1. Background

1.1. Introduction to the River Report

This *State of the River Report for the Lower St. Johns River Basin* was written by a team of academic researchers from Jacksonville University (JU), University of North Florida (UNF), Valdosta State University (VSU), and Florida Southern College (FSC). Over the years, this report has undergone an extensive review process including local stakeholders and an expert review panel with the expertise and experience in various disciplines to address the multi-faceted nature of the data.

The *State of the River Report* was funded through the Environmental Protection Board (EPB) of the City of Jacksonville (COJ), Florida, and the River Branch Foundation. The report comprises one component of a range of far-reaching efforts initiated by Jacksonville Mayors John Delaney and John Peyton and continued by the *River Accord* partners (including COJ, the St. Johns River Water Management District (SJRWMD), JEA, Jacksonville Water and Sewer Expansion Authority (WSEA; until 2011), and the Florida Department of Environmental Protection (DEP) to inform and educate the public regarding the status of the Lower St. Johns River Basin (LSJRB), Florida (Figure 1.1).

1.1.1. Purpose

The *State of the River Report's* purpose is to be a clear, concise document that evaluates the current ecological status of the Lower St. Johns River Basin (LSJRB) based on a vast amount of scientific information.

1.1.2. Goals and Objectives

The overarching goal of the *State of the River Report* is to summarize the status and trends in the health of the LSJRB through comprehensive, unbiased, and scientific methods.

The tangible objectives of the report project include the design, creation, and distribution of a concise, easy-to-understand, and graphically pleasing document for the general public that explains the current health of the LSJRB in terms of water quality, fisheries, aquatic life, and contaminants.

Secondary objectives include the production of a baseline record of the status of the St. Johns River that can serve as a benchmark for the public to compare the future health of the river. This baseline information can be used by the public and policymakers to focus management efforts and resources on areas that need the most improvement first and to gauge the success of current and future management practices.

1.1.3. River Health Indicators and Evaluation

The *State of the River Report* describes the health of the LSJRB based on a number of broad indicators in four major categories:

- WATER QUALITY

  Dissolved Oxygen (DO)
  Nutrients (Nitrogen & Phosphorus)
  Turbidity
  Algal Blooms
  Bacteria (Fecal Coliform)
  Metals
  Tributaries
  Salinity

- FISHERIES

  Finfish Fishery
  Invertebrate Fishery

- AQUATIC LIFE

  Submerged Aquatic Vegetation
  Wetlands
  Macroinvertebrates
  Threatened and Endangered Species
  Non-native Aquatic Species

- CONTAMINANTS

  Toxics Release Inventory: Point Sources of Contaminants in the LSJR Region
  Polyaromatic Hydrocarbons (PAHs)
  Metals
  Polychlorinated Biphenyls (PCBs)
  Pesticides

The *State of the River Report* is based on the best available data for each river health indicator listed above. How each indicator contributes to, or signals, overall river health is discussed in terms of its 1) *Current Status*, and 2) the *Trend* over time.

The *Current Status* for each indicator is based on the most recent data and is designated as “satisfactory” or “unsatisfactory.” In some cases, this designation is defined by whether the indicator meets state and federal minimum standards and guidelines, and in other cases, the designation is based on alternative criteria as described in the sections.

The *Trend* is derived, where possible, from statistical analyses of the best available scientific data for each indicator and reflects historical change over the time period analyzed. The *Trend* ratings for each indicator are designated as “conditions improving,” “conditions stable,” “conditions worsening,” or “uncertain.” The *Trend* rating does not consider initiated or planned management efforts that have not yet had a direct impact on the indicator. Statistical tests to indicate trends vary with each indicator and are described in each section.

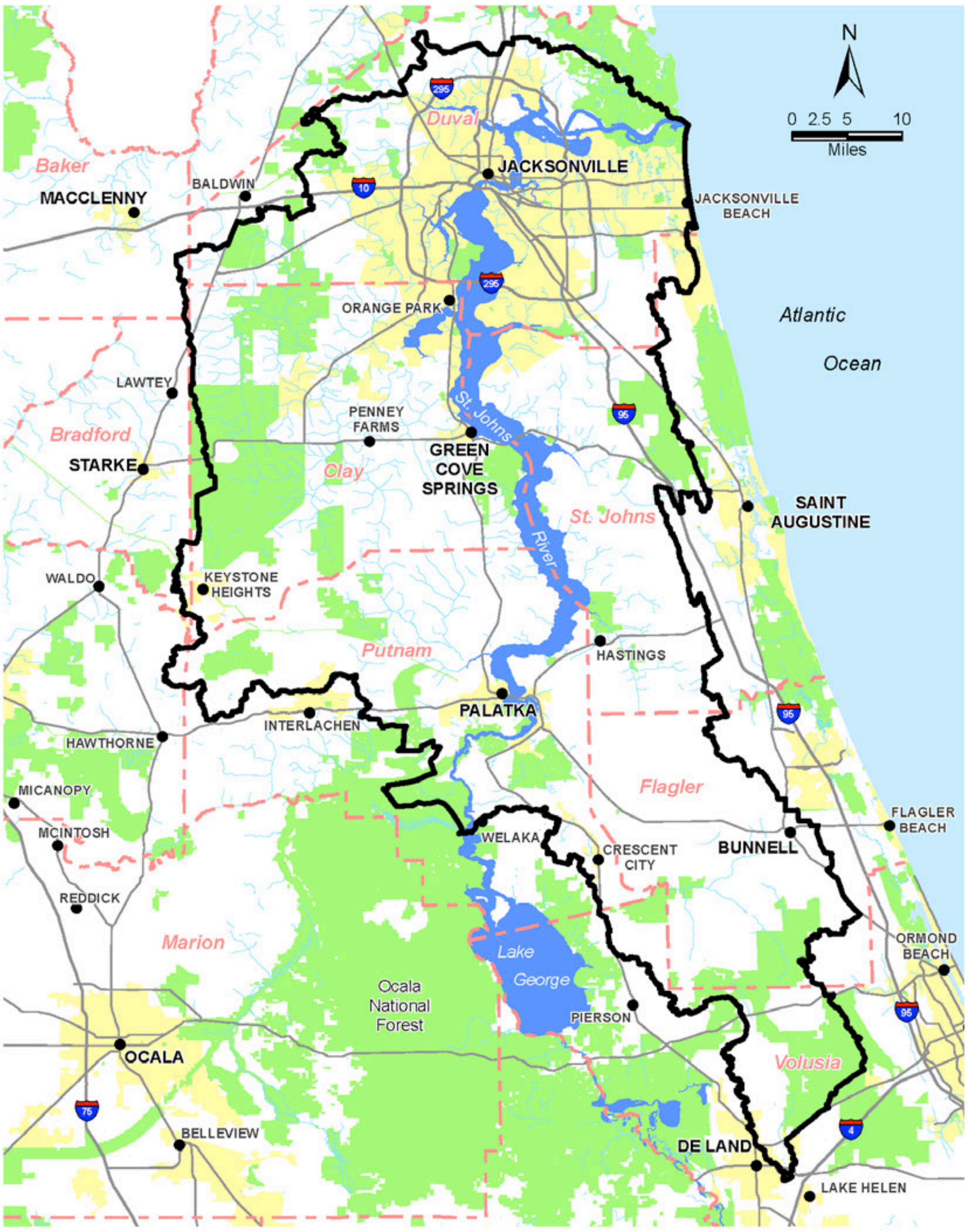

Figure 1.1 Geopolitical Map of the Lower St. Johns River Basin, Florida (outlined in black).

1.2. St. Johns River Basin Landscape

The LSJRB in northeast Florida has long been recognized as a treasured watershed - providing enormous ecological, recreational, socioeconomic, and aesthetic benefits. However, during recent years, it has also been recognized as a threatened watershed, which is critically in need of resource conservation, water quality improvement, and careful management.

1.2.1. Geopolitical Boundaries

For management purposes, the entire St. Johns River watershed is commonly divided into five basins: the Upper Basin (southern, marshy headwaters in east central Florida), the Middle Basin (the area in central Florida where the river widens, forming Lakes Harney, Jesup, and Monroe), the Lake George Basin (the area between the confluence of the Wekiva River and St. Johns River and that of the Ocklawaha River and the St. Johns River), the Lower Basin (the area in northeast Florida), and the Ocklawaha River Basin (the primary tributary for the St. Johns River). The LSJRB is the focus of this State of the River Report.

As a constant, this Report defines the LSJRB in accordance with the SJRWMD definition: "the drainage area for the portion of the St. Johns River extending from the confluence of the St. Johns and Ocklawaha rivers near Welaka to the mouth of the St. Johns River at Mayport" (**SJRWMD 2008**; Figure 1.1).

