922.) When England acquired Florida in 1763, the Spanish fishermen in Saint Andrew Bay left for Cuba. English settlers who arrived in Saint Andrew Bay in 1765 found groves of oranges and figs left behind. They named the town Wells after one of the families and grew indigo using slaves from 1765 to 1782. Another town during the same time period was Dyer's Point located on the western tip of Panama City, which is now the location of the Port of Panama (1915 Brochure and West 1922.) With the return of the Florida land back to Spain after the signing of the Peace Treaty of 1783, English settlers fled to English territories and abandoned their prosperous cities including Wells (west 1922.) Again, the Saint Andrew Bay area lay quiet and abandoned except for a few Creek tribes who moved into the area in the 1700s. By the time the United States purchased Florida from Spain in 1819, most of the original Native American tribes in Florida were gone, and a new Native American tribe known as the Seminoles or Creek Indians was organizing down in the Peninsula of Florida. However, a few Creek Indian tribes, chased off their lands in Alabama and Georgia, had already assembled in the wilderness of the Saint Andrew Bay area (Womack 1994.)

In the early 1800's, Native American tribes fought against white settlers who were trying to take their lands. After the purchase of Florida, the United States government decided to move the Native Americans off their land to make room for more white settlers and to stop Indian attacks. The Indian Removal Act of

1830, also known as the Trail of Tears, moved all Native Americans to Indian Territory in Oklahoma. Many Native Americans died along the way. Only those who hid from capture and those who could blend in with the white settler due to their light colored skin were allowed to remain. The people of the North Bay Clan of the Lower Muskogee Creeks, which exist in the SAB today on a parcel of land along Deer Point Lake, are descendants of Creek Indians who hid in the area to avoid capture (My Florida Genealogy and Womack 1994.)

In the early 1820s, some Georgians and others moved onto land near the bay and built plantation settlements in areas now known as Old Town near current day Panama City, Bayhead on current day Deer Point Lake, and Lynn Haven,.

In 1827 ex-governor of Georgia, John Clark was given charge of the live oaks along the shores of Saint Andrew Bay by his friend General Jackson. Timber was an important commodity for shipbuilding and Clark was the "Keeper of the Trees." He built a home in Old Town on the bluffs of what is now Beach Drive in Panama City west of Lake Caroline. He lived there with his wife, Nancy, until their deaths in October 1832 from Yellow fever that he caught while visiting New Orleans (West 1922 and Houpt 2007.) Yellow fever was spread by mosquitoes and was prevalent every fall in New Orleans. Fortunately, it did not spread in Saint Andrew Bay. The Clarks are two of the three known cases of Yellow fever in the area (West 1922.)

After the War of 1812, William Loftin, who served in the war, came down from North Carolina where he was a sheriff in Jackson County and built a home near North Bay. In 1830, he moved from his house in North Bay to his newly built house just one mile east of the Clark's residence. There he engaged with Henry Rivere and J.M. White to develop a community called Austerlitz on East Bay. In November 1835, Loftin purchased large sections of land from the government in

the sections 12 and 13 of township 4. After the land purchase, Loftin built a new house just east of the Austerlitz development area. There, after being granted permission from the legislature, he operated a ferry between Ferry Point and Military Points on East Bay. He died in 1845 and is buried in the Parker cemetery. Austerlitz was renamed Parker in 1886 (West 1922.)

In the same time period, the Clark's residence was renovated into a hotel called the "Tavern." In 1842 while Major Armstead was keeper, David R. Blood came from London in a black sloop. He checked into the Tavern with the intent of studying the bay for a short time. His black sloop was affectionately called the Widow by locals in the area. Blood continued to study the bay for twelve years before he was called back to England in 1857 (West, 1922.)

In 1945, the writer Caroline Hentz, for which Lake Caroline was named, began to visit Saint Andrew Bay during the summers. At this time, the post office referred to the town as Saint Andrew on Saint Andrew Bay. During the summers, the population would reach between 1200-1500 residents (Houpt 2007.)

The civil war broke out between the Federal Union of the North and the Confederates of the South in 1861. At that time, salt was the only way to preserve food. Salt was produced through evaporation of salt water in a kiln over a fire. Saint Andrew Bay became a major source of salt for the Confederate troops. Between 1861 to 1865, an estimated 2500 men engaged in salt manufacturing along the shoreline of the bay. As a result, Federal troops began raiding and destroying the salt production in September 1862. On December 10, 1863, the Federal Union sent in the bark, the "Restless," which was a gunboat and it shelled the community of Old town with cannons. In the end, the gunboat destroyed the entire community of Old Town including all 32 cottages and

homes as well as the house that John Clark built (Centennial, 1915 Brochure, and West 1922.)

CITY GROWTH AROUND THE BAY

In 1879, Lambert Ware moved to the area followed by his brother, Francis in 1882. They operated the Ware Mercantile and the Ware Wharf at the present day site of Harbour Village at Historic Saint Andrew Condominiums and Saint Andrew Marina near the corner of 10th Street (Houpt 2007.)

In 1885, with the passing of the Homestead Act, land in the area was homesteaded for one-dollar per acre. A Cincinnati mail-order company, the Saint Andrew Bay Railroad, Lands, and Mining Co., bought property in the Saint Andrew Bay area, and started nationally advertising 25 feet x 82 feet lots for $1.25. The advertisement attracted a lot of people and started a settlement boom as over 300,000 lots were sold (Maddox and King 2009 and Houpt 2007.) As the price for lots increased to $8.00, the company went bust. One prominent individual in Saint Andrew history who responded to the ad was George M. West, a northern railroad man. In 1885, he purchased the property along Beach Drive where the Clarks home once stood. Some recognized homesteaders were S.L. Slade, G.B. Thompson, and J.R. Irwin. In 1888, Slade platted his land around the current day's courthouse near Massalina Bayou and named it, Floriopolis. Thompson secured land west of the main street known today as Harrison Avenue including the Bay Line Depot. Irwin secured land including Harrison Avenue, and later sold it to G.W. Jenks (Maddox and King 2009 and Centennial.) In 1888, G.W. Jenks and C.J. Demorest platted their land, called Park Resort, and the following year renamed it Harrison for the president at that time. During that time, only four families lived in Harrison year-round. Any

unsold land in the above-mentioned homesteads was purchased by G.M. West in 1905 (Centennial.)

In addition to the homesteaders, some prominent land developers were G. M. West, R.L. McKenzie, A.J. Gay, and A.B. Steele. West, McKenzie, and Gay worked together under the Gulf Coast Development Co. to promote the Harrison area. McKenzie was a naval stores man, and A.J. Gay owned a large quantity of land that is now known as the Panama City Country Club in Lynn Haven. A.B. Steele extended his Dothan to Cottondale railroad to Saint Andrew Bay after West, McKenzie, and Gay offered him 25% ownership in Gulf Coast Development Co. He completed the railroad in 1908 and named it the Atlanta & St. Andrew Bay Railroad Co., but it was referred to as the Bay Line. With the completion of the railroad, the population in the area exploded as immigrants had an easy way to reach the cities of the bay. In addition, numerous tourists rode the Bay Line to the bay then they crossed in launches to Land's End pavilion on current day's Shell Island (Centennial.)

