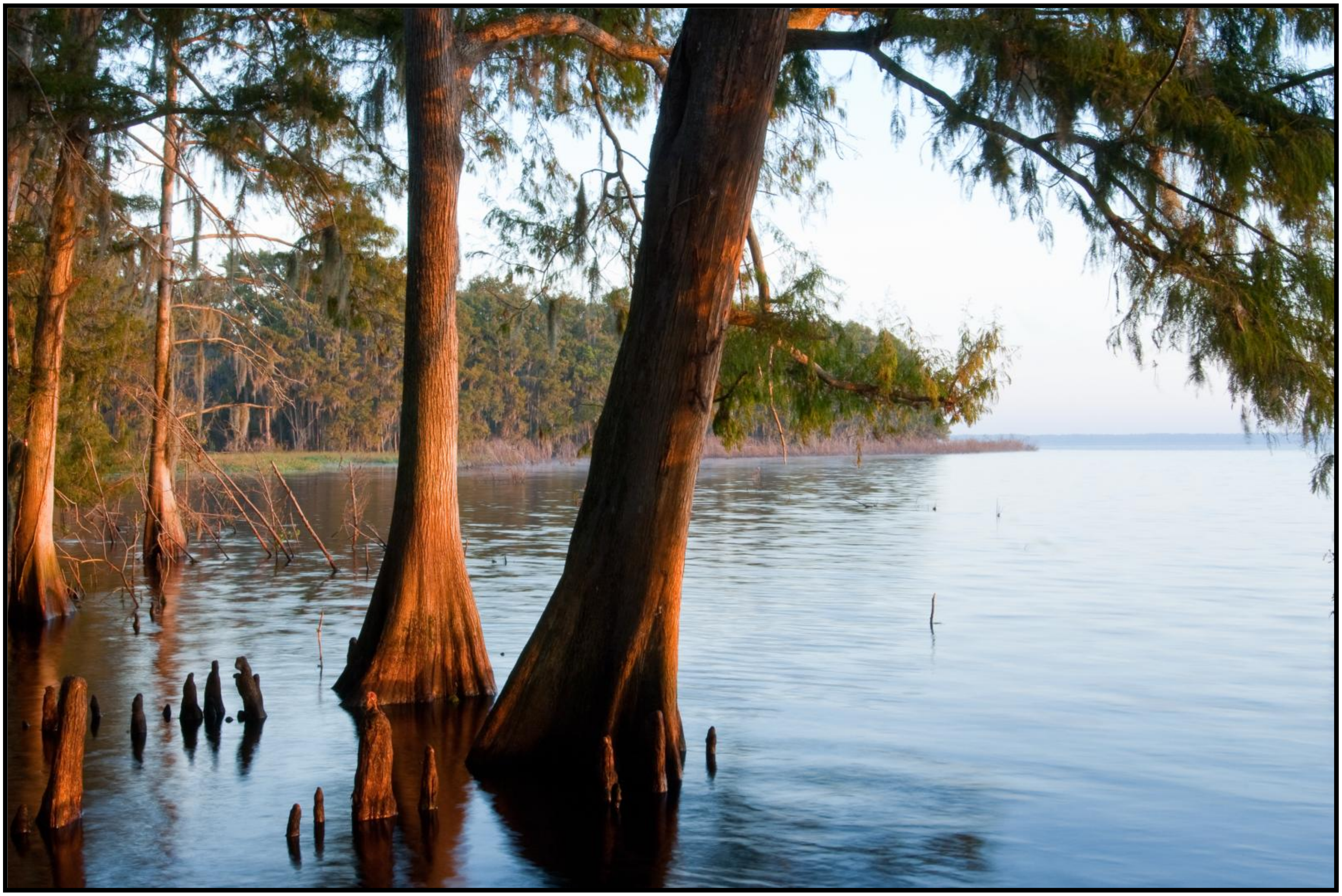
Orange Creek Basin Surface Water Improvement And Management Plan



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EXECUTIVE SUMMARY

The purpose of the Orange Creek Basin Surface Water Improvement and Management Plan is to implement provisions of the Surface Water Improvement and Management (SWIM) Act to develop and implement plans and programs for improvement and management of surface waters with degraded water quality, in coordination with state agencies, local governments, and others. This updates the 1996 Orange Creek Basin Surface Water Management Plan. The St. Johns River Water Management District (District) began work in the Orange Creek Basin (OCB) in 1991, and in 2003 the District's Governing Board approved the OCB as a priority basin under the SWIM Act.

The large lakes in the OCB - Newnans, Lochloosa, and Orange - cover 25,461 acres. Lochloosa Lake, Orange Lake, and Paynes Prairie are designated as Outstanding Florida Waters. Water quality in Newnans, Lochloosa, and Orange lakes has deteriorated below state standards due to excess nutrients. Newnans Lake is now one of the most degraded large lakes in Florida. Large-scale herbicide treatment of invasive aquatic plants may have contributed to degraded water quality in Orange and Lochloosa lakes.

Needed to restore water quality in Newnans, Lochloosa, and Orange lakes and Paynes Prairie are improved intergovernmental cooperation and funding for projects to reduce nutrient loading to Newnans Lake; to identify sources of nutrients to Lochloosa and Orange lakes; to implement revised aquatic plant management strategies for Newnans, Lochloosa, and Orange lakes; and to restore hydrology and wetlands in Paynes Prairie.

The Orange Creek Basin covers 425 square miles, mostly in Alachua County, which had a 34% population increase in recent decades. Dominant land uses in the OCB in 2004 were forest, forest regeneration, water, and wetlands, a 5% decrease from 1989.

Surface water management issues addressed in the OCB SWIM Plan are:

- hydrology (altered hydrologic regimes, extreme low lake levels, water supply),
- aquatic species management (control of invasive exotics, management of floating vegetation),
- water quality (lake trophic state conditions and trends, sources of pollution),
- lake sediments (organic sediment accumulation in lakes),
- fish and wetland-dependent wildlife habitats and communities (wildlife management and enhancement of fish and wetland-dependent wildlife habitats),
- future protection of the Orange Creek Basin (land conservation and restoration),
- public outreach (public participation opportunities and interagency coordination), and
- OCB program management (full-time employee and contract staff support).

Hydrology

Surface water in the OCB flows south into Orange Creek and into sinkholes in Paynes Prairie and Orange Lake. There are two water-control structures in the OCB: culverts that flow from Prairie Creek into Paynes Prairie and a weir at the outlet from Orange Lake. Earthen berms and canals have been removed in Orange Creek Restoration Area, are being removed in Paynes Prairie, and remain around parts of Orange Lake. The District monitors hydrology at 35 OCB stations. There was no trend in annual rainfall from 1903-2010 for Gainesville (49.6 inches) or Ocala (49.9 inches). Lake level in Newnans, Lochloosa, and Orange lakes fluctuates significantly due to rainfall and drought, reaching extreme levels several times since the 1930s.

The Orange Creek Basin Advisory Council, which met from 1993-2001, addressed low water levels in Orange Lake. A resulting report described previous efforts to plug sinkholes in Orange Lake. Based on analysis of sinkhole intervention alternatives, the Council voted that water level stabilization would be harmful to Orange Lake. The District subsequently denied a permit to Marion County to plug a sinkhole in Orange Lake because water level stabilization would harm lakeshore wetlands. The Florida Land and Water Adjudicatory Commission upheld the District's permit denial.