The LSJRB includes portions of nine counties: Clay, Duval, Flagler, Putnam, St. Johns, Volusia, Alachua, Baker, and Bradford (**Brody 1994**). Notable municipalities within the Lower Basin include Jacksonville, Orange Park, Green Cove Springs, and Palatka (Figure 1.1).

The LSJRB covers a 1.8 million-acre drainage area, extends 101 miles in length, and has a surface area of water approximately equal to 115 square miles (**Adamus, et al. 1997**; **Magley and Joyner 2008**).

1.2.2. Existing Land Cover

The LSJRB, including all aquatic and adjoining terrestrial habitats, consists of approximately 68% uplands and 32% wetlands and deepwater habitats (Figure 1.2, see Appendix 1.2.2.A. for acres and definitions of categories).

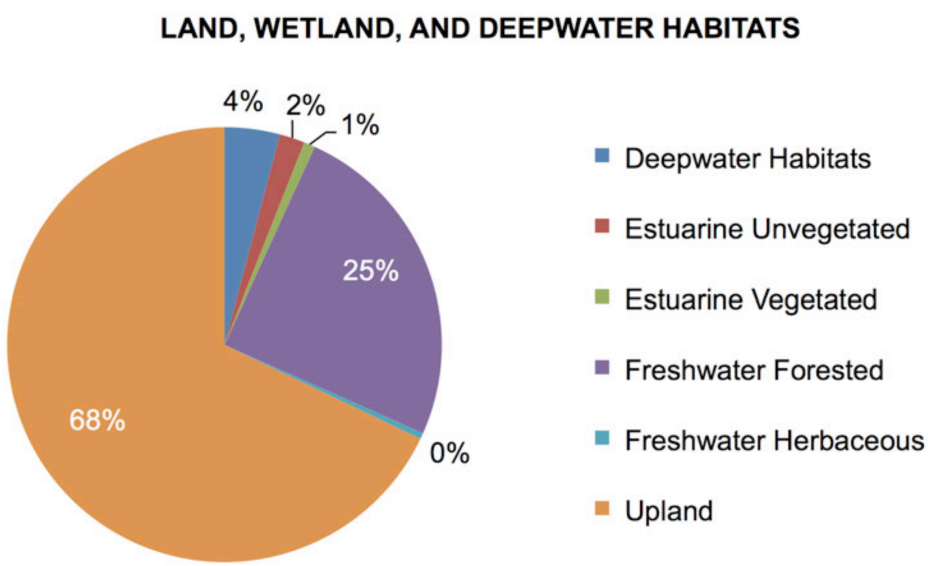

Figure 1.2 Total percentages for land, wetland, and deepwater habitats within the Lower St. Johns River Basin, Florida. (Source: SJRWMD Wetlands and Deep Water Habitats GIS Maps, 1972-1980; ***SJRWMD 2007****)*

Within the LSJRB in 2004, the dominant land covers were upland forests (35%) and wetlands (24%), and 18% was considered urban and built-up. Since the 1970s, the proportion of the total basin designated as upland forests and agriculture has decreased, while the proportion designated as urban and built-up has increased (see Appendix 1.2.2.B.; **SJRWMD 2007**).

1.2.3. Ecological Zones

The LSJRB is commonly divided into three ecological zones based on expected salinity differences (**Hendrickson and Konwinski 1998**; **Malecki, et al. 2004**). The ***mesohaline riverine zone*** is the most northern ecological zone in the LSJRB, stretching from the Atlantic Ocean to the Fuller Warren Bridge. The mesohaline riverine zone is typically deeper and well-mixed with an average salinity of 14.5 parts per thousand (ppt) and a fast flow rate. South of the Fuller Warren Bridge, the St. Johns River widens into a broad, shallow, slow-moving, tidal area called the ***oligohaline lacustrine zone***. This zone extends from the Fuller Warren Bridge to Doctors Lake and has an average salinity of 2.9 ppt. South of Doctors Lake to the confluence of the St. Johns and Ocklawaha rivers near Welaka, the LSJRB transitions into the ***freshwater lacustrine zone***. This zone stretches through the Middle and Upper Basins of the St. Johns River as well. The freshwater lacustrine zone is lake-like, has an average salinity of 0.5 ppt, and experiences tidal fluctuations that are lower than those observed in the other ecological zones.

1.2.4. Unique Physical Features

The St. Johns River is unique and distinctive due to a number of exceptional physical features.

The St. Johns River is the longest river in Florida. Stretching 310 miles and draining approximately 9,430 square miles, this extensive river basin drains about 16% of the total surface area of Florida (**DeMort 1990**; **Morris IV 1995**).

The St. Johns River flows northward. The result of this northward flow is that the *Upper* St. Johns actually lies south of the *Lower* St. Johns (**DeMort 1990**). The St. Johns River is one of the few rivers in North America to flow north.

The St. Johns River is one of the flattest major rivers in North America. The headwaters of the St. Johns River are less than 30 feet above sea level. The river flows downward on a slope ranging from as low as 0.002% (**Benke and Cushing 2005**) to about 1% (**DeMort 1990**). This slope is governed by the exceptionally flat terrain of the drainage basin and most of the decline occurs in the first 100 miles of the river. In fact, the river bottom at the mouth of Lake Harney is below sea level (**Bowman 2009**). This extremely low gradient contributes to a typically slow flow of the St. Johns River. This holds back drainage, slows flushing of pollutants, and intensifies flooding and pooling of water along the river creating numerous lakes and extensive wetlands throughout the drainage basin (**Durako, et al. 1988**). The retention time of the water, and its dissolved and suspended components, in the river is on the order of three to four months (**Benke and Cushing 2005**). High retention times of pollutants have severe impacts on water quality.

The Lower St. Johns River is a broad, shallow system. The average width of the Lower St. Johns River from Lake George to Mayport is one mile, although the flood plain reaches a maximum width of ten miles (**Miller 1998**). The average depth of the river is 11 feet (**Dame, et al. 2000**). The variability in width of the river can result in different water flow patterns and conditions on opposing banks of the river (**Welsh 2008**).

The St. Johns River receives saltwater from springs. Several naturally salty springs feed into the St. Johns River Drainage Basin. The most significant inputs of salty spring water originate from Blue Springs, Salt Springs, Silver Glen Springs, and Croaker Hole Spring (**Campbell 2009**). Inputs from these salty springs cause localized areas of elevated salinity (>5 ppt) in otherwise freshwater sections of the river (**Benke and Cushing 2005**). The amount of flow from springs is highly variable and dramatically affected by droughts (**Campbell 2009**).

The St. Johns River drains into the Atlantic Ocean. The average discharge of water at the mouth of the St. Johns River is 8,300 cubic feet per second (**Miller 1998**) or 5.4 billion gallons per day (**Steinbrecher 2008**). However, this flow rate is dwarfed by the volume of tidal flow at the mouth of the river, which is estimated to be approximately seven times greater than the freshwater discharge volume (**Anderson and Goolsby 1973**). This difference often causes "reverse flow," or a southward flow, up the river. Reverse flow has been detected as far south as Lake Monroe, 160 miles upstream, and is influenced as much by weather conditions as by ocean tides (**Durako, et al. 1988**). Natural water sources for the St. Johns River are direct rainfall, rainfall from runoff, underground aquifers, and springs. Continual input from springs and aquifers supplies the river with water that discharges into the Atlantic Ocean, despite drought periods or seasonal declines in rainfall (**Benke and Cushing 2005**). Water quality depends on the primary sources of water at any given time.

The Lower St. Johns River is a tidal system with an extended estuary. The tidal range at the mouth of the river at Mayport, Florida is about six feet (**McCully 2006**). The Atlantic Ocean's tide heights are large compared to the slope of the St. Johns River, and at times, can produce strong tidal currents and mixing in the northernmost portion of the river. The

St. Johns River is typically influenced by tides as far south as Lake George, 106 miles upstream (**Durako, et al. 1988**). During times of drought when little rainwater enters the system or extreme high tides, river flow-reversal can occur as far south as Lake Monroe, 160 miles upstream (**Durako, et al. 1988**). Tidal reverse flows occur daily in the LSJR, and net reverse flows, as much influenced by winds as by tides, can occur for weeks at a time (**Morris IV 1995**).

The salinity of the St. Johns River is heavily affected by seasonal rainfall patterns and episodic storm and drought events. In general, there is a predictable seasonal pattern of freshwater input from rainfall into the Lower St. Johns River, with the majority of rain falling during the wet season from June to October (**Rao, et al. 1989**). However, this seasonal pattern of rainfall can be overridden by less predictable, episodic storm events, i.e., hurricanes, tropical storms, or nor'easters, or drought events, like the droughts of the early 1970s, the early 1980s, 1989-1990, and 1999-2001 (**DEP 2010d**). In turn, surges of freshwater from heavy rainfall tend to reduce salinity levels in the river. Increased salinity occurs during periods of drought, when there is a deficit of fresh rainwater into the river. Thus, rainfall can prompt a chain of events in the river, where changes in salinity lead to impacts on aquatic plants and animals. Simplified examples of several sequenced events are illustrated below (Figure 1.3).