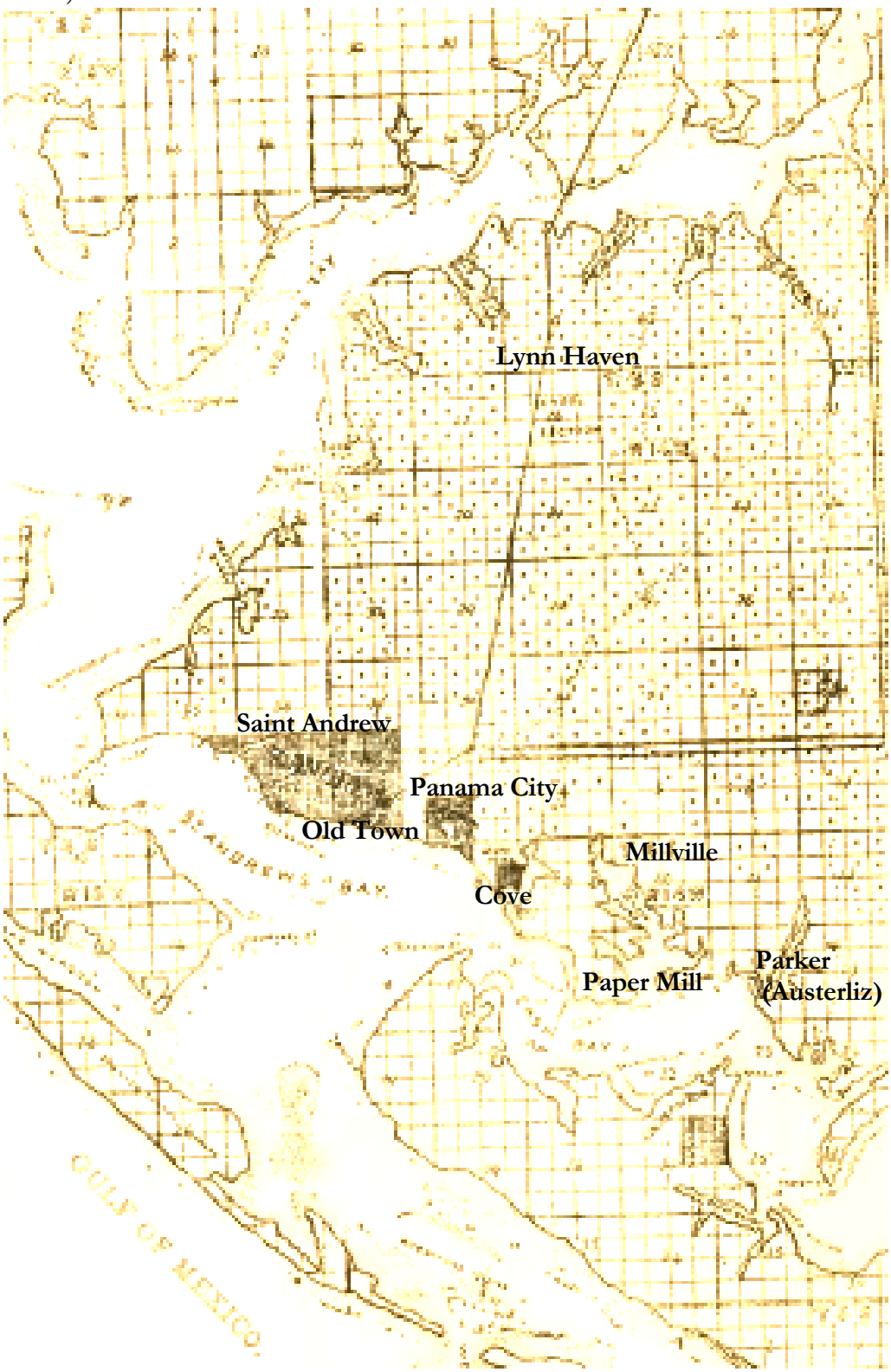
In 1906, Harrison was renamed to Panama City. The name, Panama City, was chosen in honor of the Panama Canal that was being constructed in Central America and because when a line was drawn from Cincinnati to the Panama Canal, the line crossed through this area. Three years later Panama City was incorporated by 34 votes, and R.L. McKenzie served as the first mayor. In addition, McKenzie served as state representative for Washington County from 1909 to 1913. His leadership paved the way for the formation of Bay County. His efforts secured the building of the Coastal Highway through Panama City, the dredging of the West Pass Navigation channel, the establishment of the International Paper Co. in the area, and the cutting of the inter-coastal waterways (Centennial.) Today the original homesteads make up the area known as the McKenzie Park in Panama City. McKenzie Park was named in honor of R.L.

McKenzie because he served the bay area for over 50 years and his efforts helped secure the development of Panama City (Maddox and King 2009.)

Saint Andrew incorporated in 1908 and the town included Old Town, Waretown near the Saint Andrew marina, Cincinnati Hill at the west end from 13th Street to 15th Street, and West End near the end of Michigan Avenue. J.H. Drummond was the first mayor of Saint Andrew and brought a railroad spur into Saint Andrew in 1914. The spur split and one went south to the long dock at the south end of Frankford Avenue and the other continued west and reached the bay at the Saint Andrew Marina just south of 11th Court. The spur provided fishermen with a railroad to ship their catch and it provided another launch site for tourist and residents going to Land's End. The train arrived daily from Dotham, Alabama with passengers, goods, and timber for the sawmill.

Another prominent land developer worth mentioning is W.H. Lynn, a publisher of a national veterans magazine, who decided to develop two towns in Florida for northern Civil War veterans. One town was Lynn Haven and the other was Saint Cloud (Maddox and King 2009.) In 1910, Lynn platted 7,400 lots on cutover land near North Bay to develop his town, Lynn Haven, with streets named for states. Each lot was sold for fifty dollars. The lot size was 50 feet x 150 feet and came with a free five-acre lot out of town for farming (Centennial.) Lynn Haven was incorporated in 1913, and J.H. Hughey served as first mayor (Maddox and King 2009.) The Saint Andrew Bay area is shown as it was in 1888 on Robert Oneal's map in *Figure 7*. Notice the map divides the area into sections, townships, and ranges. Lynn Haven is in Township 3 near Section 16, while Saint Andrew is in Section 6 and 7 of Township 4.

Figure 7. Robert Oneal's Parcel Map of Saint Andrew Bay Area in 1888 (Clifford 1888.)



Many of the cities incorporated as city populations increased, and the population in the bay section of Washington County grew to a size that warranted the division of the county to form a new county. In 1913, parts of Washington, Calhoun, and Walton counties combined to form Bay County, named for all the bays in the area (Britannica 2009, Brochure 1915, Maddox and King 2009, and Centennial.) Lewis Henry Howell served as first State Legislator and W.A. Brown served as the first sheriff for the new county. Panama City became the county seat and the Owl's Nest on the dock of one of the piers at the end of Harrison was utilized as a temporary county courthouse and jail until the new courthouse on Fourth Street was completed in 1915. In 1920, the interior of the courthouse was damaged by fire leaving only the exterior walls. The courthouse was reconstructed and it still serves Bay County to this date. The Bay County courthouse is listed as being one of five original Florida structures (Brochure 1915 and Maddox and King 2009.)

Another railroad line called the Birmingham, Columbus, & St. Andrew Bay started up in 1912. Trains ran from Chipley to Southport's train station and passengers had to take a boat across North Bay to the dock at Lynn Haven. Later the Lynn Haven dock would be extended into a bridge that crossed North Bay (Maddox and King 2009 and Centennial.)

S.S. TARPON

Before the railroad came to Saint Andrew Bay, the main source of transportation for people and goods was by boat. The most notable boat was a 160 feet long steamship named the Tarpon. After being acquired by the Pensacola, St. Andrew & Gulf Steamship Company, the S.S. Tarpon driven by its captain, Willis Green Barrow, started making weekly trips in 1903. The S.S. Tarpon travelled between Mobile, Alabama and Carrabelle, Florida along the Gulf Coast and included stops

at Panama City, Saint Andrew, and Millville among others (Maddox and King 2009 and Houpt 2007.) The S.S. Tarpon transported passengers and goods including beer, sugar, and flour. The S.S. Tarpon was known for being on time no matter the weather, and for thirty-four years, it was considered the most reliable vessel in the Panhandle. Unfortunately, Captain Barrow had a bad habit of overloading the vessel past the normal carrying capacity. Unfortunately, his overloading and persistence to stay on time lead to the sinking of the S.S. Tarpon in 1937. On the evening of August 31st the S.S. Tarpon left Pensacola with 31 passengers and a full load including beer, flour, sugar, canned goods, and iron for the sawmill. At 2:00 a.m. in the morning on September 1st, the vessel started taking on water from a leak in the bow causing the vessel to list port. Although the crew was able to right the vessel temporarily to even keel by throwing cargo overboard, the vessel began to list again as dawn approached due to gale force winds and pounding waves. Against the first mate, L. E. Danford's, attempt to direct the vessel towards the coastline in an effort to beach the vessel before it sank, Captain Barrow forced the vessel back on course. The S.S. Tarpon took on too much water and before he gave the order to abandon ship, the vessel was sinking by the stern. It sank eight miles off the coast of Panama City Beach in ninety-five feet of water. Eighteen of the 31 passengers died including the 81-year-old captain. The site is now an underwater archeological preserve with the National Parks Service. (Houpt 2007 and NPS 2009)