There are no Minimum Flows and Levels rules adopted for Newnans, Orange or Lochloosa lakes. In 1994 the District's Governing Board adopted a Reservation of Water rule that reserves water flowing from Prairie Creek into Paynes Prairie. District analyses to determine impacts of projected demand for public water supply through 2030 predicts declines in the surficial aquifer of up to 2.5 ft in parts of the Newnans, Lochloosa, and Orange lake basins.

Aquatic Species Management

The Florida Fish and Wildlife Conservation Commission (FWC) controls aquatic plants in OCB water bodies. In Newnans, Lochloosa, and Orange lakes, FWC manages water lettuce and water hyacinth at the lowest feasible level. FWC manages hydrilla on a lake-by-lake basis, guided by their new statewide position on hydrilla management. In Lochloosa and Orange lakes, hydrilla is now resistant to Fluridone herbicide. Due to concerns that large-scale herbicide treatment of aquatic plants can contribute to long-term degradation of water quality, the District recommends that hydrilla be managed at the lowest feasible level in Newnans and Lochloosa lakes, that hydrilla management in Orange Lake be guided by FWC's statewide position, and that dispersal of hydrilla from Orange Lake to other water bodies be minimized.

Non-native Island Apple Snails were discovered in Newnans Lake in 2007. Efforts to eradicate the snail were not successful.

Floating vegetation provides habitat for a high diversity of fish and wildlife, notably reptiles and amphibians. Floating vegetation existed in Orange Lake 1,300 years ago, was a common feature in the 1800s, and fluctuates with lake level and other factors. Orange Lake vegetation has not increased in area since the 1930s. Low oxygen can occur beneath floating vegetation. FWC recommends managing floating vegetation by normal water level fluctuations, spot treatment of woody vegetation, burning, and limiting size and maximizing edge to improve wildlife utilization.

FWC and the Florida Department of Environmental Protection (FDEP) removed 5,272 acres of the floating and rooted emergent vegetation in Orange Lake from 2003-2005 to restore deep marsh displaced by floating vegetation. There was a significant increasing trend in total phosphorus (TP) in Orange Lake from 1994-2010. Due to concerns about long-term degradation of water quality in an Outstanding Florida Water due to large-scale vegetation removal, the

District determined that mechanical shredding of lake vegetation with in-lake disposal requires prior District permit review to consider potential water quality impacts.

Water Quality

The District collects water quality and plankton samples monthly in Newnans, Lochloosa, and Orange lakes and their major tributaries. Alachua County monitors water quality, including coliform bacteria, in some Gainesville creeks and small lakes. From 1994-2010 Newnans, Lochloosa, and Orange lakes showed elevated concentrations of chlorophyll, TP, and total nitrogen (TN). Median Trophic State Index (TSI) from 1994-2010 was 85 in Newnans Lake, 70 in Lochloosa Lake, and 67 in Orange Lake. Through 2003, dominant phytoplankton in Newnans, Lochloosa, and Orange lakes were cyanobacteria, dominated by *Cylindrospermopsis raciborskii.*

Lochloosa and Orange Lakes are Outstanding Florida Waters in which no degradation of water quality is permitted. From 1994-2010 there were significantly increasing trends in TP in Newnans, Lochloosa, and Orange lakes, independent of lake level and time. From 1994-2010 Newnans Lake had a decreasing TSI trend, there was no significant TSI trend in Lochloosa Lake, and Orange Lake had an increasing TSI trend. When lake level was included in TSI analyses, none of the lakes showed a significant TSI trend. Trend analyses are complicated by seasonality and atypical hydrology that leads to strong relationships between water quality and lake level.

Water quality in Newnans, Lochloosa, and Orange lakes is influenced by TP, lake level, water color, and abundance of submerged plants. Newnans Lake has the highest TP and TSI of the OCB lakes. In Orange and Lochloosa lakes, hydrilla abundance can result in decreased phytoplankton.

Newnans Lake sediment cores showed that nutrient and carbon accumulation increased since about 1900. Deeper sediments indicate a decrease in macrophyte and increase in phytoplankton production over time. Lochloosa Lake sediment cores indicated that cyanobacteria have been in the lake during last 100-plus years, peaking in the 1980s. Orange Lake sediment cores showed that nutrient and carbon accumulation increased through time, with phosphorus sediments increasing since about 1990. Before 1900, deeper sediments in Orange Lake contained abundant plant fragments while recent lake sediments appeared composed of fine organic matter.

The District developed a Hydrological Simulation Program–Fortran (HSPF) model to create water and nutrient budgets for Newnans, Lochloosa, and Orange lakes and to develop and refine Pollutant Load Reduction Goals (PLRGs) for the lakes. There may be a significant groundwater contribution to Lochloosa, while there is little evidence for groundwater contribution to Newnans Lake.

The Hawthorn Group, a phosphorus-rich geologic layer, is near or at the land surface in portions of the OCB, contributing to the naturally elevated historic trophic state of Newnans Lake. Human activities such as ditched and dredged segments of Little Hatchet and Hatchet Creeks have increased loading of Hawthorn-derived phosphorus into Newnans Lake.

In 2003 FDEP adopted a list, updated in 2009, of OCB water bodies that do not meet state water quality standards. FDEP developed Total Maximum Daily Loads (TMDLs) of pollutants for

Newnans and Orange Lakes. The U.S. Environmental Protection Agency adopted TMDLs for Lochloosa Lake. The District's PLRG and FDEP's TMDL agreed on the target TSI for Newnans Lake. FDEP agreed to accept the external phosphorus load estimated for Newnans Lake by the District's PLRG analysis.

The FDEP Orange Creek Basin Working Group completed the Orange Creek Basin Management Action Plan in 2008, which addresses reductions in external pollutant loads needed to restore water quality to state standards in surface water bodies listed as impaired and for which FDEP had developed a Total Maximum Daily Load. District projects in the plan are land acquisition; development of PLRGs for Newnans, Lochloosa and Orange lakes; and a commitment to monitoring of water quality.

A portion of the stormwater (non-point source pollution) in the Gainesville MS4 urban area drains to Newnans Lake. The Gainesville Clean Water Partnership consists of MS4 permit holders in the OCB (Alachua County, City of Gainesville, Florida Department of Transportation) and addresses NPDES requirements in the Gainesville urban area. There are currently 36 permitted wastewater treatment facilities in the OCB, 12 with NPDES permits. The Newnans Lake basin contains 786 inspected on-site septic systems, while there are 261 septic systems in the Lochloosa Lake basin and 1,263 in the Orange Lake basin.

The District is revising the OCB HSPF model to estimate loading of nutrients to Newnans, Lochloosa, and Orange lakes from various land uses in each lake basin and from each lake's sub-basins. Studies showed that phosphorus loading to Newnans Lake is mostly derived from the phosphorus-rich Hawthorn Group in surficial groundwater flowing into tributaries, particularly Little Hatchet Creek around Gainesville Regional Airport. A blueberry farm contributes phosphorus to Newnans Lake, likely from cow manure from a former dairy at the site. Groundwater seepage appears to be a negligible source of water or phosphorus to Newnans Lake. There was no significant correlation between wind speed and water quality in Newnans Lake. The City of Gainesville is beginning a Little Hatchet Creek and Lake Forest Creek Watershed Management Plan to reduce pollutant loading to Newnans Lake.

In 2010 the District completed the first of a three-year experimental harvest of gizzard shad from Newnans Lake, removing 205,188 pounds. Shad harvesting should accelerate the lake's response to future efforts to reduce external phosphorus loading.

To improve water quality in Paynes Prairie, the District provided $1,065,500 to the City of Gainesville for the Depot Avenue Stormwater Park and $1,343,653 for the Paynes Prairie Sheetflow Restoration Project, which includes purchase of land in the Paynes Prairie basin.