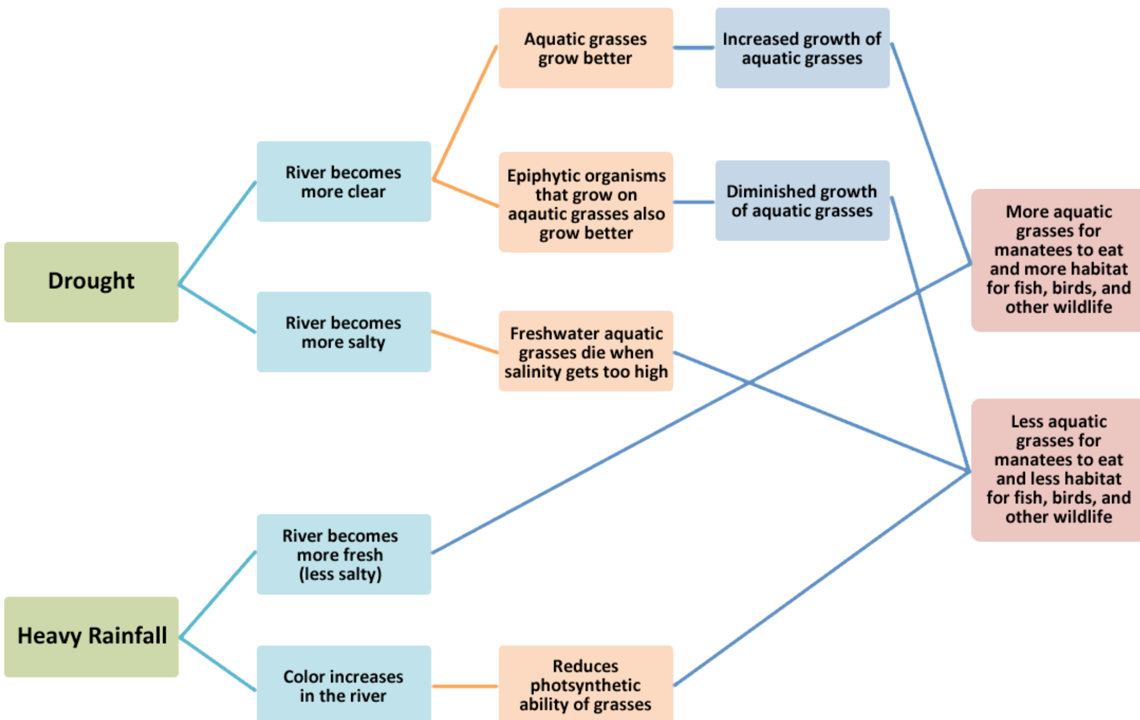

Figure 1.3 Simplified example of sequenced events that can occur in the Lower St. Johns River Basin stimulated by changes in rainfall.

The St. Johns River can be influenced by local wind direction. *S*urface stress of local winds upon the river plays a secondary role compared with remote winds on the ocean that affect the river's flow. However, these local winds can cause flow enhancements. South winds blowing to the north accelerate the flow of water toward the ocean, if the flow is not opposed by a strong tidal current. Similarly, north winds can push river water back upstream (**Welsh 2008**). Strong sustained north winds from fall nor'easters or summer hurricanes can push saltwater up the river into areas that are usually fresh. Although considered a natural occurrence, reverse flow of the river can impact flora and fauna with low salinity tolerances and cause inland areas to flood.

The St. Johns River is a dark, blackwater river. Southern blackwater rivers are naturally colored by dissolved organic matter derived from their connections to swamps, where plant materials slowly decay and release these organic materials into the water (**Brody 1994**). The Dissolved Organic Matter (DOM) limits light penetration, and therefore photosynthesis, to a very shallow layer near the surface of the river.

1.3. Human Occupancy of the Region (pre-1800s)

1.3.1. Native Americans

The Lower Basin of the St. Johns River watershed has been occupied, utilized, and modified by humans for over 12,000 years (**Miller 1998**). As the Ice Age ended, the first Floridians were the Paleo Indians. They inhabited a dry, wide Florida hunting and gathering for food and searching for fresh water sources. Gradually, the glaciers melted, sea levels rose, and Florida was transformed. By approximately 3,000 years ago, the region resembled the Florida of today with a wet, mild climate and abundant freshwater lakes, rivers, and springs (**Purdum 2002**). The conditions were favorable for settlement, and early Indians occupied areas throughout the state. In fact, historians estimate that as many as 350,000 Native Americans were thriving in Florida (including 200,000 Timucua Indians in southeast Georgia and northern Florida), when the first French and Spanish explorers arrived in the 1500s (Figure 1.4; **Milanich 1995**; **Milanich 1997**).

The Native Americans that occupied much of the LSJRB were part of a larger group collectively known as the Timucua Indians. Actually a group of thirty or more chiefdoms sprinkled in villages throughout north Florida and southeastern Georgia, the Timucua Indians were bound to one another linguistically by a common language called Timucua (**Granberry 1956; Granberry 1993**). The Timucua language was spoken throughout the LSJRB north of Lake George and its tributary the Oklawaha River (**Milanich 1996**). By the 17th century, the Spaniards living in the region referred to a distinct group of Timucua known as the Mocama (translates to "the sea") (**Ashley 2010**). The Mocama Indians spoke a unique dialect of the Timucua language called Mocama. They lived near the mouth of the St. Johns River and on the Sea Islands of southeastern Georgia and northeastern Florida (St. Simons, Jekyll, Cumberland and Amelia Islands) as far back as A.D. 1000 (**Worth and Thomas 1995**). Evidence has suggested that the Mocama had extensive trading networks that stretched as far west as the Mississippi River (**Ashley 2010**). Archaeological evidence also suggests that the Mocama became a permanent settlement and cultivated maize for food, in addition to traditional hunting and gathering (**Thunen 2010**). The Timucua Indians did modify the land to their advantage, such as burning and clearing land for agriculture and constructing drainage ditches and large shell middens (**Milanich 1998**). But, by today's standards, these impacts on the landscape were small in scale and spread out over a vast terrain.

The numbers of Native Americans in Florida plummeted during the 16th and 17th centuries, as many were killed by European diseases or conflicts (**Davis and Arsenault 2005**). By the 1700s, the original Timucua population in Florida had vanished (Figure 1.4).

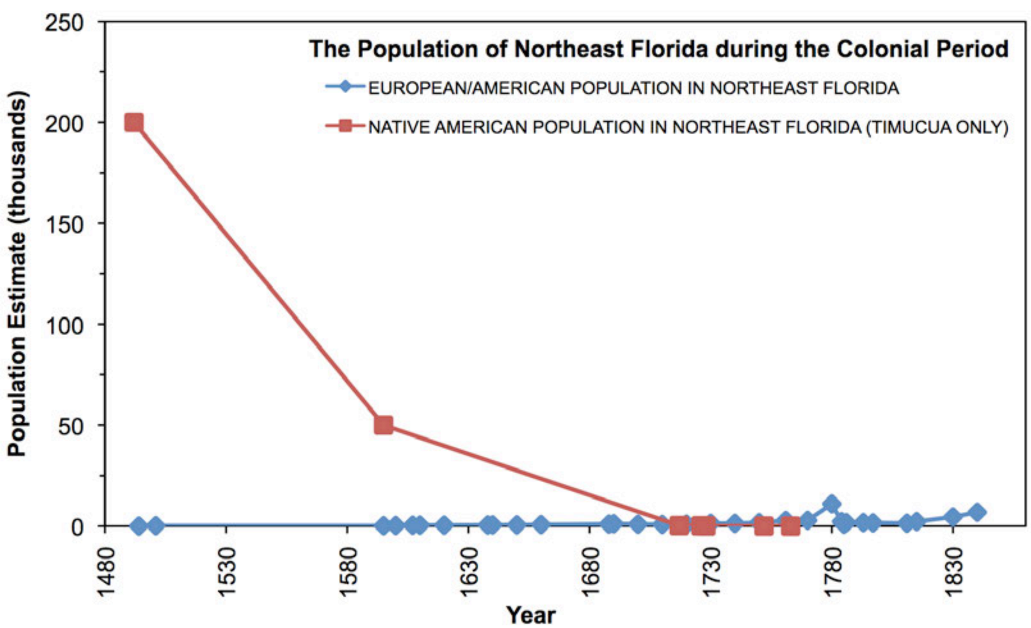

*Figure 1.4 Population of northeast Florida during the Colonial Period, 1492 to 1845. (Sources: Population estimates for the Timucua Tribe in northeast Florida were taken from **Milanich 1997**, and "Northeast Florida" is defined as all lands inhabited by Timucua Indians. Population estimates for European Colonists were taken from **Miller 1998**, and "Northeast Florida" loosely includes settlers in "the basin of the northward-flowing St. Johns River from Lake George to the mouth, as well as the adjacent Atlantic Coast and the intervening coastal plain" (**Miller 1998**). Complete data table provided in Appendix 1.3.1.*

1.3.2. Europeans

The first permanent European colony in North America was Fort Caroline, founded in 1564 by the French near the mouth of the St. Johns River (**Miller 1998**). One year later, the Spanish conquered the French, and from 1565 to 1763, the still-wild territory of Florida flew the flag of Spain (**Schafer 2007**). The epicenter of the Spanish colony became St. Augustine, and few colonists ventured beyond the walls of the guarded city. In retrospect, the footprint of these Spanish settlers on Florida was light. Apart from introducing non-native citrus, sugarcane, and pigs (the wild boars of today), they altered the environmental landscape very little along the St. Johns River watershed as compared to what was to come (**Warren 2005**; **Schafer 2007**).