MILLVILLE

In 1886, Henry Bovis, a French Canadian, and his associates purchased property at the head of the Watson Bayou and built the St. Andrew Lumber Co., a lumber mill with a capacity of 20,000 feet per day. The mill attracted laborers looking for work during the beginning of hard times that lead to the Great Depression. The mill workers built Millville, a small town around the lumber mill. The Millville

post office opened in 1899. Bovis ran the mill until he sold it to a foreign organization lead by Julius Freyer. Afterwards, Bovis went into mercantile and was Millville's postmaster until his death in 1907. Freyer renamed the mill the German-American Lumber Co., expanded the mill to a holding capacity of 80,000 feet per day, and modernized the mill with a planing mill and a dry kiln. At the time the company incorporated in 1901, the company held 150,000 acres for growing timber and $250,000 in capital. Hundreds moved to Millville to work for the mill. According to the Panama City Pilot newspaper, the mill burned down on December 19, 1906. The German-American Lumber Company set out to rebuild the lumber mill and by September 2007, a new lumber mill with the capacity of 100,000 feet per day was complete with two bands saws, edgers, planing mill, machine shop, and electric plant that produced light for the mill and the town. The lumber company also owned a general mercantile store where the workers who worked for store credits purchased their goods. Millville developed into an industrial and commercial center for the Saint Andrew Bay area. The area once again began to prosper with new settlers, homesteaders, land developers, and exports including fish, salt, and lumber. By 1911, in addition to the German-American Lumber Mill and its company store, Millville had six general stores, two grocery stores, a drug store, a hat shop, a large gym, a movie theater, a skating rink, a livery, a millinery, and a turpentine operation.

In 1913, Millville incorporated and W.I. Singletary was elected as the first mayor. According to the 1920 census, Millville had a population of 1,887 people and was still the largest town in the area with Panama City's population coming in second (Houpt 2007 and Centennial.) The area of Millville continued to prosper until World War I broke out in 1914. At that time, the federal government seized the German-American Lumber Co. under the Trading with the Enemy Ac after William L. Wilson and Mitchell Palmer of the Alien Property Custodians reported that Millville was a cover-up for a German naval base and all residents were of

German descent. Of course, all the local residents in the Saint Andrew bay area knew this was false. G. M. West, the publisher and editor of local newspapers, published in the July 1918 edition of the St. Andrew Bay News that Washington was camouflaging the truth to make it easier for citizens to accept the force sale of the German-American Lumber Company worth $4,000,000 for a mere $1,000,000 to W.C. Sherman, and Minor C. Keith. The lumber company was sold to W.C. Sherman, and Minor C. Keith in 1918 for $1,425,000 and they renamed the lumber mill St. Andrew Bay Lumber Co. In 1920, Sherman bought out Keith and renamed the lumber mill Sherman Lumber Co. The mill closed in July 1930 when it ran out of lumber. Several attempts were made in the year after it closed to burn it down. Three unknown arsons finally accomplished burning the mill down with gasoline or kerosene on March 22, 1931. Unfortunately, the fire was so intense that the fire burned nineteen homes down that were located in Millville near the mill. Sherman received a check from the insurance company for the mill, but he never rebuilt it (Panama City Pilot: July 1918, March 13, 1919, Jan. 20, 1928, July 1930, March 1931, Nov. 19, 1931 and St. Andrew Bay News, July 1918.) Luckily, for the Millville residents and unemployed lumber mill workers, the Southern Kraft Co. chose Bay Harbor, just one mile south of the Sherman lumber mill to build a paper mill facility that opened in February 1931 (Centennial.) The paper mill known today as the Smurfit-Stone Container Corporation is still a major provider of jobs in Bay County as seen in *Figure 8* on the following page.

Figure 8. Aerial image of Millville with paper mill in bottom right corner. Notice the watercolor of Watson Bayou from the discharge of the paper mill (FDCA 2009.)

PANAMA CITY EXPANSION

The area continued to grow with a real estate boom in the 1920's. Much to the dismay of the residents of Saint Andrew, Bay Harbor, and Millville, a bill introduced through a special session in November 1925 combined the municipalities of Millville, Panama City, and Saint Andrew. A year later, Bay Harbor, Millville, and Saint Andrew annexed into the incorporated limits of Panama City (Houpt 2007.) Dixie-Sherman Hotel, the areas first high-rise, built on the corner of Fifth Street and Jenks Avenue in 1926 stood nine stories high and was a focal point until it's demolishing in 1970. Also in 1926, Bay High School on Harrison Avenue opened and it combined the students from the small high schools located all over the county.

Thanks to the efforts of McKenzie, the mayor of Harrison, work began on the construction of the Coastal Highway along the Gulf coast through Panama City and work began on the construction of the bridges that connect Panama City along the highway to the east and west of the bays. In 1929, the state opened both the DuPont and Hathaway bridges crossing the bays, which allowed tourist an east-west access to Panama City and Panama City Beach (Centennial.) Also, Mayor McKenzie and other leaders in Bay County worked together to bring the Southern Kraft Co., a subsidy of the International Paper Co. to look at Bay County as a possible location for Florida's first paper mill. In 1930, the Southern Kraft Co. came and liked the cutover land that could easily be reseeded. They purchased large quantities of land and set out to reseed the land. Construction and clearing for the $10,000,000 facility on the Bay Harbor at the entrance to Watson Bayou began in April 1930 and was finished in February 1931 ahead of schedule. In 1932, Mr. and Mrs. J. B. Atkinson, Jr. donated 292 acres tract that was used as a private airstrip to Panama City for a municipal airport. The airstrip was called Atkinson Field. In 1938, the construction for an airport and two long

runways began. With the completion of the airport, Atkinson Field became Fannin Field, in honor of Panama City's mayor at that time (Wikipedia 2009.)

Due to the efforts by McKenzie and others, the Corps of Engineers completed the cutting and dredging of the West Pass navigation channel in 1934, which allowed ships a safe route from the Gulf of Mexico to the paper mill and Panama City port (Centennial.) In 1935, Springfield a city northwest of Parker and northeast of Millville incorporated as the area continued to grow with the paper mill (Maddox and King 2009.)

World War II effected Bay County's economy and population immensely when areas around the bays were chosen as sites for the Army Air Corps and the U.S. Navy. The Army Air Corps opened Tyndal Field, named in honor of World War I Lieutenant Frank B. Tyndall, on Bay County land just southeast of DuPont Bridge as a gunnery school in 1941. Many men trained at the gunnery including Clark Gable who joined the Air Force in 1942. He spent nine weeks at Tyndall Field and graduated with silver wings on January 6, 1943(Womack 1997.) Since World War II, Tyndall Field has grown and it is now referred to as Tyndall Air Force Base (Womack 2009.)

In 1942, the Navy opened a base on land by St. Andrew Bay in Panama City Beach just southwest of the Hathaway Bridge. In addition, J. A. Jones constructed the Wainwright Shipyard, named in honor of General Jonathan Wainwright, just east of the Hathaway Bridge at Dyer's Port. This is the same location as today's Port Panama City. In 1942, Wainwright Shipyard hired 18,000 workers which built the 102 liberty ships and 6 tankers used in World War II (Maddox and King 2009, Centennial, Cvitkovitch 2000, and Houpt 2007.)

In 1945, the Naval Base was recommissioned as a U.S. Navy Countermeasures Station. It has changed its name many times over the years, and it is now

currently known as Naval Support Activity (NSA) Panama City. Wainwright Shipyard began dismantling the Liberty ships used in World War II. Of which, some were built in Wainwright Shipyard in earlier years. Wainwright Shipyard continued to build boats and ships. (Maddox and King 2009, Houpt 2007.) The majority of the servicemen who spent some time stationed in Panama City settled down in the area after the war (Houpt 2007 and Womack 2009.)