Alachua County completed a Stormwater Master Plan for unincorporated areas of the county, focused primarily on water quantity, with a secondary focus on water quality. A county-wide Hydrologic and Hydraulic Model can be refined for design of water quality improvement projects. The Stormwater Master Plan identified 19 stormwater basins and 12 roads where water quality improvements are required, and recommended a public education program dedicated to stormwater management.

The Marion County Watershed Management Program identified structural and non-structural projects to address water quality issues, and incorporated these projects into a five-year Stormwater Implementation Program. Marion County adopted fertilizer, irrigation, and springs protection ordinances.

Lake Sediments

Bathymetry and LIDAR data provided surface area and volume data for Newnans, Lochloosa, and Orange lakes.

In Newnans Lake soft sediments cover the lake bottom at an average thickness of 8.2 ft and maximum thickness of over 16 ft. Sediments in Newnans Lake are high in organic matter, which accumulated at 0.56 cm/year over the past century. Phosphorus retention in Newnans Lake sediments is low likely due the lake's shallow depth, low calcium and high dissolved organic carbon, and disturbance by feeding of gizzard shad. The base of a former weir in Prairie Creek was removed in 1999, facilitating downstream sediment transport.

During the 2001 drought, 87 ancient canoes were discovered buried in Newnans Lake sediments. The Newnans Lake canoe site is listed on the National Register of Historic Places, requiring that proposals to dredge sediments from Newnans Lake undergo state and federal review.

During extreme droughts over the past several thousand years, burning of sediments deepened Orange Lake. Since the 1920s Orange Lake has received and retained more surface water, providing fewer opportunities for lake-bottom burns, which are difficult to permit. During the 2001 drought, sediment compacted and oxidized in Orange Lake, lowering the lake bottom by 16 inches in places. During the 2001-2002 drought, FWC scraped 175 acres of organic sediment and vegetation in Orange Lake and created 7 wildlife islands.

Lochloosa Lake sediment accumulation rates since early in the 20^{th} century were 0.48 cm/yr, 0.60 cm/yr, and 0.83 cm/yr.

A review of dredging as a restoration tool for lake water quality improvement concluded that dredging is an additional tool and not a primary method of water quality restoration. The District's focus for water quality restoration in Newnans, Lochloosa, and Orange lakes is on reducing external loading of nutrients from the lake basins and increasing ability of lake sediments to store phosphorus. The District could consider removal of lake sediments if significant external load reductions did not result in reduced in-lake concentrations.

Fish and Wetland-Dependent Wildlife Habitats and Communities

FWC manages fish and wildlife in Newnans, Lochloosa, and Orange lakes through regulating and permitting fishing, hunting, and collection of alligator eggs and hatchlings. FWC is also managing habitats in the OCB lakes by mapping littoral zone vegetation, and drafting fish and wildlife habitat management guidelines for wading birds, waterfowl, bald eagles, centrarchid fish, reptiles, amphibians, and round-tailed muskrats.

Primary sport fisheries in Newnans, Lochloosa, and Orange lakes since 1996 are sunfish or bream, black crappie, and largemouth bass. In 2009, Newnans Lake ranked in the bottom third for angler success for these sport fish, while Lochloosa ranked in the middle third statewide for sunfish and black crappie, and in the top third for largemouth bass. Orange Lake ranked in the middle third for black crappie and in the top third for sunfish and largemouth bass. Since 1996 an average of 0.35 fish were caught per hour of fishing in Newnans Lake, 0.62 fish were caught per hour of fishing in Lochloosa Lake, and 1.23 fish were caught per hour of fishing in Orange Lake. Since 1996, FWC augmented stock of sport fish in Newnans and Lochloosa lakes and did not stock fish in Orange Lake.

Eight percent of alligators harvested in Florida from 2000-2009 were from Newnans, Lochloosa, and Orange lakes, mostly by airboat. In 2009, a record high of 438 alligators were harvested from Orange Lake. Approximately 3,000 alligator eggs per year have been collected from OCB wetlands since 2004.

The most common waterfowl in the OCB lakes are green-winged teal, blue-winged teal, American widgeon, ring-necked ducks, ruddy ducks, and lesser scaup. Bird Island, a bird sanctuary owned by Alachua Audubon Society, and Redbird Island in Orange Lake have historically supported important rookeries for wading birds. Alachua Audubon Society and FWC are working together to enhance rookery habitat on Bird Island and other parts of Orange Lake. FWC limits mechanical vegetation management and herbicide application close to wading bird rookery sites in Orange Lake.

Habitats surrounding Newnans, Lochloosa and Orange lakes are a core nesting area for Florida bald eagles that has been stable for years, indicating high-quality breeding and foraging habitats. Healthy fish and waterfowl populations are integral to foraging by bald eagles. Bald eagle nests in the OCB are monitored by FWC.

Several mammal species in the Orange Lake basin are affected by lake management. The round-tailed muskrat as a focal species because of sensitivity to extreme water level fluctuations and habitat changes.

FWC spent $1,239,883 since 1996 on habitat restoration projects in Newnans, Lochloosa, and Orange lakes. In 2002-03, FDEP and FWC applied herbicide to 400 acres of coastal plain willow in Orange Lake to restore deep marsh habitat.

Review for an Environmental Resource Permit (ERP) is required for certain proposed activities on lakes including mechanical shredding and in-lake disposal of aquatic vegetation. ERP exemptions exist, under certain circumstances and with limitations, for removal of aquatic plants, removal of tussocks, and associated replanting and removal of organic material. FWC can permit removal of aquatic vegetation along shorelines for lake access.

Alachua County has the authority to enforce state water quality standards via local code. Alachua County regulates alteration of surface waters, wetlands, and upland buffers through land development regulations, and regulates fill materials that may leach phosphorus and excavations that would lead to exposure of phosphorus-rich sediments that might adversely impact groundwater and/or surface water. The Alachua County and City of Gainesville fertilizer codes promote efficient and proper use of fertilizer to protect groundwater and surface water. The Alachua County landscape irrigation code enforces water conservation.

Future Protection of the Orange Creek Basin

Partly to improve water quality and restore and maintain natural hydrological regimes, the District and partners acquired 49,823 acres of conservation land in the OCB since 1989. the District provided $32,603,566, 63% of total purchase price. Land transactions were a combination of full fee, joint fee, and easements for conservation or flowage. The District's 2011 acquisition map includes about 7,180 acres of potential acquisitions in the Newnans Lake basin with an estimated purchase price of $17,950,000. Alachua County acquired 5,886 acres in the Orange Creek Basin since 2003, with $3,400,718 provided by the District. Alachua Conservation Trust, a non-profit land trust, and partners including the District acquired 5,700 acres in the OCB.

Conservation lands managed by the District in the OCB are Newnans Lake Conservation Area, Lochloosa Wildlife Conservation Area, Longleaf Flatwoods Reserve, and Orange Creek Restoration Area. Land management goals for District-managed properties include improving water quality and maintaining natural hydrological regimes. District abides by silvicultural Best Management Practices on lands that it manages. As OCB land management plans are updated, they will include opportunities to reduce loading of nutrients and other pollutants to downstream water bodies.

Public Outreach

At least 43 clubs, organizations, agencies, and local governments are stakeholders in the OCB. The Orange Creek Basin Advisory Council from 1993-2001 provided guidance on strategies for water body management, protection and restoration, and promoted public awareness and intergovernmental cooperation regarding OCB issues. The Council initiated and approved the 1996 Orange Creek Basin Surface Water Management Plan.