In 1763, the British took control of Florida. Two years later, John Bartram, appointed as botanist to His Majesty George III of England, surveyed the natural resources of Florida that were now available for English use and benefit (**Stork 1769**). On this journey, John Bartram was accompanied by his son William, who would later become famous in his own right for discoveries recorded during his solitary travels through the southern colonies in the 1770s (**Bartram 1998**). The writings of this father and son provide evidence that the First Spanish Period left behind a wild and largely untouched land full of untapped resources and potential.

During the 20 years that the British occupied Florida, landscape modifications for colonization and agriculture were intensive. Large tracts of land were cleared for plantations intended for crop exportation, and timber was harvested and exported for the first time (**Miller 1998**). During the American Revolution, Florida became a haven for British loyalists, and the population of Florida ballooned from several thousand to 17,000 (**Milanich 1997**). The Spanish reacquired Florida in 1783, most of the British settlers left the area, and the state population declined again to several thousand (Figure 1.4). The Spanish continued plantation farming within the LSJRB, but did not exploit the land as successfully as the British (**Miller 1998**). Spain held Florida until the region was legally acquired by the United States in 1821. At this time, exploration and exploitation of the St. Johns River Basin began in earnest.

1.4. Early Environmental Management (1800s to 1970s)

The history of environmental management of the St. Johns River watershed, and water resources in Florida in general, is a complex, convoluted, but relatively short history. Major milestones in environmental management in Florida have taken place within just the last century, with much of the story occurring during our living memory (Table 1.1). The story of water management in Florida unfolds as a tale of lessons learned, a shift from reigning to restoring, from consuming to conserving.

Like the tides, management efforts in the watershed have surged and retracted over the last 100 years. Many landmark policies and programs have been initiated in response to environmental changes deemed intolerable by the public and the policymakers who represent them.

Noticeable, but small-scale, changes occurred in the St. Johns River Basin during pre-Columbian times, when northeast Florida was occupied by the Timucua Indians (**Milanich 1998**). It was not until the Colonial Period, particularly during the British occupation in the late 1700s, that the environment experienced large-scale alterations. Such landscape modifications as the conversion of wetlands to agriculture and the clearing of forests for timber surged again in the mid-1800s after Florida was granted statehood (**Davis and Arsenault 2005**).

Most of the earliest changes to the landscape of the LSJRB were utilitarian in purpose, but the late 1800s and early 1900s were fraught with changes driven by the profitable, even whimsical, tourist industry. Tourists were fascinated with promotional accounts describing this land of eternal summer, filled with wild botanicals and beguiling beasts (**Miller 1998**). The growing village of Jacksonville became the initial portal to Florida, and a thriving tourist industry flourished as steamboats began to shuttle tourists up the St. Johns River. By 1875, Jacksonville was the most important town in Florida (**Blake 1980**). First tourists, and then developers and agricultural interests, were enticed to the rich and largely unexploited resource that was early Florida (**Blake 1980**). By the early 1900s, the population of northeast Florida was increasing at a slow, steady rate (see Figure 1.5).

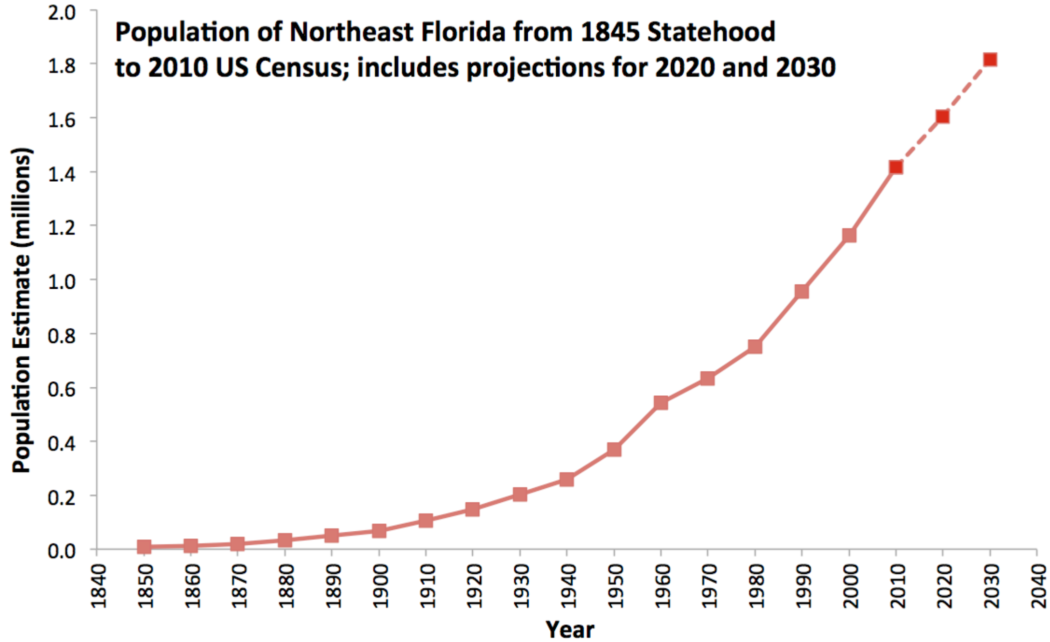

*Figure 1.5. Population of northeast Florida from the time Florida was granted statehood to the 2010 U.S. Census including future population projections to 2030. ("Northeast Florida" includes population counts from Clay, Duval, Flagler, Putnam, and St. Johns counties. Sources: Population counts for the years 1850-1900 were provided by Miller 1998. Counts from 1900-1990 were extracted from **Forstall 1995**, and 2000 and 2010 counts from the USCB. (**USCB 2000; USCB 2010**) Note: U.S. Census data were not available for Flagler County in 1900 and 1910. Population estimates for 2020 and 2030 were extracted from the Demographic Estimating Conference Database (**EDR 2015**), updated August 2014.*

Impacts to the environment mirrored the steady population growth during the early 1900s. Entrepreneurs, investors, and government officials in Florida at this time were thoroughly focused on the drainage and redirection of water through engineering works (**Blake 1980**).

The immigration of new settlers was moderate during Florida's first century as a state, because the region still proved inhospitable and rather uninhabitable to the unadventurous. Not only was the region full of irritating, disease-carrying mosquitoes, Florida was just too hot and humid. But, that all changed when air conditioners for residential use became affordable and widespread after WWII (**Davis and Arsenault 2005**). Florida's population exploded around the 1950s and has continued to skyrocket ever since (Figure 1.5; **USCB 2000**).

By the 1960s, a century of topographical tinkering was taking its toll. Ecosystems across Florida were beginning to show signs of stress. Sinkholes emerged in Central Florida (the Upper Basin of the St. Johns River) indicating a serious decline in the water table (**SJRWMD 2010a**). Flooding, particularly during storm events, was destructive and devastating. Loss of wetlands peaked during this time, as wet areas were rapidly converted to agriculture or urban land uses (**Meindl 2005**). Water works, such as the Kissimmee Canal and Cross Florida Barge Canal, continued into the 1960s, but public opposition against such projects was mounting (**Purdum 2002**).

During 1970-71, Florida experienced its worst drought in history, and the attitudes toward water began to shift from control and consumption to conservation (**Purdum 2002**). During 1972, the "Year of the Environment," the Federal and State governments passed a number of significant pieces of environmental legislation (see Table 1.1). The laws of the early 1970s, such as the National Environmental Policy Act, Endangered Species Act, and Clean Water Act, showcased a change in our approach to resource use and our attitudes regarding ecosystem services, nature, and the environment. From this time forward, environmental management began to take a shift towards consideration of the outcomes of our actions.