TABLE 3. DEPICTING THE TOWNS AND THEIR SCHEDULE OF INCORPORATION.

CITIES INCORPORATED IN BAY COUNTY AREA

CITIES INCORPORATED		CITIES COMBINED AND REINCORPORATED	
NAME OF CITY	**YEAR**	**NEW COMBINED NAME**	**YEAR**
Saint Andrews	1908 →	Panama City	1926
Panama City	1909 →	Panama City	1926
Lynn Haven	1913		
Millville	1913 →	Panama City	1926
Bay Harbor	? →	Panama City	1926
Springfield	1935		
Edgewater	1948 →	Panama City Beach	1971
Long Beach	1948 →	Panama City Beach	1971
Panama City Beach	1948 →	Panama City Beach	1971
Cedar Grove	1952		
West Panama City Beach	1959 →	Panama City Beach	1971
Callaway	1963		
Parker	1967		

The area continued to grow and many cities incorporated in time as shown in *Table 3*. The post-war time saw continued growth of industry, and beach development aimed at tourism (Womack 2009.) As early as the 1940's, water supplies were threatened with saltwater intrusion from the fast population growth. As the cities grew, the groundwater table dropped and drawdown was

occurring near well pumps. By 1950, the population of Bay County grew to 42,689. According to Richards, the groundwater withdrawal from the Florida aquifer in the coastal section of Bay County in 1960 was 15 to 20 million gallons per day. This caused a drawdown near the center of the pump that exceeded 125 feet. A new source of water was needed to supply the growing area. In 1957, a Special Act of Legislature gave Bay County permission to build and operate the Deer Point Lake Reservoir. In order to build the reservoir, Bay County impound 4572 acres including the upper portion of North Bay at Deer Point with a sheet pile dam with a spillway fixed at 4.5 feet above sea level (NWFWMD 2001 and NWFWMD 2008.) The dam completed in 1961, held 32,000 acre-feet of water. Originally, the reservoir was saltwater, but over time it flushed out. In the beginning, the reservoir was used for commercial water supplies and later as the salinity dropped to zero, the reservoir supplied both commercial and drinking water to all of Bay County. The Northwest Florida Water Management District (NWFWMD) protects the reservoir. The NWFWMD monitor the 282,880 acres watershed that drains into the reservoir. Today, all Bay County municipalities receive water from the reservoir (Richard 1997 and NWFWMD 2001.) On average, Bay County pumps 50 million gallons per day of water to be used as potable water (NWFWMD 2008.)

With the water issue resolved and the introduction of air conditioning to Bay County, the area grew in popularity. Both resident and tourist enjoyed the beaches in the spring and summer and visited popular location like the Hangout, Miracle Strip Amusement park, and Petticoat Junction. Once spraying for dog flies began in the 1970s, visitors from the northern states and Canada came to stay for the fall or winter season. During this time, condominiums constructed on the beach became very popular (Womack 2009.) Growth continued and larger and taller condominiums were built on the beaches until the recent recession period brought everything to a halt. Even though the construction of

condominiums and homes stopped, hotels, restaurants, and retail stores catered to tourism continued. Pier Park built across the street from the beaches of the Gulf of Mexico is an entertainment complex with outdoor village style stores and restaurants, eighty-acre city park to hold special events and summer concerts. Many of the events scheduled for Panama City Beach have some or all of the activities held here. Tourism has grown in the area to include Spring Breakers, Motorcyclists for Thunder Beach Rallies, middle class families, and even upscale tourist. According to Cvitkovitch, recent data showed four million of the seven million visitors who came to northwest Florida came to Bay County. The new airport recently named Northwest Florida Beaches International Airport when completed in 2010 should bring increase opportunities for growth to Bay County.

Department of Health Advisory recommending people not to swim at this beach in Panama City Beach on the Gulf of Mexico due to high bacterial count from fecal matter. This beach access is 500 feet from the one my family and I use. There was not any notice at that beach access although it shares the same water. Photographed by Pamela Brown.

A stormwater pipeline buried under sand on the beach in Panama City Beach. Photographed by Pamela Brown.

View of the same stormwater pipeline above. Photograph shows the constant stream of water that is unrelated to rain events that flows into the Gulf of Mexico each day. Photographed by Pamela Brown.

C h a p t e r 5

ENVIRONMENTAL CONCERNS AND SOLUTIONS

Although the Department of Environmental Protection(DEP) has determined the water from Econfina Creek and Sandy Creek to be the best quality, the Department of Health(DOH) has issued a fish consumption advisory for Largemouth bass, Bowfin, and Gar caught in the Deer Point Lake Reservoir due to high mercury content. DOH recommends limiting the listed fish to six ounces per month to avoid the potential for adverse human health effects from mercury.

LAND USE- PAST, PRESENT, FUTURE

Most of the counties in the SABE watershed have small populations that do not affect the water quality of the watershed with the exception of Bay County. Calhoun County, which borders northeastern Bay County, does not have any significant towns in the watershed and the total population count in 2008 was 13,617. Gulf County, due south of Calhoun County and borders southeastern Bay County, has the towns of Port Saint Joe and Mexico Beach in the watershed. The county population in 2008 was 15,667 with an estimated 3,638 (Census 2009) living in Port Saint Joe and an estimated 1,033 living in Mexico Beach. Jackson County, due north of Calhoun County and borders the northern tip of Bay County, does not have any of its eleven municipalities in the watershed and the total population count in 2008 was 49,656. Walton County, which borders the southwestern part of Bay County, does not have any significant towns in the watershed and it has a total population count of 58,837 as of 2008. Washington County, due north of Bay County, does not have any of its five municipalities located in the SABE watershed, and its population count was 23,928 as of 2008.

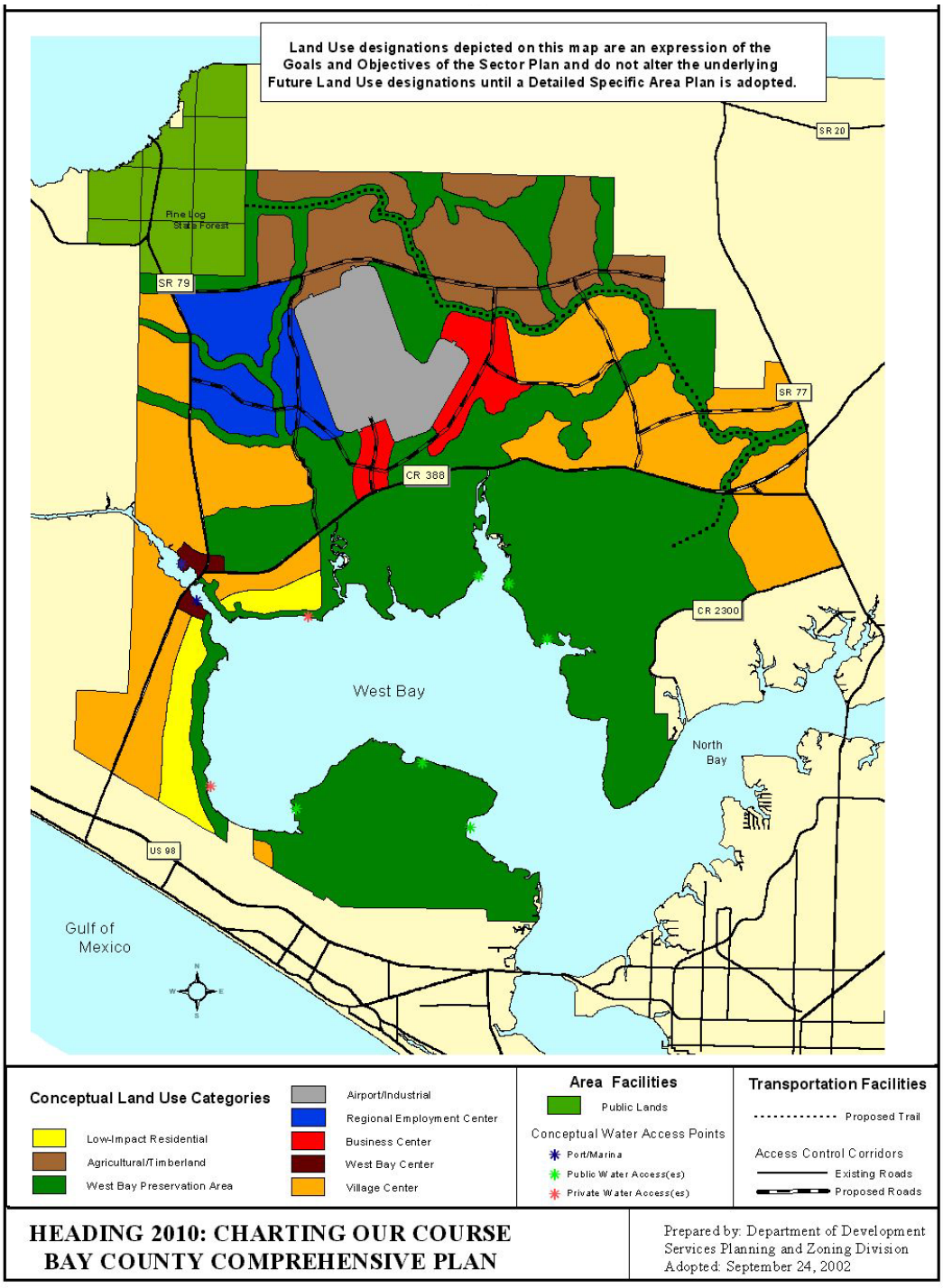
The 2008 population count for Bay County was 163,946 with seven municipalities and seven unincorporated cities all in the watershed (Wikipedia 2009 and Census 2009.)