The District provides materials related to water conservation and other water resource education; public information and media outreach activities; and outreach activities relating to local, regional, state and federal governments and elected officials. The District initiated a volunteer program in partnership with Alachua County and the Gainesville Clean Water Partnership that over 11 years recruited 520 individuals and 173 groups who donated approximately 92,000 hours of outreach for water-related programs and events and waterway cleanups.

Alachua County staff produce and distribute brochures that address reducing nutrient pollutants in water, give presentations at homeowners associations, schools, and local events; and coordinate campaigns to increase pet waste removal and keeping grass out of street drains and stormwater systems.

The District convened in 2011 a new Orange Creek Basin Lake Management Interagency Working Group consisting of state agencies and local government to better coordinate planning of in-lake management activities in Newnans, Lochloosa and Orange lakes.

OCB Program Management and Support

The OCB program peaked from 1996- 2002 with 4 full-time scientists, and decreased since 2002. The OCB SWIM program in FY 10-11 had one full-time employee equivalent divided among three staff, with assistance from five on-site contingent workers. One part-time consultant provided program management services since 2006. For FY 11-12, no OCB contingent workers or consultants are budgeted and no FTEs are assigned to the OCB SWIM program.

Schedule and Funding Needs

To address issues described in the OCB SWIM Plan, a list of 56 potential projects for the next five years is provided, with an estimated total five-year cost of $7,580,000. This includes District-led projects as well as projects proposed by others. Implementation of projects depends on obtaining permits and funding.

INTRODUCTION

SURFACE WATER IMPROVEMENT AND MANAGEMENT (SWIM) ACT

The purpose of this Orange Creek Basin Surface Water Improvement and Management Plan is to implement provisions of the Surface Water Improvement and Management (SWIM) Act enacted by the Florida Legislature. The legislative findings and intent of the SWIM Act are as follows:

Surface Water Improvement and Management Act

373.451 Short title; legislative findings and intent.—

(1) Sections 373.451-373.4595 may be cited as the –Surface Water Improvement and Management Act."

(2) Legislative intent.—The Legislature finds that the water quality of many of the surface waters of the state has been degraded, or is in danger of becoming degraded, and that the natural systems associated with many surface waters have been altered so that these surface waters no longer perform the important functions that they once performed. These functions include:

- (a) Providing aesthetic and recreational pleasure for the people of the state;
- (b) Providing habitat for native plants, fish, and wildlife, including endangered and threatened species;
- (c) Providing safe drinking water to the growing population of the state; and
- (d) Attracting visitors and accruing other economic benefits.

(3) The Legislature finds that the declining quality of the state's surface waters has been detrimental to the public's right to enjoy these surface waters and that it is the duty of the state, through the state's agencies and subdivisions, to enhance the environmental and scenic value of surface waters.

(4) The Legislature finds that factors contributing to the decline in the ecological, aesthetic, recreational, and economic value of the state's surface waters include:

- (a) Point and nonpoint source pollution; and
- (b) Destruction of the natural systems which purify surface waters and provide habitats.

(5) The Legislature finds that many surface water problems can be and have been corrected and prevented through plans and programs for surface water improvement and management that are developed and implemented by the water management districts, the department, and local governments.

(6) It is therefore the intent of the Legislature that each water management district develop plans and programs for the improvement and management of surface waters within its boundaries.

(7) It is also the intent of the Legislature that the department, the water management districts, and others conduct research to provide a better scientific understanding of the causes and effects of surface water pollution and of the destruction of natural systems in order to improve and manage surface waters and associated natural systems.

Through the SWIM Act, the Legislature directed water management districts to develop and implement plans and programs for improvement and management of surface waters with degraded water quality, in coordination with state agencies, local governments, and others. Water management districts were also directed to conduct scientific research to provide a better understanding of causes and effects of surface water pollution and destruction of natural systems.

HISTORY OF THE ORANGE CREEK BASIN SWIM PROGRAM

The St. Johns River Water Management District (District or SJRWMD) began work in the Orange Creek Basin (OCB) in Alachua County in 1991 with an analysis of the diversion of water from Camps Canal to Paynes Prairie (Robison 1992). In 1996 the Orange Creek Basin Surface Water Management Plan (Lasi and Shuman 1996) was unanimously approved by the Governing Board of the St. Johns River Water Management District. In 2003 the Governing Board of the St. Johns River Water Management District approved the Orange Creek Basin as a priority under the SWIM Act. The Orange Creek Basin Surface Water Management Plan (Lasi and Shuman 1996) served as the initial SWIM Plan for the new Orange Creek Basin SWIM program.

PURPOSE OF THE ORANGE CREEK BASIN SWIM PLAN

This plan serves as the first official SWIM plan for the Orange Creek Basin, as well as an update to the Orange Creek Basin Surface Water Management Plan (Lasi and Shuman 1996), referred to hereafter as the 1996 Plan. The OCB SWIM Plan meets requirements of SWIM plans defined in the SWIM Act. The OCB SWIM Plan refers frequently to the 1996 Plan rather than repeating information in the earlier plan. The OCB SWIM Plan provides updates of key information provided in the 1996 Plan, reports on projects begun or completed since 1996, and recommends projects to be implemented in the next 5 years, through 2016.

For quick reference, the 1996 Plan can be downloaded as a pdf file from the SJRWMD website at floridaswater.com/orangecreek. Click on ―Surface Water Management Plan". The 1996 Plan can be ordered on CD from the District librarian at SHallowell@sjrwmd.com. Paper copies of the 1996 Plan are no longer available.

The OCB SWIM Plan addresses the U.S. Environmental Protection Agency's (EPA) elements of a comprehensive watershed (= basin) plan (Appendix B). Addressing the EPA elements, while not required, helps to make potential projects listed in the OCB SWIM plan eligible for federal Section 319 funding.

A VISION FOR THE ORANGE CREEK BASIN

In addition to the goals described in the 1996 Plan, the OCB SWIM Plan establishes that the Orange Creek Basin is a statewide priority for surface water restoration and protection. Newnans, Lochloosa, and Orange lakes combined cover 25,461 acres at median lake level. Lochloosa Lake, Little Lochloosa Lake, Orange Lake, Cross Creek, River Styx, and Paynes Prairie are designated as Outstanding Florida Waters. Paynes Prairie is a recognized National Natural Landmark. Newnans, Lochloosa, and Orange lakes have historically had clear tea-colored water and healthy aquatic habitats that support healthy populations of sportfish including largemouth bass, bluegill, and black crappie.

Since the SWIM Program was created in 1987, water quality in Newnans, Lochloosa, and Orange lakes has deteriorated below state standards due to excess nutrients and invasive non-native aquatic plants. Newnans Lake is one of the most degraded large lakes in Florida in terms of water quality, exceeding Lake Apopka, which has shown substantial water quality improvement since 1995. Hydrilla has occasionally covered large areas of Lochloosa and Orange lakes in recent years, degrading some aquatic habitats and impeding boat access. Large-scale herbicide treatment of hydrilla can contribute to degraded water quality in these lakes.

Water quality in Newnans, Lochloosa, and Orange lakes and Paynes Prairie can be restored. Diagnostic work by the District has identified sources of excess phosphorus to Newnans Lake and developed water budgets and nutrient budgets for Newnans Lake and water budgets for Lochloosa and Orange lakes. Needed are improved intergovernmental cooperation, as well as funding to design and implement projects to reduce phosphorus loading to Newnans Lake; to identify external sources of nutrients to Lochloosa and Orange lakes; to develop and implement a revised hydrilla management strategy for Newnans, Lochloosa, and Orange lakes; and to restore hydrology and wetlands in Paynes Prairie.