The Clean Water Act (CWA) and its companion act, the Clean Air Act, have been some of the most enduring and influential pieces of legislation from the 1970s. The CWA addressed key elements that affect the long-term health of the nation's rivers and streams. The CWA requires states to submit a list of their "impaired" (polluted) waters to the U.S. Environmental Protection Agency (EPA) every two years (or the EPA will develop the list for them). States determine impairment primarily by assessing whether waterbodies maintain certain categories of use, e.g., fishable and swimmable. Whether a use is impacted or not is typically based on whether the water body meets specific chemical and biological standards or exhibits safety risks to people. Once a state has an approved or "verified 303(d)" list of impaired waters, it must develop a management plan to address the issues that are causing the impairment. This process of identifying and improving impaired waters through the CWA has played a major role in modern environmental management from the 1980s through the 2000s.

Table 1.1 Timeline of environmental milestones, Lower St. Johns River Basin, Florida: from European colonization to 2010s

DATE	EVENT
1765-1766	During the British occupation of Florida, John Bartram, the "Botanist to the King," and his son William Bartram toured the St. Johns River (**Davis and Arsenault 2005**).
1773-1777	Naturalist William Bartram chronicled his travels up the St. Johns River producing detailed descriptions of pre-statehood, Northeast Florida. "Bartram's observations remain an invaluable tool for environmental planning—restoring paradise—in northeastern Florida" (**Davis and Arsenault 2005**).
1821	Adams-Onis Treaty: United States legally acquired Florida (**Blake 1980**).
1835-1842	Second Seminole War: Many steamboats were first brought to the St. Johns River for combat with the Indians, but continued to operate out of Jacksonville for civilian purposes after the war (**Buker 1992**).
1845	Florida granted statehood.
1850	Swamp and Overflowed Lands Act: stated that Florida could have from the Federal government any swamp or submerged lands that they successfully drained (**Leal and Meiners 2002**).
1868	Florida's first water pollution law established a penalty for degrading springs and water supplies (**SJRWMD 2010a**).
1870-1884	Famed author of *Uncle Tom's Cabin*, Harriet Beecher Stowe, wintered in Mandarin and wrote essays extolling the beauties of the St. Johns River and attracting tourists to Florida (**Blake 1980**).
1870s	Increasing number of tourists visited Florida via steamboats up the St. Johns River.
1875	Jacksonville was the most important city in Florida (**Blake 1980**).
1880	Construction of jetties at the mouth of the St. Johns River was started in order to stabilize the entrance of the shipping channel. They were not finished until 1921 (**Davis 1925**).
1884	Water hyacinth introduced into the St. Johns River near Palatka (**McCann, et al. 1996**).
1895	The Port of Jacksonville shipping channel was deepened to 15-ft (**GLD&D 2001**).
1896	Water hyacinth had spread throughout most the LSJRB and was hindering steamboat navigation, causing changes in water quality and biotic communities by severely curtailing oxygen and light diffusion, and reducing water movement by 40-95% Palatka (**McCann, et al. 1996**).
1906	The Port of Jacksonville shipping channel was deepened to 24-ft (**GLD&D 2001**).
1912	Intracoastal Waterway from Jacksonville to Miami was completed (**SJRWMD 2010a**).
1916	The Port of Jacksonville shipping channel was deepened to 30-ft (**GLD&D 2001**).
1935	Cross-Florida Barge Canal construction was initiated.
1937	Federal government completed deepening of the St. Johns River to 30 feet deep from the ocean to Jacksonville.
1937	Construction was suspended on Cross-Florida Barge Canal.
1945	River and Harbor Act of 1945 authorized the construction of the Dames Point Fulton Cut. This 34-ft-deep cut-off channel eliminated bends in the shipping channel at Dames Point, Browns Creek and Fulton (St. Johns Bluff). The straightening of the channel shortened the distance between the City of Jacksonville and the ocean by about 1.9 miles.
1950s	Bacteria pollution was first documented in the St. Johns River (largely due to the direct discharge of untreated sewage into the river).
1952	The Port of Jacksonville shipping channel was deepened to 34-ft (**GLD&D 2001**).
1964	Construction continued on Cross-Florida Barge Canal.
1966-1967	Sinkholes occurring in Central Florida (within the Upper Basin of the St. Johns River) indicating a serious drop in the water table (**Purdum 2002**).
Dec. 5, 1967	The City of Jacksonville received a letter from the Florida Air and Water Pollution Control Commission and State Board of Health, who "ordered the City within 90 days to furnish plans and an implementation schedule to end the disposal of 15 million gallons per day of raw sewage into the St. Johns River and its tributaries" (**Crooks 2004**).
1967-1968	Voters approved the consolidation of the Jacksonville and Duval County local governments.
1968	Initial flooding of the Rodman Reservoir. The Rodman Dam was completed and dammed the lower Ocklawaha River.
1970	National Environmental Policy Act: required federal agencies to consider the environmental impacts and reasonable alternatives of their proposed actions.

1970s	"Cleanup of the St. Johns River was impressive, but many of its tributaries remained heavily polluted; landfills were opened, but indiscriminate littering of wastes continued; polluting power plants and fertilizer factories closed, but other odors remained" (**Crooks 2004**). "Discharges occur to river of primary treated effluent or raw sewage. Periodic blue-green algal blooms and fish kills" (**DEP 2002**).
1970-1971	Florida experiences its worst drought in history (**Purdum 2002**).
1971	Construction stopped on Cross-Florida Barge Canal.
1972	Several federal and state environmental laws were passed. • Florida Water Resources Act: established regional water management districts and created a permit system for allocating water use (**Florida Legislature 1972b**). • Federal Clean Water Act: required that all U.S. waters be swimmable and fishable (**Congress 1972a**). • Land Conservation Act: authorized the sale of state bonds to purchase environmentally imperiled lands (**Florida Legislature 1972c**). • Environmental Land and Water Management Act: initiated the "Development of Regional Impact" program and the "Area of Critical State Concern" program (**Florida Legislature 1972c**). • Comprehensive Planning Act: called for the development of a state comprehensive plan (**Florida Legislature 1972a**). • Marine Mammal Protection Act: prohibited the killing or hurting of marine mammals in U.S. waters (**Congress 1972b**).
1973	Endangered Species Act: conservation of threatened and endangered plants and animals and their habitats (**Congress 1973**).
Mar. 1973	"Press release announced that the St. Johns River south of the Naval Air Station to the Duval County Line at Julington Creek had been deemed safe for water contact sports" (**Crooks 2004**).
1973-1974	The U.S. Army Corps of Engineers and DEP (then the Dept. of Natural Resources) implemented "maintenance control" of invasive aquatic plants (namely water hyacinth). Maintenance control replaced crisis management and kept water hyacinth populations at the lowest feasible level.
1977	The federal government funded a shipping terminal on Blount Island (**Crooks 2004**).
1977	Seventy-seven sewage outfalls closed, and the St. Johns River became safe for recreational use again (**Crooks 2004**). Movement to regional wastewater treatment systems providing higher levels of treatment than before.
Jun. 18, 1977	St. Johns River Day Festival marked the completion of the St. Johns River cleanup, and there were reports of some types of aquatic life returning to the river (**Crooks 2004**).
1978	The Port of Jacksonville shipping channel was deepened to 38-ft (**GLD&D 2001**).
Mid - late 1980s	"Outbreak of Ulcerative Disease Syndrome in fish occurs from Lake George to mouth of river. Exhaustive studies are conducted, but specific cause is not determined" (**DEP 2002**).
1987	Surface Water Improvement and Management (SWIM) Act: Recognized the LSJRB as an area in need of special protection and restoration (**SJRWMD 2008**).
1987	Water Quality Attainment Plan adopted by City of Jacksonville City Council. The plan addressed causes and remedies for non-attainment of water quality criteria.
1988	"The Florida Department of Environmental Regulation delegated authority to permit dredging and filling of wetlands to the St. Johns River Water Management District" (**SJRWMD 2010a**).
1988	"With funding from the SWIM program, the St. Johns River Water Management District began restoration of the Upper Ocklawaha River Basin and the Lower St. Johns River Basin" (**SJRWMD 2010a**).
1989	SJRWMD publishes the first SWIM Plan for the LSJRB.
1990s	"Blue-green algal blooms occur in freshwater portion of the river" (**DEP 2002**).
1991	The Florida Times-Union began a monthly series of investigative reports entitled "A River in Decline." This series reported that 17% of septic tanks were failing. In 1990, 47% of tributaries failed to meet appropriate health standards for fecal coliform. In 1990, 50% of privately owned sewage treatment plants violated local regulations. 80% of pollutants in Jacksonville's waterways could be attributed to stormwater runoff (**Crooks 2004**).
Early 1990s	The Florida Department of Environmental Regulation "downgraded formerly pristine areas of Julington and Durbin Creeks in southern Duval County from GOOD to FAIR water quality due to stormwater, sewage, and other runoffs from the rapidly growing suburb of Mandarin." Half of the wetlands in this area were destroyed during this time period (**Crooks 2004**).
Late 1990s	Blooms of an exotic freshwater, toxin-producing, blue-green algae called *Cylindrospermopsis* occurred (**DEP 2002**).
1997	The Lower St. Johns River Basin Strategic Planning Session (the "River Summit") led to the development of a 5-year "River Agenda" plan.