Like most counties in Florida, Bay County is experiencing urban sprawl. Urban sprawl occurs as cities grow and housing within the city becomes limited. Developers build homes on the outer perimeters of the city, and families who want a cheaper home away from the congestion of the inner city move there. As the outer area grows, businesses follow the families to the outer perimeters of the city and establish gas stations, restaurants, and shopping centers. Unfortunately, most urban sprawl occurs before a sufficient land use plan is developed. Thus poor land use occurs in vulnerable areas. In Bay County, a good example is the cities that developed along the shores of the bay or coastline. Many marshes were filled, many dunes flattened, and many habitats lost during this development stage. In addition, the development of cities reduces the tree coverage and increases the air and water pollution as more hard surfaces cover the urban areas.

In the past, Bay County's growth has concentrated in the south portion of the county around the bays. Evidence of growth without adequate land use zones can be seen in the cities where businesses and industries intermingle with residential development. However, Bay County does have some advantages over many of the counties in the southern part of the state. For one, water covers over one-third of the county. In addition, it has an advantage of limited available land to develop, as St. Joe Paper Co. (St. Joe) owns over half of Bay County's private land. Thus, St. Joe has unintentionally controlled urban sprawl by purchasing all available land in the 1930s to seed furrowed rows with slash pines and leave the pines to grow. Seventy years later, the slash pine rows evolved into forest as succession of the land lead to continued growth and an understory developed. In time, the Bay County residents forgot the lands were privately held

and most saw the land as conserved public land. Nevertheless, all this changed in the 1990s when St. Joe transitioned from the silviculture industry to land developer. At that time, Panama City-Bay County International Airport (Airport Authority) came to St. Joe with the idea of moving the existing encroached airport out to St. Joe's property on the north side of the bay. St. Joe agreed to explore the idea of relocating the airport and even went so far as to donate 4,000 acres for the new airport. In the meanwhile, St. Joe began developing their one million acres of land in Florida into residential communities like Watercolors at Seaside with the help of Peter Rummell, former Disney real estate executive. In the decade to follow, many communities were developed along the coastal lands of Florida. Bay County residents and activist knew that eventually their conserved forest would be converted into residential communities as well. St. Joe was aware that the residents of Bay County did not want the land developed and the residents saw St. Joe as a threat. In order to avoid opposition, St. Joe decided to include the residents of Bay County, activist, environmentalist, property owners, and government officials in the planning of the 72,500 acres community. In 2001, Bay County, Airport Authority, and St. Joe began the process of developing the West Bay Sector Plan for the new airport and surrounding land through community outreach workshops. The West bay Sector Plan was completed in 2007 with open-space preservation areas designed as wildlife corridors; environmental sensitive land around the bay designated as protected land; economic development zones for residential, commercial, and industrial growth; planned road infrastructure and future mass transportation; public facilities including schools, libraries, and parks; and utilities as seen in *Figure 10*.

Figure 10. West Bay Sector Plan with conceptual land use categories including transportation and other facilities.



In November 2007, the Airport Authority broke ground on the airport relocation project in West Bay (News Herald, Nov. 2, 2007.) According to the Airport Authority, "the project is moving along, should be completed on time, and should open on schedule in May 2010." This spring the project had problems with excessive rain and erosion. DEP stepped in and fined both the environmental consultant ($200,000) and the contractor ($250,000) for its lack of site preparation and stormwater pollution prevention. In September, DEP fined Phoenix, the contractor, $1.7 million dollars for cutting corners in its Stormwater Pollution Prevention Plan, which allowed stormwater and sediments to runoff into nearby protected wetlands (News Herald, Sep. 18, 2009.) Since that time, Gary Kelly, the CEO of Southwest Airlines announced it would be bringing service to the new airport with eight non-stop flights from four different cities (News Herald, Oct. 21, 2009.) The airport and the West Bay Sector Plan are expected to attract many businesses and opportunities for the Bay County area. In the process, the planned community should promote growth and urban sprawl development in the SABW.

EROSION

Erosion can come as a result of severe storms that surge through the bays or urban development and clearing of the land. In the past, erosion caused by storm surges has changed the landscape of the Florida coast. An assessment of the Florida maps of 1827, 1855, 1934, 1945, 1968, and 1970 reveals the changes in the shoreline over the years from erosion (West, 1922 and Landry, 1994.) According to Landry, the erosion is slow with an overall erosion rate of 0.7 feet per year and it is due to storm surges, and human modifications including beach stabilization and navigation controls.

As indicated by the changes noted with a closer examination of the islands on Williams' 1827 West Florida map in *Figure 9* and his original map in *Figure 10*, one or more severe storms passed through the area sometime between 1764 and 1821. These storms broke the single long sand spit lying between the Gulf of Mexico and Saint Andrew Bay into three islands with passes between them. From east to west on the map, Williams marked East Pass, Crooked Island formed in 1779 (Landry, 1994), West Pass, Hammock Island (the largest island), Shanty Cove Pass, and the small one-mile long Sand Island. Sand Island no longer existed by the time the U.S. Coast Survey published their 1855 map. According to West, eventually, the pass through Spanish Shanty Cove closed and the West Pass closed in 1861. After the West Pass closed, the East Pass deepened to twenty-one feet. Storm events in 1886 and 1904 opened up the Shanty Cove pass, but after both events, the westerly winds and tides eventually closed the pass back up again (West, 1922.)

Figure 9. A closer view of Williams' Map of West Florida of the area shows three islands at the entrance to Saint Andrew Bay.