Within 5 years, measures of success will be a positive trend in water quality in Newnans, Lochloosa, and Orange lakes and Alachua Sink. These lakes will have reduced concentration of phosphorus and nitrogen; less turbid water; more diverse plankton communities with less cyanobacterial biomass, more green algae and more copepods; and greater abundance of submersed vegetation and sport fish.

OVERVIEW OF THE ORANGE CREEK BASIN

The Orange Creek Basin is located in the western portion of the Ocklawaha and St. Johns River basins (= watersheds) in Alachua, Marion and Putnam counties (Figure 1). The Orange Creek Basin covers 425 square miles and occupies approximately 44% of the land area in Alachua County (Figure 2). Marion County borders the south and west shorelines of Orange Lake and the south side of Orange Creek. Putnam County borders the north side of Orange Creek.

A detailed overview of the Orange Creek Basin and its surface water issues is provided in the Orange Creek Basin Surface Water Management Plan (Lasi and Shuman 1996). Rather than repeating information that has not substantially changed since 1996, refer to the 1996 Plan for the OCB overview. The 1996 Plan includes historic uses of water bodies in the Orange Creek Basin and conditions leading to the need for restoration and protection, required in SWIM plans by statute. Some information in the 1996 Plan required updates provided in this plan. The OCB SWIM Plan includes updates to several figures and tables in the 1996 Plan as well as new figures that were not in the 1996 Plan.

Since the St. Johns River Water Management District is tasked with regional water management, the OCB SWIM Plan focuses on the water bodies of greatest regional significance, which are the three largest lakes in the basin: Newnans, Lochloosa, and Orange lakes. Paynes Prairie is also addressed because it receives flow from Prairie Creek and discharges directly to the Floridan aquifer through Alachua Sink, a small sinkhole lake. Boundaries for the Orange Creek Basin (Figure 2) and for the sub-basins of Newnans, Lochloosa, and Orange lakes (Figures 3, 4, 5) are based on those used in the District's hydrologic model described later in this plan. Total area of the sub-basins for Newnans, Lochloosa, and Orange lakes is 222,142 acres (Table 1).

Table 1. Area of lake sub-basins within the Orange Creek Basin.

Sub-Basin	Area (acres)
Newnans Lake	73,472
Lochloosa Lake	56,267
Orange Lake	92,403

POPULATION TRENDS

Population increased in Alachua and Marion counties between 1990 and 2009 based on U.S. Census Bureau data (Figure 6). During that period, population increased 34% in Alachua County and 68% in Marion County. Population trends in Putnam County were not analyzed since it contributes flow only to Orange Creek, downstream of the 3 large lakes.

LAND USE TRENDS

Land use classifications for the OCB SWIM Plan are based on natural-color and color-infrared aerial photographs taken from December 2003 to March 2004. Land use was determined by extracting data from the District's Land Use and Land Cover (2004) layer of the Geographic Information System (GIS). Basins for Newnans and Orange lakes extend beyond the 2003-2004 aerial photographs. Since land use could not be delineated in those unphotographed areas, total acreage by land use for Newnans and Orange lakes (Table 2) is less than total acreage of these lake sub-basins shown in Table 1.

Dominant land uses in the Orange Creek Basin in 2003-2004 were forest, forest regeneration, water and wetlands, which characterized 62% of the land use (Figures 7, 8; Table 2). Forest, forest regeneration, water and wetlands were the dominant lands uses around Newnans, Lochloosa, and Orange lakes, and characterized 78% of the land use in the Newnans Lake basin, 73% in the Lochloosa Lake basin, and 43% in the Orange Lake basin (Figures 9, 10, 11; Table 2).

Table 2. Land use in the Orange Creek Basin and basins of Newnans, Lochloosa, and Orange lakes based on 2003-2004 aerial photographs.

	Orange Creek Basin		**Newnans Lake**		**Lochloosa Lake**		**Orange Lake**	
Land Use Classification	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**
Agriculture	20,876	5	1,424	2	1,620	3	13,700	15
Forest	115,929	30	28,119	42	21,341	38	21,515	23
Forest Regeneration	33,986	9	10,178	15	7,967	14	5,951	6
Industrial and Commercial	14,598	4	3,443	5	783	1	1,887	2
Low Density Residential	16,980	4	1,444	2	972	2	3,011	3
Medium and High Density Residential	17,393	5	1,826	3	170	0	505	1
Openland	12,137	3	3,021	5	1,031	2	2,588	3
Pasture	36,403	10	2,268	3	3,744	7	17,875	19
Water and Wetlands	88,930	23	15,160	21	11,730	21	13,174	14
Lake	25,461	6	6,589	9	6,908	12	11,965	13
total basin acres	**382,694**		**66,972**		**56,267**		**92,172**	
forest, water, wetlands %		**60**		**65**		**71**		**51**

Land use classifications for the 1996 Plan (page 48) were based on 1988-1989 aerial photographs. It is not feasible to directly compare changes in acreage of land uses between 1988-1989 and 2003-2004 because different methods were used to classify land uses. Land cover classes based on the 2003-2004 photographs were reclassified for use in the Orange Creek Basin hydrologic simulation model discussed later in this plan. With those differences in mind, dominant land uses in the OCB in 1988-1989 were forest, water, and wetlands, which characterized 67% of the land use in the OCB. Acreage of forest, forest regeneration, water and wetlands in the Orange Creek Basin in 2003-2004 was 62%, a 5% decrease from 1988-1989.

CHRONOLOGY OF PROJECTS, EVENTS, AND ACTIVITIES SINCE 1996

The 1996 Plan (page 60) includes a chronology of important management events. Appendix C continues with a list of Orange Creek Basin projects and other events and activities since 1996, with emphasis on those involving the St. Johns River Water Management District. Some of these projects and other events and activities are described in more detail later in this plan.

ISSUES, GOALS, AND PROJECTS

Primary and secondary issues and goals for surface water management in the Orange Creek Basin remain largely as stated in the 1996 Plan, with modifications and additions made in the OCB SWIM Plan shown in blue in Table 3.

Table 3. Primary and secondary issues and goals for surface water management in the Orange Creek Basin.

HYDROLOGY
Issue: Altered Hydrologic Regimes Goal - Restore and maintain, to the extent practicable, desirable, and allowable by flood control requirements, the natural hydrology of waterbodies in the basin such that physical and biological processes that affect the ecological function of these water bodies are sustained.
Issue: Extreme Low Lake Levels Goal - Determine the effects of extreme low water levels (extended infrequent low water periods) on the ecological functions and recreational opportunities of OCB lakes; identify desirable lake low water frequencies and duration characteristics, balancing ecological and recreational needs; and implement lake level management measures designed to attain desirable low water frequencies and durations.
Issue: Water Supply Goal – Coordinate with the SJRWMD staff in water supply planning, consumptive use permitting, and Minimum Flows and Levels development to assure that permitted withdrawals of surface water and groundwater do not significantly harm water resources of the Orange Creek Basin.
AQUATIC SPECIES MANAGEMENT
Issue: Control of Invasive Exotics Goal – Improve and expand existing aquatic plant management techniques, preferably within the framework of an integrated aquatic plant management program, with the purpose of achieving maintenance control of all invasive exotic plant species, (including hydrilla); survey for and monitor invasive non-native animals in lake and wetland habitats and eradicate or control their populations.
Issue: Management of Floating Vegetation Goal - Determine if floating vegetation in OCB lakes represent a surface water management problem, and if so, identify and implement management measures to best address this problem.
WATER QUALITY
Issue: Lake Trophic State Conditions and Trends Goal – Understand the underlying causes that determine current trophic conditions in Orange Creek Basin lakes so that appropriate lake restoration measures can be identified and implemented to help restore water quality in lakes influenced by cultural eutrophication.
Issue: Sources of Pollution Goal – Provide the framework (technical, administrative, political, and social) needed to reduce or eliminate existing sources of pollution in water resources of the Orange Creek Basin and to protect those water resources from future degradation.