1998	Several Florida environmental groups brought a lawsuit against the U.S. Environmental Protection Agency (EPA) for its failure to enforce the Total Maximum Daily Load (TMDL) provisions in the Federal CWA (*Florida Wildlife Federation, Inc., et al. v. Browner*, (N.D. Fla. 1998) (No. 4:98CV356). In 1999 the lawsuit against EPA was settled with a Consent Decree, which required EPA and the Florida Department of Environmental Protection (DEP) to begin implementation of the TMDL provisions of the CWA. The Consent Decree required EPA to establish TMDLs if the State of Florida does not (13-year schedule to establish TMDLs).
July 30, 1998	St. Johns River is designated as an American Heritage River (**DEP 2002**).
Sept. 17, 1998	DEP submitted the 1998 303(d) list of impaired waterbodies to the EPA for approval. The 1998 303(d) list included 53 waterbodies in the LSJR. The list was approved by EPA in November 1998.
1999	Florida legislature enacted the Watershed Restoration Act (Florida Statute Section 403.067) to provide for the establishment of TMDLs for pollutants of impaired waters as required by the Clean Water Act.
1999	DEP formed a local stakeholders group to review the TMDL model inputs.
April 26, 2001	Florida adopted a new science-based methodology to identify impaired waters as c. 62-303, F.A.C. (Identification of Impaired Surface Waters Rule).
June 10, 2002	Following an unsuccessful rule challenge by various individuals and environmental groups (Case No. 01-1332R, Florida Division of Administrative Hearings), the Impaired Surface Waters Rule (c. 62-303, F.A.C.) became effective.
July 2002	DEP appointed the Lower St. Johns River TMDL Executive Committee to advise the Department on the development of TMDLs and a Basin Management Action Plan (BMAP) for the nutrient impairments in the mainstem of the LSJR.
Dec. 3, 2002	Four Florida environmental groups filed suit in federal court against the U. S. EPA for failure of EPA to approve/disapprove Florida's Impaired Waters Rule as being consistent with the CWA (*Florida Public Interest Research Group Citizen Lobby, Inc., et al., v U.S. EPA et al.*)
2002	The U.S. Army Corps of Engineers began the St. Johns River Harbor Deepening Project (**JAXPORT 2008**). The dredging project deepened "the outer 14 miles of the St. Johns River federal channel from the mouth of the river to Drummond Point" (**GLD&D 2001**). The channel was deepened to 41 ft in areas where there is a limestone rock bottom. The main shipping channel is maintained at this depth presently.
2002	The hydrodynamic model for the LSJR Mainstem TMDL is completed.
2003	"River Summit 2003" takes place, and the River Agenda is revised.
Sept. 4, 2003	DEP determined that most of the freshwater and estuarine segments of the LSJR were impaired by nutrients, and a verified list of impaired waters for the LSJR was adopted by Secretarial Order.
Sept. 30, 2003	The nutrient TMDL for the LSJR was originally adopted by Florida (Rule 62-304.415, F.A.C.).
April 27, 2004	Florida's nutrient TMDL was initially approved by the EPA Region 4.
Aug. 18, 2004	St. Johns Riverkeeper and Linda Young (Southeast Clean Water Network) filed suit against the EPA on the basis that the targets upon which the TMDL were based were not consistent with the existing Class III marine dissolved oxygen criterion.
Oct. 21, 2004	EPA found that the nutrient TMDL for the LSJR did not implement the applicable water quality standards for dissolved oxygen and rescinded its previous approval of the nutrient TMDL for the LSJR.
May 24, 2005	The Executive Committee identified the water quality credit trading approach for the Basin Management Action Plan (BMAP).
Early fall 2005	Large clumps of surface scum, caused by the toxic blue-green algae *Microcystis aeruginosa*, bloomed from Lake George to Jacksonville. Some samples exceeded World Health Organization recommended guidelines (**SJRWMD 2010a**).
2005-2008	U.S. Army Corps of Engineers is extending the harbor deepening from Drummond Point to JAXPORT's Talleyrand Marine Terminal from 38 ft to a maintained depth of 40 ft.
2006	Blooms of algae continue in the St. Johns River. "Algal blooms are caused by a combination of hot, overcast days, calm wind and excessive nutrients in the water, such as fertilizer runoff, stormwater runoff, and wastewater" (**SJRWMD 2010a**).
Jan. 23, 2006	EPA established a new nutrient TMDL for the LSJR that would meet the dissolved oxygen criteria.
May 25, 2006	Site-Specific Alternative Criteria (SSAC) for dissolved oxygen in the LSJR (F.A.C. 62-302.800(5)) was adopted by the Florida Environmental Regulation Commission and submitted to the EPA for approval. The SSAC was developed by DEP in cooperation with the SJRWMD.
July 13, 2006	St. Johns Riverkeeper and Clean Water Network filed a suit in federal Court challenging the EPA's approval of rule 62-302.800 (in effect, the SSAC). (*St. Johns Riverkeeper, Inc., et al. v. United States Environmental Protection Agency, et al.*, No. 4:2006cv00332, 2006 (N.D. Fla.))
July 2006	The River Accord: A Partnership for the St. Johns was established.
Sept. 2006	The project collection process for the LSJR Mainstem BMAP started, which provided the list of efforts that will implement the TMDL reductions and restore the river to water quality standards.
Oct. 10, 2006	EPA approved Site-Specific Alternative Criteria (SSAC) for dissolved oxygen in the marine portion of the St. Johns River.
2007	The U.S. Army Corps (USACE) started studying the impacts of blasting and dredging to deepen the navigation channel to a maintained 45 feet from the mouth of the river to Talleyrand Terminals (**USACE 2007**).