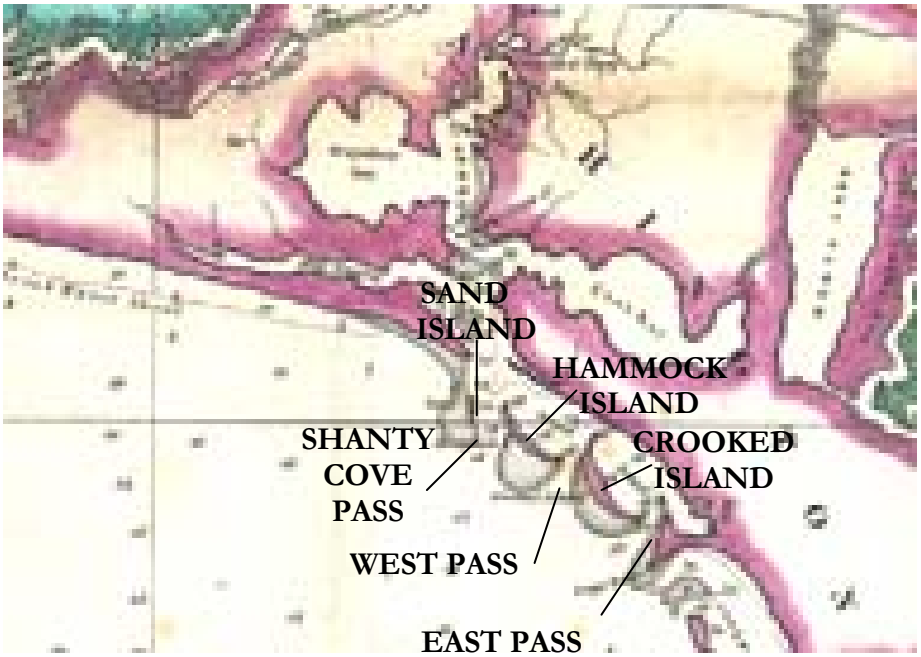
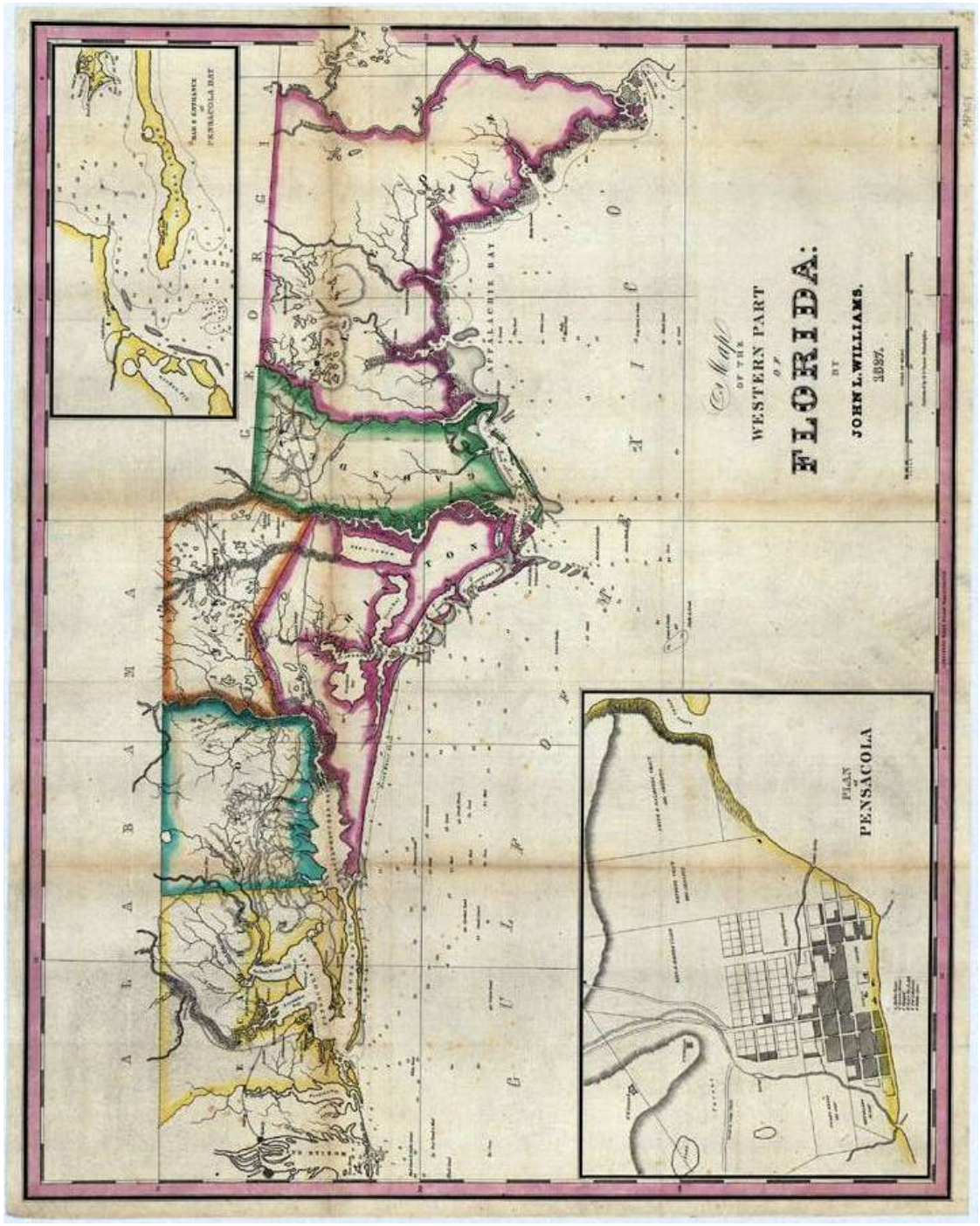


Figure 10. Williams' Map of West Florida as the area appeared during his survey from 1821to 1826. The map was published in 1827.



WATER RESOURCES –PAST, PRESENT, AND FUTURE

The SABW contains numerous ponds, lakes, streams, and wetlands. These surface waters seep into the groundwater and eventually flow into the Floridan Aquifer. The Floridan Aquifer is recharged by the karst ponds in the northwest portion of the SABW and the water flows through the Floridan Aquifer into the Econfina Creek. The Econfina flows into the Deer Point Lake Reservoir. Deer Point Lake is the main source of potable water and because it is a surface water source, it is vulnerable to drought and storm surge. Econfina Creek water flowing into Deer Point Lake has been determined as the best quality of water; however, Deer Point Lake has high levels of mercury from an unknown source. The cause could be pre-reservoir time since no preliminary studies of the upper portion of North Bay were taken to see what effects flooding a five feet deep soft estuarine bottom and seagrass beds with freshwater might have on the water quality or health of the future reservoir (NWFWMD 2008.) As a result, Deer Point Lake experienced surplus growth of submerged aquatic vegetation (SAV) beginning in the 1960s. Attempts to control SAV included lake draw downs in the winter months in an effort to expose SAV to cold and the introduction of grass carp from Amur River in Mongolia. By 1999, the SAV was no longer the focus as lemon bacopa grew uncontrollably over almost half of the lake's surface (NWFWMD 2008.) NWFWMD created a Surface Water Improvement and Management Plan (SWIM) for the SABW in an effort to protect water quality of Deer Point Lake. NWFWMD has purchased 41,000 acres along Econfina Creek and areas of water recharge, since the SWIM was established. Water quality is monitored by NWFWMD on a regular basis through numerous stations along Econfina Creek and in Deer Point Lake (NWFWMD 2009.)

Present progress in Bay County includes developing inland well pumps, treatment facilities, and infrastructure to protect the environment and provide an additional water supply for the population increase. Continued wetland restoration projects for Cat Creek, Devils Hole, Ward Creek West in addition to future projects developed to restore wetlands in Lynn Haven have been proposed. The 719.3-acre Ward Creek West is currently being restored from its existing furrowed row slash pine to a natural wet pine flatwoods and savanna. So far, over 140 acres have been planted with wiregrass along the creek to enhance wetland functions

NONPOINT SOURCE DISCHARGE

Stormwater runoff has been identified the primary non point source discharge of pollutants in the SABW. Stormwater runoff from developed areas flows into nearby surface waters. It carries pollutants from lawns, roads, buildings, farms, and construction sites. The pollutants are usually in the form of heavy metals, oil, grease, sediments, nutrients, bacteria, and pesticides. Pollutants can seep from surface water in to groundwater.

Stormwater runoff is managed by a permitting program. The state of Florida requires all new development except single-family residences to include a stormwater management plan using Best Management Practices (BMP) to control flooding and filter the water of impurities. BMP utilized in the area are detention ponds, retention ponds, and wetland filtration. Bay County, in accordance with the State's stormwater regulatory program, developed a Stormwater plan in 1994. The program's primary goal was to protect potable drinking water, reduce pollution from entering surface waters, and control floodwaters. The SWIM plan mention previously contains some funds to retrofit existing stormwater infrastructure in Bay County, unfortunately, there

were not enough funds for all the projects, and municipalities must obtain their own funds to complete their projects.