LAKE SEDIMENTS
Issue: Organic Sediment Accumulation In Lakes <u>Goal</u> – Develop and implement lake management strategies for restoring sediments in lakes with excessive organic sediment content and/or high sediment accumulation rates.
FISH AND WETLAND-DEPENDENT WILDLIFE HABITATS AND COMMUNITIES
Issue: Management and Enhancement of Fish and Wetland-Dependent Wildlife Habitats <u>Goal</u> – Develop and implement ~~water resource management~~ strategies ~~which~~ that provide for the protection~~, restoration, and/or rehabilitation~~ and management of high-quality lake and wetland habitats in the Orange Creek Basin ~~and~~ for the maintenance and enhancement of healthy native fish and wetland-dependent wildlife ~~habitats~~ populations, without contributing to long-term degradation of water quality. (Includes issue from 1996 Plan: Protection and Restoration of Native Aquatic Plant Populations)
FUTURE PROTECTION OF THE ORANGE CREEK BASIN
Issue: Land Conservation and Restoration <u>Goals</u> – Promote the ~~preservation~~ conservation of lands in the Orange Creek Basin that produce high water resources and related environmental benefits; facilitate the restoration of altered systems from which such benefits have been lost; and develop and implement sound management and restoration plans for acquired properties that support water resource ~~preservation~~ conservation and protection, while providing for compatible recreational use.
PUBLIC OUTREACH
Issue: Public Participation Opportunities and Interagency Coordination <u>Goal</u> – Enhance public awareness and education, increase public involvement in basin initiatives, and improve intergovernmental coordination.
OCB SWIM PROGRAM MANAGEMENT
Issue: Full-Time Employee and Contract Staff Support <u>Goal</u>: Maintain the capability within the OCB SWIM Program to develop and manage the program and its projects; field data collection; and ecological, hydrologic and GIS data management and analysis.

HYDROLOGY

Altered Hydrologic Regimes

<u>Issue</u>

Hydrography and Hydrologic Monitoring

Direction of surface water flow in the Orange Creek Basin is southerly, leading into Orange Creek (Figures 12, 13). In addition, surface waters discharge naturally into sinkholes in two areas. In Paynes Prairie, surface water flows into Alachua Sink and into the aquifer, the only water outlet from Paynes Prairie. The water surface in Alachua Sink is approximately the potentiometric surface of the Floridan aquifer during low-water conditions. Second, a complex of sinkholes along the eastern shoreline of Orange Lake, most noticeably adjacent to Heagy Burry

Park, discharge into the Floridan aquifer (Kindinger et al. 1994). Surface water flow was altered in the 1920s to divert Prairie Creek into Camps Canal from its natural flow path into Paynes Prairie.

The District's Division of Hydrologic Data Services currently monitors water level (= stage) at 35 stations and discharge (= streamflow) at 15 stations in the Orange Creek Basin (Figure 14). Data are available on the District website at webapub.sjrwmd.com/agws10/hdsnew/map.html.

Regarding direction of groundwater flow in the Orange Creek Basin, a dye-trace study conducted by the District showed that dye injected into the Orange Lake sinkhole complex at Heagy Burry Park traveled through groundwater towards the south and southeast, moving about 8 miles in a little over 6 months or about 218 ft/day. Dye was detected in wells at Reddick Elementary, Marion Correctional Institution, and UF IFAS Plant Science Unit (David Toth, SJRWMD Groundwater Division, personal communication). Direction of groundwater flow from Alachua Sink at the north rim of Paynes Prairie is northwest toward springs of the Santa Fe River.

Status of Water Control Structures

Since 1996 the only change to water-control structures in the OCB is removal of the base of the former weir in Prairie Creek at State Road 20. The Florida Department of Transportation removed the base of the weir during construction of a new SR 20 bridge in 1999. Following a unanimous vote of the Newnans Lake Task Force, after their review of several studies funded by the Florida Game and Freshwater Fish Commission (Gottgens and Crisman 1992A, Gottgens and Crisman 1992 B, FGFFC 1993), boards in the Prairie Creek weir were permanently removed by FWC in 1991 to allow natural lake level fluctuations.

Two water-control structures remain in the Orange Creek Basin. Three 66"x42" culverts owned by Paynes Prairie Preserve State Park enable flow from Prairie Creek at Camps Canal into Paynes Prairie. Flow of water through these fully open culverts is reserved for Paynes Prairie by rule of the St. Johns River Water Management District, discussed later in this chapter.

A notched concrete and steel weir at the outlet from Orange Lake at US Highway 301 was constructed in 1963 by the Alachua County Recreation and Water Conservation and Control Authority to maintain higher water levels in Orange Lake. The weir was designed to be 160 feet long with a 3-foot 8-inch wide notch in the middle that was about 30 inches deep. The original bottom elevation of the notch was designed to be 55.5 ft. NGVD 1929. The current bottom elevation of the notch is about 24 inches higher due to the notch being illegally filled several times with welded steel and concrete. The notch is now about 6 inches deep.

The District surveyed the elevation of the Hwy 301 weir in August 1993 based on NGVD 1929 benchmarks. The District resurveyed the weir in April 2011 based on NAVD 1988 data, which is 1.22 feet lower than for NGVD 1929. The 2011 survey also reflected a 0.34 ft increase due to a 1996 revision of benchmarks along Hwy 301. The current elevation (NAVD 1988) of the bottom of the notch in the Hwy 301 weir is 56.30 feet on the inflow side of the notch and 56.15 on the outflow side.

Earthen berms were historically created in Orange Lake to create farm fields in littoral wetlands. Approximate dates of berm construction are found in Warr et al. 2001. Some of these earthen berms remain in three locations: at Samson's Point on McIntosh Bay, at Cow Hammock south of Rawlings Park, and on McCormick Island.

In recent years surface water hydrology has been restored in areas of the OCB that were previously drained for agriculture. The District removed agricultural berms and canals to restore hydrology in 3,500 acres of shallow marsh in Orange Creek Restoration Area since acquisition of the former farm in 1998. Paynes Prairie Preserve State Park removed 7 miles of dikes and filled 10 miles of canals in 2000–2004 to restore sheetflow across portions of Paynes Prairie.

Extreme Low Lake Levels

Issue

Rainfall and Lake Level Trends

Analysis of annual and cumulative departures of rainfall from long-term mean annual rainfall for Gainesville and Ocala meteorological stations, using rainfall data from the Southeast Regional Climate Center (www.sercc.com/climateinfo/historical/historical_fl.html) showed that mean rainfall in Gainesville from 1903-2010 was 49.6 inches and in Ocala from 1892-2010 was 49.9 inches. There was no statistically significant trend in annual rainfall for Gainesville meteorological stations, which influence Newnans Lake (Figure 15). There was no statistically significant trend in annual rainfall for the Ocala stations, which influence Lochloosa and Orange Lakes (Figure 16).