Feb. 1, 2007	The Executive Committee determined the LSJR Mainstem BMAP load allocation approach, which assigned reduction responsibilities to wastewater plants, industries, agriculture, cities and counties with urban stormwater sources, and military bases with stormwater sources.
April 2007	SJRWMD launched the public awareness initiative, "The St. Johns: It's Your River," in order to help the public understand their personal impacts to the river and their responsibility for the river's condition (**SJRWMD 2010a**).
August 2007	Urban stormwater loads were identified and quantified by local jurisdictions for the LSJR Mainstem BMAP.
Jan. 17, 2008	EPA approves the LSJR nutrient TMDLs based on the recently adopted SSAC.
April 2, 2008	DEP revised the Surface Water Quality Standards (c. 62-302.530, F.A.C.) to match the EPA approved list of TMDLs for nutrients in the LSJR.
July 17, 2008	Earthjustice (representing the Florida Wildlife Federation, Conservancy of Southwest Florida, Environmental Confederation of Southwest Florida, St. Johns Riverkeeper, and Sierra Club) filed a lawsuit against the EPA "for failing to comply with their nondiscretionary duty to promptly set numeric nutrient criteria for the state of Florida as directed by Section 303(c)(4)(B) of the Clean Water Act" (**Earthjustice 2008**; *Florida Wildlife Federation, Inc., et al. v. Johnson et al.,* 4:2008cv00324 (N.D. Fla.)).
Aug. 6, 2008	The first annual "State of the River Report for the Lower St. Johns River Basin" was released by researchers at Jacksonville University and the University of North Florida.
August 2008	The LSJRB SWIM Plan Update was released. The plan was prepared by SJRWMD, Wildwood Consulting, Inc., and the Lower St. Johns River Technical Advisory Committee (TAC). The plan outlines milestones, strategies, and objectives to meet goals associated with water quality, biological health, sediment management, toxic contaminants remediation, public education, and intergovernmental coordination.
Sept. 17-18, 2008	SJRWMD held a technical symposium on the preliminary findings of studies examining the cumulative effects of proposed surface water withdrawals on the water resources of the St. Johns and Ocklawaha rivers. In October 2008, the National Research Council agreed to provide technical review of the SJRWMD's assessment of potential cumulative impacts to the St. Johns River from proposed surface water withdrawals (**SJRWMD 2010a**).
Oct. 17, 2008	DEP finalized Lower St. Johns River Nutrients TMDL.
Oct. 27, 2008	The final Basin Management Action Plan (BMAP) for the Implementation of TMDLs for Nutrients was adopted by the DEP for the LSJRB Mainstem. The BMAP was developed by the Lower St. Johns River TMDL Executive Committee in cooperation with the DEP, SJRWMD, local industries, cities, counties, environmental groups, and many other stakeholders.
Jan. 16, 2009	EPA issued a formal determination under the CWA that numeric nutrient water quality criteria are necessary in Florida, and the DEP released plans to accelerate its efforts to adopt numeric nutrient criteria into State regulations.
May 19, 2009	DEP released FINAL Drafts of the LSJRB Group 2 Cycle 2 – Verified List and Delist List of Impaired Waters. These lists update the 2004 303(d) list of waters in need of water quality restoration. The lists are submitted to EPA Region 4 as an update to the Florida 303(d) list.
July 2009	DEP adopts by rule fecal coliform TMDLs for 22 tributaries to the Lower St. Johns River.
November 2009	DEP adopts by rule several TMDLS: eight for fecal coliform, two for nutrients, five for dissolved oxygen and nutrient, one for dissolved oxygen, and two for lead.
Jan. 15, 2010	EPA provided amendments to DEP's FINAL Drafts of the Lower St. Johns River Basin Group 2 Cycle 2 – Verified List and Delist List of Impaired Waters. These lists update the 2004 303(d) master list of impaired waters. The lists are submitted to EPA Region 4 as an update to the Florida 303(d) list.
May-December 2010	A major bloom of *Aphanizomenon* and a major fish kill with unusual characteristics occurred in early summer and these events were followed in mid-summer by an additional bloom of *Microcystis* and other cyanobacteria species and a second more typical fish kill. Massive drifts of an unusual, persistent foam occurred from mid-summer through the fall. Unusually high dolphin mortalities occurred May-September. National Oceanic and Atmospheric Administration (NOAA) designated LSJR dolphin mortalities during the summer of 2010 an Unusual Marine Mammal Mortality Event initiating a multi-agency task force to investigate the causes.
July 2010	DEP adopts by rule five fecal coliform TMDLs for tributaries to the Lower St. Johns River.
Aug. 2010	The Lower St. Johns River Tributaries Basin Management Action Plan (BMAP), which addresses fecal coliform TMDLs for fifteen tributaries, was adopted. These fifteen tributaries include Craig Creek, McCoy Creek, Williamson Creek, Fishing Creek, Deep Bottom Creek, Moncrief Creek, Blockhouse Creek, Hopkins Creek, Cormorant Branch, Wills Branch, Sherman Creek, Greenfield Creek, Pottsburg Creek, Upper Trout River, and Lower Trout River. This plan was developed collaboratively by the City of Jacksonville, JEA, Duval County Health Department, Florida Department of Transportation, Tributary Assessment Team, the Basin Working Group Stakeholders, and the Florida Department of Environmental Protection (Tributary BMAP II - **DEP 2010a**).

Nov. 14, 2010	EPA Administrator Lisa P. Jackson signed final "Water Quality Standards for the State of Florida's Lakes and Flowing Waters" (inland waters rule). The final standards set numeric limits, or criteria, on the amount of nutrient pollution allowed in Florida's lakes, rivers, streams and springs. On April 11, 2011, DEP requested EPA to withdraw its January 2009 determination that numeric nutrient criteria are necessary in Florida; to repeal November 2010 rulemaking establishing numeric criteria for inland streams, lakes, and springs; and to refrain from establishing any future numeric criteria. On June 13, EPA sent an initial response to DEP's petition. In their response, EPA was prepared to withdraw the federal inland standards if DEP adopted, and EPA approved, their own protective and scientifically sound numeric standards. On March 5, 2012, EPA promulgated an extension of the effective date of the "Water Quality Standards for the State of Florida's Lakes and Flowing Waters" (inland waters rule) by four months to July 6, 2012. (The extension does not affect or change the February 4, 2011 date for the SSAC provision.) This extension afforded the State additional time to finalize their own rule establishing numeric nutrient criteria for the State and submit it for EPA review. On November 30, 2012, EPA approved DEP's standards for numeric nutrient criteria in Florida's flowing waters, springs, lakes, and South Florida estuaries, and in June 2013, EPA approved DEP's criteria for estuaries, and coastal waters (**EPA 2013a**). In October 2014, EPA rescinded federally adopted criteria and DEP criteria were in effect. While this rule did not include criteria for the Lower St. Johns River Basin, it began a process for numeric criteria later applied to estuary-specific numeric nutrient criteria that do include the LSJR.
Feb. – Apr. 2011	DEP released final TMDLS for Arlington River for nutrients; Mill Creek for dissolved oxygen and nutrients; and lead in Black Creek and Peters Creek.
May 10, 2011	SJRWMD issued to JEA a single consumptive use permit that consolidated 27 individual permits and allows groundwater withdrawals of up to 142 million gallons per day in 2012 and up to 155 million gallons per day in 2031 if key conditions are met.
July 2013	DEP begins an initiative to revise bacteria criteria for Florida's beaches and recreational waters. (**DEP 2014e**).
September 2013	EPA approved DEP's revised criteria for dissolved oxygen, which takes into account stream conditions and percent oxygen saturation (**DEP 2013k).**
October 2013	DEP released a final Florida Mercury TMDL (**DEP 2013e**).
November 2014	The Florida Environmental Regulation Commission (ERC) approved numeric nutrient criteria specific for several estuaries, including the Lower St. Johns River.
December 2014	RockTenn and Rayonier, two companies with facilities in the region, filed a legal challenge to the ERC's approval of the estuary-specific numeric nutrient criteria (**News4JAX 2014**).
January 2015	"St. Johns River Economic Study," edited by Dr. Courtney T. Hackney, is released to public. (**Hackney 2015**)
January 2016	Florida Governor Rick Scott signs into law the Environmental Resources Bill, which defines flow levels for springs, creates a management plan for some South Florida watersheds, and sets guidelines for the Central Florida Water Initiative, an effort to secure water supply for Central Florida (**CBSMiami 2016**).
July 2016	Florida Environmental Regulation Commission approves changes to Florida water quality criteria.
October 2016	Legal challenges to new water quality standards are set aside by Florida administrative law judge.
January 2017	DEP releases a draft TMDL for nutrient in Crescent Lake that includes site-specific numeric interpretations of the narrative nutrient criterion.

1.5. Modern Environmental Management (1980s to 2000s)

The deluge of new environmental legislation in the 1970s caused a backlash during the 1980s from a property rights perspective (**Davis and Arsenault 2005**). At the same time, readily observable symptoms of environmental degradation continued to surface. The St. Johns River began having periodic blooms of blue-green algae, lesions in fish, and fish kills (**DEP 2002**). Each of these conditions was a visible expression of degraded water quality in the river and represented changes that were not acceptable to the public and policymakers.

Since the 1990s, water quality improvements have been achieved in Florida through the seesawing efforts of policymakers and public and private stakeholders (Table 1.1). The policymakers push on the legislative side (via governmental regulatory agencies), while public/private interests push on the judicial side (via lawsuits in the courts). The last four decades have been marked by this oscillation between lawsuits and laws. The result has been incremental and adaptive water quality management.

An important element of protecting the St. Johns River is the possession of a good understanding of the economic impact the river has on the region. To that end, the Florida Legislature in 2013 funded a report on the river's economic value to the state of Florida (**Hackney 2015**). This report describes the economic impact of the St. Johns River in terms of a conceptual model relating natural functions with natural values, an assessment of wetland importance for flood prevention and nutrient removal, the effect on real estate values along or near the river, the importance of surface water in both water-use and water quality dimensions, and the impact of recreation and ecotourism.

In January 2016, the Environmental Resources bill was signed into law. This law addresses flow levels in springs, management plans for certain watersheds in South Florida, including Lake Okeechobee and the St. Lucie and

Caloosahatchee Rivers, and guidelines for the Central Florida Water Initiative, a multi-agency effort to secure water resources for Central Florida. Business and industry groups, along with environmental groups like Audubon Florida and the Nature Conservancy, have supported its effort to advance protection of water resources. Other groups, such as the St. Johns Riverkeeper and the Florida Springs Council, have opposed the bill, citing weakened protections for land around springs and a lack of emphasis on water conservation (**Staletovich 2016**) and interbasin water transfer authority for each water management district that exceeds its jurisdictional boundaries. Another concern is the provision that when any water management district declines a consumptive-water-use permit due to impact on river or spring flow levels, that district must submit its water supply plan to DEP for additional review and revision, thus effectively weakening the water management districts' authority over permitting (**Curry 2016**).

DEP has developed new criteria for bacteria at beaches and other recreational waters. Instead of counting the large class of fecal coliform bacteria, the new criteria will specify counts of *Escherichia coli* for freshwater and enterococci for marine waters. These species have been shown to be better predictors of bacterial contamination with human health implications. This process was initiated in July 2013 and is complete.