Non-profit organizations have stepped in to help find funding for the stormwater projects and other important environmental projects in the SABW. In addition, they educate the public and provide the facts on environmental issues so the public can make sound choices. One notable group is Bay Environmental Study Team (BEST) also known as Friends of St. Andrew Bay. They have been at the forefront for many studies and restoration efforts in the SABW. Their latest accomplishment is the release of their new documentary film, *Fragile Shores: The Waters of the St. Andrew Bay.* This documentary focuses on the impacts of pollutants in stormwater runoff carried to Saint Andrew Bay by constructed drainage systems in urban areas. The documentaries goal is to express the growing threat of pollutants to the health of the bay and share solutions that communities can do to prevent pollutants from entering the bay. In addition, volunteers with the non-profit organization, Saint Andrew Bay Resource Management Association (RMA) have been monitoring the water quality in the bays, bayous, and their tributaries since its establishment in 1990 (NWFWMD 2008.)

WASTEWATER

Wastewater at an average rate of 100 gallons per day must be treated before discharging into nearby waterbodies. Groundwater discharging by spray fields, percolation ponds, and nonsurface water points is considered partially reusable since discharge can enter local groundwater. Surface water discharge is done on a permit basis based on water quality effluent limits. Bay County is making progress in reducing the level of effluent entering the SAB. In addition, Bay County's first Advance Wastewater Treatment (AWT) plant began operation in

1999 to treat domestic wastewater. Currently all municipalities in the SABW have AWT facilities. All municipalities discharge into the Saint Andrew Bay except Panama City Beach who discharges into West Bay. According to NWFWMD, total allowance of wastewater to the SAB is 50 million gallons per day and to present day total discharges are under the total allowed and water quality is monitored RMA (NWFWMD 2008.) However, with increasing population and tourism, the level of domestic treated wastewater will increase and improved techniques will be required to maintain water quality. Efforts in Bay County to reuse treated wastewater on golf courses are currently being implemented. In addition, Panama City Beach is currently reusing wastewater for lawn irrigation and has proposed a plan to treat domestic wastewater with a wetland treatment site north of Lake Powell. Panama City Beach must obtain funding to complete the project (NWFWMD 2008.) Future projects include reusing wastewater for cooling generators at the Lansing Smith power plant

POINT SOURCE DISCHARGE

Point source discharge (PSD) pollutants are specific pollutants discharged up to a specific amount into the environment through a permitting program that sets the limits for quantity and type of pollutants allowed. No studies have been completed to determine the maximum loads of PSD pollutants in the SABW waterbodies. For example, Arizona Chemical Company and the Stone Container Corporation are permitted to discharge industrial wastewater into Military Point Lagoon.

AIR QUALITY

According to EPA, the SABW is classified as "attainment," which means that documented air pollution levels are below the minimal standards set by the National Ambient Air Quality Standards (NAAQS.) The pollutants levels are measured nitrogen dioxide (NO2), sulphur dioxide (SO2), carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM10), lead (Pb), and ozone (O3.) The standard minimums are levels that protect public Division of Air Source Management has one station located at the Department of Health in downtown Panama City for monitoring PM10 levels in air quality. In addition, there is an ozone monitor in Panama City Beach to monitor ozone pollution and transports along the coast of the Gulf of Mexico. This data can be obtained at www.epa.gov/air/data/index.html. Three industrial sources of air pollutants are Arizona Chemical, Lansing Smith Power Plant, and Stone Container (NWFWMD 2008.) . The chemical levels for PSD in Bay County can be viewed on *Table 4* (NWFWMD 2008.)

Table 4. Different air pollutants from sources that are permitted to discharge in the SABW.

Air Pollutant Sources for the Ecosystem (tons/year)

SOURCES	Nox	SO2	VOC	CO	PM10
Arizona Chemical	110	186	173	22	13
Stone Container	3,577	3,910	1,120	4,146	627
Gulf Power (Smith)	7,251	48,776	33	276	176
Total of 3 Sources	**10,938**	**52,872**	**1,326**	**4,444**	**873**
Other Stationary Sources	29	22	109	78	27
Total, All Stationary	**10,967**	**52,894**	**1,435**	**4,522**	**900**

LANDFILL AND INCINERATOR

The landfill is located off the Steelfield Road in the western portion of the county and is not actually located in the SABW. It is located in the Choctawhatchee Bay drainage basin to the west. However, the Bay County incinerator is located in the northeastern portion of the county in the SABW. It is a Refuse to Energy (RTE) facility that buns garbage to generate electricity. The RTE produces approximately 11 MW and sells the electricity to Gulf Power (NWFWMD 2008.)

POWER PLANT

Lansing Smith Coal Fired Power Plant located 15 miles north of Panama City on the shore of North Bay is operated by Gulf Power Company, a subsidiary of Southern Co. It has four generating units producing 945,000 with "Low NOx" burners to reduce nitrogen dioxide emission to below its 1992 rates. In addition, Gulf Power has invested in environmental controls that further reduce NOx, SO2, and mercury levels (NWFWMD 2008.)

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Pamela Brown collecting trash on the beach near Lake Powel, while Ellie Leah records the type of trash collected. Surprisingly, water bottle caps ended up having the highest collection count.
Photographed by Erika Brown.

Here are other volunteers collecting trash and recording data near Lake Powell on National Beach Clean Up day.
Photographed by Pamela Brown.

CONCLUSION

St. Andrew By has proven a "blissful haven" for many since this prophetic sentence was penned (by Caroline Hentz), and many more will find peace upon its beautiful shores in days and years to come.--George Mortimer West, 1922.

In the past, Florida's wonderful climate and amazing natural beauty attracted people to Florida for more than four centuries. Many areas around water resources like springs, lakes, rivers, and bays were appealing to settlers who were looking for a place to call home. In the beginning, resources were plenty and no one thought they would ever need to plan for a time when resources became scarce. In time, these areas grew from small settlements to towns, and eventually to large cities. As resources are used and natural systems like wetlands, rivers, lakes, bays, and beaches are altered for our wants and needs, the watershed including the surface water and groundwater that we depend on are altered too. Unfortunately, the development of urban areas has a negative impact on the natural systems, and currently our water resources are defenseless to impacts or changes in surface water and groundwater flow, and water quality. The water resources that attracted people to Florida need protection if we expect them to be here for us in the future. To save our water resources, we must save our watersheds.

Watersheds are important in the development and continuance of our societies. They provide water for potable, personal, business, and industrial uses. Saint Andrew Bay watershed is no different from any other area of urbanization. The

communities in the SABW need to unite and work together. They must focus on the SABW's future land-use plan including residential, commercial, industrial, and municipal uses. They must reduce the total nonpoint and point source pollutants. They must improve the water quality for freshwater, brackish, and saline waterbodies. Finally, they must protect the SABW's species biodiversity and habitats through conservation if they truly want to keep SABW as one of Florida's most diverse watersheds.

BIBLIOGRAPHY

Annual Estimates of the Population for Incorporated Places in Florida, Listed Alphabetically: April 1, 2000 to July 1, 2004. U.S. Census Bureau. Date verified July 23, 2009. http://www.census.gov/popest/cities/tables/SUB-EST2004-04-12.xls

Bay County History and Information. My Florida Genealogy. Date verified September 15, 2009. http://www.myfloridagenealogy.com/fl-county-bay.html

Biodiversity of the Northern Gulf Coast. Northwest Florida Environmental Conservancy, Part 2. Northwest Florida Environmental Conservancy (NWFLEC.) Date verified June 2009. <http://www.nwflec.com/>

Brochure "Greeting from Bay County Florida," 1915. Date verified August 10, 2009. http://fcit.usf.edu/FLORIDA/docs/b/baycounty.htm

Clifford, P. A. 1888. An Authentic Report and History of St. Andrew, Florida. Cleveland, OH: publisher unknown.

Coultas, C.L., and Y.P.Hsieh. 1997. Ecology and Management of Tidal Marshes. New York: Chapman and Hall/ International Thomson Publishing.

Crowe, J.B., W. Huang, F.G. Lewis. 2008. ***Assessment of Freshwater Inflows to North Bay from the Deer Point Watershed of the St. Andrew Bay System.*** Havana: Northwest Florida Water Management District. Water Resources Assessment 08-01

Cvitkovitch, Eileen. 2000. Images of America: Bay County. Charleston, SC: Arcadia Publishing.