Since 1996 lake levels (stage) in Newnans, Lochloosa, and Orange lakes have fluctuated significantly, reaching extreme levels several times (Figures 17, 18, 19). Record low lake levels were recorded in 2001 in Newnans and Orange Lakes and near-record low lake levels were recorded in Lochloosa Lake in 2002. Near-record high lake levels were recorded in Newnans and Orange Lakes in 1998 and again in Newnans Lake in 2004.

Proposed Stabilization of Orange Lake

The District's Governing Board convened the Orange Creek Basin Advisory Council from 1993-2001 primarily to address public concerns about low water levels in Orange Lake. Council members were appointed by the Governing Board to represent a diversity of interests throughout the Orange Creek Basin. A Scientific Advisory Committee was established in 1995 to address scientific issues. A District report on historical perspectives on hydrology and vegetation in Orange Lake described previous efforts to plug sinkholes adjacent to Heagy Burry Park in Orange Lake in order to increase lake levels, increasing access to Orange Lake during droughts for boats with outboard motors (Warr et al. 2001).

At the request of the Orange Creek Basin Advisory Council and its Scientific Advisory Committee, the District completed an extensive analysis of sinkhole intervention alternatives for Orange Lake (Shuman et al. 1999). Based on these investigations, in 2000 the Orange Creek

Basin Advisory Council voted 7-3 not to manipulate water levels on Orange Lake, concluding that lake stabilization would be harmful to Orange Lake. To improve power boat access to Orange Lake during droughts, the Council unanimously recommended dredging access channels.

In 2003 Marion County applied to the St. Johns River Water Management District for an Environmental Resource Permit (Application No. 4-001-85187-1) to plug a sinkhole in Orange Lake adjacent to Heagy Burry Park. Alachua County formally opposed issuance of the permit. The District concluded that the project would not be clearly in the public interest, a requirement for Outstanding Florida Waters such as Orange Lake. The District determined that the project would result in harm to approximately 859 acres of shallow marsh and 69 acres of forested wetlands that would not experience sediment exposure during frequent low water levels. Without sediment exposure, species diversity would disappear from the shallow marsh, and forested wetland seedlings, such as cypress, would not be able to germinate. In addition, the loss of shallow marsh would reduce spawning and feeding habitat for fish and wildlife that use these habitats.

Since Marion County did not propose mitigation to offset these impacts, the District denied the Environmental Resource Permit request based on the determination that the project would adversely impact the values of wetlands; cause adverse impacts to the abundance, diversity and habitat of fish, wildlife and listed species; and change the hydroperiod of wetlands and surface waters so as to adversely affect wetland and other surface water functions. Marion County appealed to the Florida Land and Water Adjudicatory Commission, which unanimously voted in 2005 to uphold the District's denial of the permit. Alachua County spoke in support of the District at the hearing of the Adjudicatory Commission.

Water Supply

Issue

Water supply was not addressed in the 1996 Plan and was added to the OCB SWIM Plan because of the increasing significance of water supply to surface water levels and flows. Lake levels and flows can be lowered due to local or regional groundwater withdrawals or use of lake water for water supply.

Minimum Flows and Levels

There are no Minimum Flows and Levels rules adopted for Newnans, Orange or Lochloosa lakes, and these lakes are not on the District's priority list for establishment of Minimum Flows and Levels. There are 4 smaller lakes in the OCB for which the District adopted rules (40C-8.031 F.A.C.) for Minimum Flows and Levels: Wauberg, Tuscawilla, Cowpen, and Star.

Reservation of Water for Paynes Prairie

In 1994 the District's Governing Board adopted into rule a ―Reservation of Water for Paynes Prairie". This was the first time that this rule had been utilized in Florida.

> 40C-2.302 Reservation of Water from Use. The Governing Board finds that reserving a certain portion of the surface water flow through Prairie Creek and Camps Canal south of Newnans Lake in Alachua County, Florida, is necessary in order to protect the fish and wildlife which utilize the Paynes Prairie State Preserve, in Alachua County, Florida. The Board therefore reserves from use by permit applicants that portion of the surface water flow in Prairie Creek and Camps Canal that drains by gravity through an existing multiple culvert structure into Paynes Prairie. This reservation is for an average flow of 36 cubic feet per second (23 million gallons per day), representing approximately forty five percent (45%) of the calculated historic flow of surface water through Prairie Creek and Camps Canal.

An administrative challenge was filed by 6 people who own and operate fish camps on Orange Lake. The Administrative Hearing Officer concluded that the water reserved by the Reservation Rule is required for the protection of fish and wildlife of Paynes Prairie, based on ―substantial and uncontroverted evidence" (Smith vs. SJRWMD #94-0544).

As background, Newnans Lake drains into Prairie Creek, which historically flowed into Paynes Prairie. Camps Canal was constructed in the 1920s to dewater Paynes Prairie, which was a cattle ranch owned by the Camps family. Camps Canal diverted Prairie Creek flow away from Paynes Prairie into a forested wetland that discharges into Orange Lake. After Paynes Prairie Preserve State Park was established in 1971, the park breached the Camps Canal levee and installed culverts to restore a portion of Prairie Creek's historic flow into Paynes Prairie.

The average flow cited in the Reservation of Water rule is based on the Streamflow Synthesis and Reservoir Regulation (SSARR) hydrologic model implemented by the District and based on 1942–1991 data (Robison 1992, Robison et al. 1997). The District continues to monitor water level and flow in Prairie Creek at State Road 20, which is 2.93 miles upstream of the culverts flowing into Paynes Prairie, and in Camps Canal at County Road 234, which is 1.14 miles downstream of the culverts.

Water Supply Planning

The District projects total water demand to increase 18% District-wide from 1995 and 2030. The District performed draft analyses to determine impacts of projected water demand through 2030 on groundwater and surface water resources. If projected water demands were to occur and groundwater continued to be the primary source, the potentiometric surface of the Floridan aquifer system would decline regionally in response to cumulative withdrawals of water from the Floridan aquifer system. In response to these declines in the potentiometric surface of the Florida aquifer and in response to withdrawals from intermediate and surficial aquifer systems, water levels in the surficial aquifer system would decline and contribute to unacceptable impacts to water resources and related natural systems throughout the District.

While none of the surface waters in the Orange Creek Basin have been identified by the District for water supply development, the potentiometric surface has already declined, and additional decline would be expected from increased groundwater withdrawals. Thus, there are concerns about Floridan and surficial drawdowns and impacts to natural systems.

Initial groundwater modeling simulations, as part of the development of the draft District Water Supply Plan, have projected changes in the elevation of the potentiometric surface of the Floridan aquifer system in response to projected increases in groundwater withdrawals through 2030. In the Orange Creek Basin, predicted declines of 3 ft to greater than 10 ft in the Floridan aquifer are predicted around the Murphree wellfield operated by the Gainesville Regional Utilities, which provides potable water to the City of Gainesville (Figure 20).

Based on these same initial groundwater flow models, the District projected changes in the surficial aquifer system water levels in response to projected increases in groundwater withdrawals through 2030. In the Orange Creek Basin, the surficial aquifer is predicted to decline between 1–2.5 ft in scattered parts of the Newnans and Lochloosa lake basins (Figure 21). Declines of 0.35-1 ft in the surficial aquifer are predicted in scattered parts of the Newnans and Lochloosa lake basins and in large areas on the south and west sides of Orange Lake (Figure 21).