New changes to water quality standards were announced by the DEP in July 2016 (**DEP 2017b**). These changes establish new water quality criteria for 39 chemicals that previously had no limits in Florida, such as beryllium, a metal used in copper alloys and the cause of chronic beryllium disease (**OSHA 2017**). The new rule also updates water quality criteria for 43 other chemicals, for which standards have existed but have not changed since 1992 (**DEP 2016d**). Some of these changes lower allowable concentrations of chemicals, such as trichloroethylene, a chlorinated solvent used in degreasing applications (**Klas 2016**). Other changes increase allowable concentrations of chemicals, including several discharged by the hydraulic fracturing ("fracking") and pulp and paper industries (**Klas 2016**). FDEP conducted several public workshops on the proposed rule, and its scientific methods for determining human health criteria and risk factors were developed and reviewed by a group of scientists from universities within and outside Florida, as well as state and federal environmental agencies (**DEP 2016l**).

The rule was approved in July 2016 by a 3-2 vote of the Environmental Regulation Commission (**Turner 2016**) The Environmental Regulation Commission, a seven-member board selected by the Florida Governor, had two vacant seats at the time of the vote: the seat representing the environmental community, and the seat representing local governments (**Klas 2016**). U.S. Senator Bill Nelson and several U.S. Congressmembers expressed concern in a letter to EPA Director Gina McCarthy (**Turner 2016**). Several entities formally requested a stay on the proposed rule, including the city of Miami, Martin County, the Seminole Tribe, and the Florida Pulp and Paper Association Environmental Affairs Inc. (**Saunders 2016**). The requests for a stay on the rule were rejected by Florida Administrative Law Judge Bram Kanter in October 2016 (**Saunders 2016**). At this time of this writing, appeals of this dismissal are ongoing within the Florida First and Third District Courts of Appeal. The rule must eventually gain approval by the USEPA.

1.5.1. Implementation of the Total Maximum Daily Load (TMDL) provisions of the Clean Water Act (CWA)

For years one aspect of the CWA was overlooked until an influential court decision in 1999. Several Florida environmental groups won a significant lawsuit against the EPA, pushing the agency to enforce the Total Maximum Daily Load (TMDL) provisions in the Federal CWA. For many waterbodies, including the LSJR, the development and implementation of a TMDL is required by the CWA as a means to reverse water quality degradation. In the TMDL approach, state agencies must determine for each impaired water body: 1) the sources of the pollutants that could contribute to the impairment 2) the capacity of the water body to assimilate the pollutant without degradation and 3) how much pollutant from all possible sources, including future sources, can be allowed while attaining and maintaining compliance with water quality standards. From this information, agency scientists determine how much of a pollutant may be discharged by individual sources, and calculate how much of a load reduction is required by that source (Pollutant Load Reduction Goal or "PLRG"). Once the required load reductions are determined, then a Basin Management Action Plan ("BMAP") must be developed to implement those reductions. Monitoring programs must also be designed to evaluate the effectiveness of load reduction on water quality.

Since 1999, the EPA, DEP, SJRWMD, and numerous public and private stakeholders have been working through this TMDL/BMAP process to reduce pollution into the LSJR and its tributaries. Several TMDLs have been adopted in the LSJRB, including those for nutrients in the mainstem and fecal coliforms in the tributaries. In most cases, adoption of TMDLs is followed by development of a BMAP. According to DEP, "the strategies developed in each BMAP are implemented into National Pollutant Discharge Elimination System (NPDES) permits for wastewater facilities and municipal separate storm sewer system (MS4) permits" (**DEP 2008b**). A mainstem nutrient BMAP was completed in October 2008. In December 2009, the DEP released the BMAP for fecal coliform in the Lower St. Johns River Tributaries (**DEP 2009b**). This BMAP addressed ten tributaries for which TMDLs had been adopted in 2006 and 2009: Newcastle Creek, Hogan Creek, Butcher Pen Creek, Miller Creek, Miramar Creek, Big Fishweir Creek, Deer Creek, Terrapin Creek, Goodbys Creek, and Open Creek (**DEP 2009b**). In August 2010, DEP released the second BMAP to address fecal coliform in fifteen LSJR tributaries (Tributary BMAP II; **DEP 2010a**). Progress reports on all these BMAPs were published by DEP in 2014. As well, a new comprehensive statewide updated list of verified impaired waterbodies was released by DEP in 2014 (**DEP 2014g**).

Table 1.2 shows the number of 303(d) impairments in 2004, 2009, and 2014, along with delisted impairments in 2009 and 2014. The 2014 impairments are primarily due to a new mercury TMDL, dissolved oxygen, fecal coliform, and nutrients (**DEP 2015a**). Figure 1.6 illustrates the breakdown of the 2014 impairments. Table 1.2 also shows the number of 303(d) impairments that were delisted in 2009 and 2014. These delistings occurred for a variety of reasons, such as satisfying water quality criteria, or confirmation that natural conditions, not anthropogenic loading, caused the observed impairment.

Current and future efforts to improve the health of the LSJR (and other waterbodies in Florida) will continue to focus on implementation of the TMDL provisions of the CWA. As this process presses forward, Florida's public and policymakers may continue to find themselves on the litigation-legislation seesaw, as both groups attempt to balance environmental concerns with an exploding population's desire to dwell and prosper in the Sunshine State.

Table 1.2 Summary of the verified 303(d) 2004, 2009, and 2014 lists of LSJR impaired waterbodies or segments of waterbodies requiring TMDLs.

YEAR	# IMPAIRMENTS	# WATERBODIES WITH IMPAIRMENT	IMPAIRMENTS DELISTE	COMMENTS
2004	153	87		
2009	123	97	67	
2014	239	151	167	Statewide mercury TMDL finalized in 2013, adding many WBIDs to impairment list.

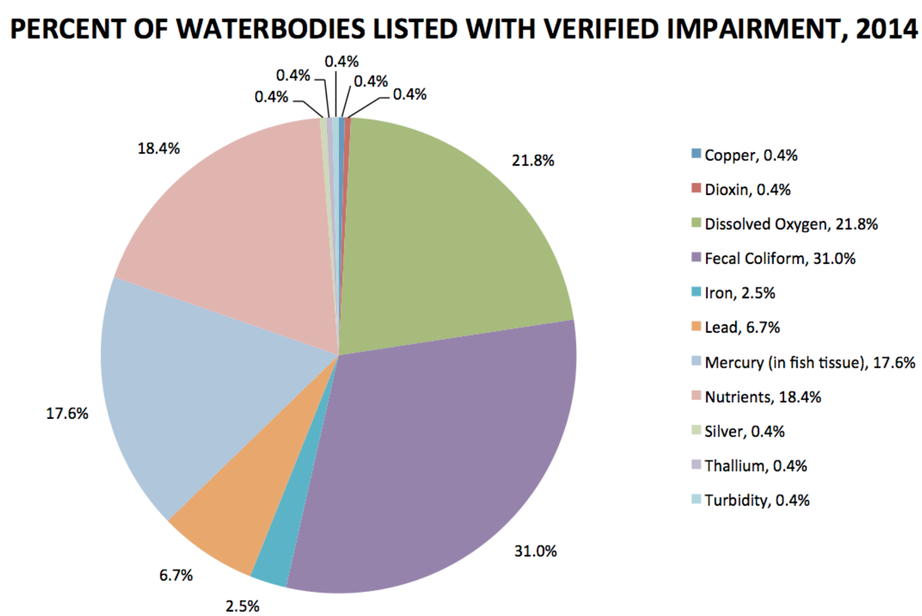

Figure 1.6 Percent of waterbodies or segments of waterbodies listed with various impairments in the Lower St. Johns River Basin in the 2014 verified list (as of April 7, 2015).

1.5.2. Water Quality Credit Trading

In 2008, the Florida Legislature passed revisions to the Florida Watershed Restoration Act that established the framework for a system of water quality credit trading in the Lower St. Johns River Basin (**DEP 2010g**). This system allows individual dischargers of a pollutant, such as a local utility or a municipality, to trade credits for nutrients, which consist of total nitrogen and phosphorus. Each individual discharger has a goal for reduction of nutrients. Because some dischargers are able to control nutrients with a very different cost outlay than others, some dischargers meet and even exceed their goals, while others do not meet the goals. Thus, those that exceed their goals possess "credits" that they can sell to those who do not meet their goals.

Prior to 2014, JEA exceeded its nutrient reduction goal and accumulated credits; however, the City of Jacksonville (COJ) did not meet its goal. On March 22, 2016, COJ and JEA executed an interagency agreement by which JEA conveys its credits to COJ at no charge to COJ (**Kitchen 2016**; **Cordova 2016**). This is accompanied by an agreement between JEA and COJ to contribute $15 million each to a plan to replace septic tanks with sewer lines in existing neighborhoods.

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