Department of Community Planning. Florida Department of Community Affairs. Date verified October 5, 2009. http://www.dca.state.fl.us/FDCP/DCP/waterfronts/Communities/Millville/index.cfm

Bibliography

Description of the Apalachicola-Chattahoochee-Flint River Basin Study. United States Geological Survey (USGS.) Date verified July 24, 2009. http://ga.water.usgs.gov/nawqa/main.description.html

Econfina Creek: The Big Picture. Northwest Florida Water Management District (NWFWMD.) Date verified July 2009. http://www.nwfwmd.state.fl.us/pubs/big_picture/Econfina_Creek.pdf.

Florida. Wikipedia, The Free Encyclopedia. Date verified June 2009. <http://en.wikipedia.org/w/index.php?title=Florida&oldid=298081541

Florida Geologic Map. South of Florida Information Access. United States Geological Survey (USGS.) Date verified June 2009. <http://sofia.usgs.gov/publications/maps/florida_geology/intro.html>

Florida Quick Facts. The State of Florida. Date verified June 2009. <http://www.stateofflorida.com>

Florida Watershed Management Approach. Florida Department of Environmental Protection (FDEP.) Date verified June 2009. <http://www.dep.state.fl.us/water/watersheds/.>

Google Maps. Google. Date verified July 24, 2009. http://maps.google.com/

Gornitz, Vivien. January 2007. ***Sea Level Rise, After the Ice Melted and Today.*** NASA Goddard Institute for Space Studies (GISS.) Date verified July 28, 2009. http://www.giss.nasa.gov/research/briefs/gornitz_09/

Himes, Dr. J., and P Moler. 2007. ***A List of the Amphibians and Reptiles of the Saint Andrew Bay Ecosystem, Florida.*** Friends of St. Andrew Bay, Biodiversity Subcommittee. http://friendsofstandrewbay.org/publications/Amph_Reptiles_SAB.pdf

Hobson, Will. ***Dozier's East Pass Mission Continues.*** Panama City News Herald. July 6, 2009. Date verified July 2009. http://www.newsherald.com/news/pass-75542-county-east.html

Home. Historic St. Andrew. Date verified July 29, 2009. <http://www.historicstAndrew.com/>

Houpt, A. P., and Saint Andrew Waterfront Partnership. 2007. Images of America St. Andrew. Charleston SC: Arcadia Publisher.

Hurricane Katrina. Wikipedia, The Free Encyclopedia. Date verified June 2009. http://en.wikipedia.org/w/inedx.php?title=Hurricane_Katrina&oldid= 299159788

E. J. Keppner PhD. 2002. ***An Inventory of the Biological Resources Reported from Saint Andrew Bay Estuarine System, Bay County, Florida. A Revision.*** St. Andrew Bay Environmental Study Team, Best Publication February 2002, 119 pp.

Kelly, P. Sep. 18, 2009. ***DEP fines Phoenix $1.7 million with DEP Report.*** News Herald of Panama City. Date verified October 15, 2009. http://www.newsherald.com/news/dep-77612-report-bay.html

Keppner, E.J., and L.A. Keppner. 2008. ***The St. Andrew Bay Ecosystem, our Environment. A Revision of "A Look to the Future."*** St. Andrew Bay Environmental Study Team, BEST Publication 0004, 90 pp.

Keppner, E.J., and L.A. Keppner. 2005. ***Tracked and Protected Species in Bay County and the St. Andrew Bay Ecosystem, Florida.*** St. Andrew Bay Environmental Study Team, BEST Publication 0007, 52 pp.

Landry, L.A. 1994. ***Underwater Archaeological Survey of Panama City Harbor and Pass, Bay County, Florida.*** Mobile District U.S. Army Corps of Engineers, Contract # DACW01-94-D-0055.

Madddox, K. and S. King. ***The History of Bay County Florida.*** Tommy Smith Elementary School. Date verified September 15, 2009. http://www.beaconlearningcenter.com/weblessons/bayhistory

Map Gallery. Bay County Online. Date verified July 24, 2009. < http://new.co.bay.fl.us/gis/gallery2.php?agreecheck=on>

Milanich, J. T. 1998. Florida's Indians from Ancient Times to Present. Gainesville: University Press of Florida.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetlands: Third Edition. New York: John Wiley and Sons, Inc.

Bibliography

Moore, C. 1918. The Northwestern Florida coast Revisited. Philadelphia: Journal of the Academy of Natural Sciences of Philadelphia, Volume: XVI. Date verified July 29, 2009. . http://books.google.com.

Northwest Florida Water Management District. 2001. ***St. Andrew Bay Watershed Surface Water Improvement And Management Plan.*** Havana: Northwest Florida Water Management District (NWFWMD.) Program Development Series 2000-2.

Odum, H.T., E. C. Odum, and M. T. Brown. 1998. Environment and Society in Florida. New York: Lewis Publishers, CRC Press LLC.

Offley, E. Nov. 2, 2007. ***New Bay Airport Gets Off Ground***. News Herald of Panama City. Date verified October 9, 2009. <http://www.visionary realestatesolutions.com/News/New_Bay_Airport.pdf>

Panama City. 2009. Encyclopedia Britannica Online. Date verified July 29, 2009. <http://www.britannica.com/EBchecked/topic/440829/Panama-City>.

Richards, Christopher J. 1997**. *Delineation of the Floridian Aquifer Zone of Contribution for Econfina Creek and Deer Point Lake: Bay and Washington Counties, Florida.*** Havana: Northwest Florida Water Management District. Water Resources Special Report 97-2.

Saint Andrew Bay: The Big Picture. Northwest Florida Water Management District (NWFWMD.) Date verified June 2009. <http://www.nwfwmd.state.fl.us/pubs/big_picture/st_andrew_bay.pdf>

Schenker, Pamela. 2009. ***Florida Demographic Summary***. The Florida Legislature. Office of Economics and Demographics Research (EDR.) Date verified June 2009. <http://edr.state.fl.us/population/popsummary.pdf>

Soil Conservation Service. 1984. ***Soil Survey of Bay County Florida.*** National Cooperative Soil Survey. United States Department of Agriculture, pp 163.

S.S. Tarpon (Shipwreck.) Florida Shipwrecks: 300 Years of Maritime History. National Park Service (NPS.) Date verified September 15, 2009. http://www.nps.gov/history/nr/travel/flshipwrecks/tar.htm

St. Joe Company: Form 10-K, Amendment 1. United States Securities and Exchange Commissions (USSEC.) Date verified July 23, 2009. <http://shareholder.api.edgar-online.com/efx_dll/edgarpro.dll?FetchFilingRTF1?sessionid=y3_jWba3uCR0o5B&ID=951120&PageBreakStyleID=2>

Surface Water Quality Standards. Florida Department of Environmental Protection (FDEP.) Date verified July 23, 2009. http://www.floridadep.org/legal/Rules/shared/62-302/62-302.pdf

Urban Sprawl. 2009. Wikipedia. Date verified October 15, 2009. http://en.wikipedia.org/wiki/Urban_sprawl

Watershed Management. Florida Department of Environmental Protection (FDEP.) Date verified July 22, 2009. http://www.dep.state.fl.us/water/watersheds/

West, G. M. 1922. Saint Andrew, FL. Saint Andrew: Panama City Publishing Company. http://books.google.com.

Whitney, E., D.B. Means, and A. Rudloe. 2004. Priceless Florida: Natural Ecosystems and Native Species. Sarasota: Pineapple Press, Inc.

Womack, M. 1994. Along the Bay; A pictorial History of Bay County. Norfolk, VA: Pictorial Heritage Publishing Company.

Womack, M. 1997, December 14. ***Actor Clark Gable attended gunnery school at Tyndall AFB***. The News Herald-Panama City. Date verified September 25, 2009. http://foronceinmylife.info/cactus_st/article/article122.html

Womack. M. 2007. ***Brief History of Panama City.*** Panama City Centennial Celebration. Date verified July 29, 2009. http://www.panamacity2009.com/history.htm