The District also preliminarily identified general areas within which anticipated water sources are not adequate to supply projected 2030 demands based on projected impacts to lakes with established rules for Minimum Flows and Levels (MFLs). In the Orange Creek Basin, lakes with established MFLs are Wauberg, Tuscawilla, Star, and Cowpen (Figure 22). Wauberg, Tuscawilla, and Star lakes are predicted to remain at or above their MFLs through 2030. Cowpen Lake, in the basin above Orange Creek, is projected to fall below its MFL as a result of projected water demand increases through 2030 (Figure 22).

The completion District's Water Supply Planning process and associated groundwater modeling, which is still underway, may provide better indications as to the extent of these potential impacts identified by the draft analysis.

Potential Projects
(See Table 16 for schedule and estimated costs)

<u>SJRWMD</u>

- Coordinate with Hydrologic Data Services Division to continue monitoring water level and discharge Newnans, Lochloosa, and Orange lakes and their basins, and in Paynes Prairie
- Coordinate with Hydrologic Data Services Division to monitor hydrology sufficient to determine long-term average volume of water flowing through Camps Canal culverts into Paynes Prairie
- Evaluate function and longevity of Camps Canal culverts to Paynes Prairie, in coordination with Paynes Prairie Preserve State Park
- Reduce basal area of forest trees on District-managed lands around OCB lakes through thinning of dense stands, to increase downstream water yield

FWC

- Remove sections of berms on the shoreline of Orange Lake at Samson's Point to restore hydrology in 400 acres of littoral wetlands separated from the lake since the 1930s-40s

AQUATIC SPECIES MANAGEMENT

Control of Invasive Exotics

Issue

The Invasive Plant Management Sub-Section of the Florida Fish and Wildlife Conservation Commission (FWC) directs control of aquatic plants in Florida public waters under Sections 369.20 and 369.22 of Florida Statutes. This program was transferred by the legislature to FWC from the Florida Department of Environmental Protection (FDEP) in FY 07-08. In the Orange Creek Basin, FDEP contracted with the SJRWMD to conduct aquatic plant management from 1981-1998. In 1998 the District ended its contract with FDEP for aquatic plant management in the OCB lakes, after the District purchased additional lands that required management of invasive aquatic and upland plants. Since 1998, FDEP has contracted with private applicators to conduct aquatic plant management in the OCB lakes.

Aquatic plant management priorities are codified as regulations of the FWC (Chapter 68F-54, F.A.C) with highest priority being control of water lettuce (*Pistia stratiotes*), water hyacinth (*Eichornia crassipes*), and hydrilla (*Hydrilla verticillata*). Florida Statutes 369.20 states, ―The Fish and Wildlife Conservation Commission shall direct the control, eradication, and regulation of noxious aquatic weeds and direct the research and planning related to these activities, as provided in this section, so as to protect human health, safety, and recreation and, to the greatest degree practicable, prevent injury to plant and animal life and property."

Following is the FWC statewide position on hydrilla management, dated April 2011. The purpose of the position and implementation guidelines can be found at myfwc.com/media/1386750/hydrilla-mgmt-position.pdf.

> It is the position of the Florida Fish and Wildlife Conservation Commission (FWC) that native aquatic plant communities provide ecological functions that support diverse native fish and wildlife communities in Florida waterbodies. FWC considers hydrilla to be an invasive, non-native aquatic plant that can, at high densities, adversely impact native plant abundance, sportfish growth, recreational use, flood control, and dissolved oxygen. Once established, hydrilla has proven difficult if not impossible to eradicate with current technology and is expensive to manage. Therefore, FWC opposes the deliberate introduction of hydrilla into waterbodies where it is not currently present. FWC prefers to manage for native aquatic plants, but recognizes that in waterbodies where native submersed aquatic plants are absent or limited, hydrilla at low to moderate densities can be beneficial to fish and wildlife. FWC will manage hydrilla on a waterbody by waterbody basis using a risk-based approach to determine the level of management.
>
> In waterbodies where hydrilla is well established, it will be managed at levels that are commensurate with the primary uses and functions of the waterbody and fish and wildlife. FWC will determine the level of hydrilla management on each public waterbody using a risk-based analysis that considers human safety issues, economic concerns, budgetary constraints, fish and wildlife values, and recreational use, with input from

> resource management partners and local stakeholders. Factors such as available control technology (e.g. herbicides), current waterbody condition, and activities occurring within the watershed will also influence the timing and level of hydrilla management."

Natural control of hydrilla can be significant under certain conditions. Growth of hydrilla can naturally be inhibited by decreased light penetration into the water column resulting from high water levels and high phytoplankton biomass. Cold weather and waterfowl feeding can also contribute to natural control. When hydrilla is not being controlled naturally, FWC can apply various contact and systemic herbicides to control hydrilla. Contact herbicides degrade within a few days after application, while systemic herbicides are active in the water up to a couple of months.

Despite a variety of herbicides available to control hydrilla, there are technological and stakeholder limitations to hydrilla control. Technological limitations to herbicide use include timing, location, temperature, water chemistry, resistance to herbicide, and potential impacts to non-target native plants. Stakeholder limitations to hydrilla management include the desire by those who hunt and fish on lakes to maintain a certain cover of hydrilla, especially during spring for bass fishing and during fall for duck hunting. These technological and stakeholder limitations can result in hydrilla management being complex and contentious.

To illustrate the decades-long challenge of managing invasive exotic plants in Newnans, Lochloosa, and Orange lakes, Figure 23 shows annual area of water lettuce treated with herbicide for each lake, Figure 24 shows the annual area of water hyacinth treated with herbicide for each lake, and Figure 25 shows the annual area of hydrilla observed by FDEP/FWC during surveys conducted by boat during 1-2 days in October of each year for each lake (FDEP/FWC, unpublished data).

Hydrilla Management in OCB Lakes

Hydrilla is the invasive exotic aquatic plant of greatest concern to the District because of its potential to dominate in lakes where water quality improvement projects result in greater light penetration and thereby harm native species and interfere with flow (flood control). The desired result of improved water quality is return of an abundant diversity of native aquatic vegetation, not dominance by hydrilla. Furthermore, treatment of large areas of hydrilla can result in long-term degradation of water quality.

In Newnans Lake, Fluridone herbicide (trade name Sonar®) was applied to control hydrilla in 1986 and 1992, treating less than 90 acres each time (FDEP/FWC, unpublished data). Hydrilla was not seen in Newnans Lake from 1998 through 2005 and has been present in small areas since 2006.

In Lochloosa Lake, contact herbicide was applied to control hydrilla during 22 of the 35 years from 1975-2010. From 1982-1994 Fluridone herbicide was applied every year except 1985 to control hydrilla in Lochloosa Lake, selecting for Fluridone-resistant hydrilla in this lake. Higher concentrations of Fluridone were subsequently used to control hydrilla in Lochloosa Lake, resulting in damage to native plants. To avoid non-target damage to native plants, Fluridone has not been used in Lochloosa Lake since 1998.

In Orange Lake, cover of hydrilla in Orange Lake exceeded 4,000 acres five times since 1974, most recently in 2007 and 2009. Contact herbicide was applied to control hydrilla in Orange Lake during 27 of the 36 years from 1974–2010. Fluridone was applied to control hydrilla in Orange Lake during 14 of the 17 years from 1982-1998, selecting for Fluridone-resistant hydrilla in this lake. Higher concentrations of Fluridone were subsequently used to control hydrilla in Orange Lake, resulting in damage to native plants. To avoid non-target damage to native plants, Fluridone has not been used in Orange Lake since 1998. In 2007 FWC denied an application from FDEP to introduce sterile (triploid) grass carp into Orange Lake to control hydrilla. The permit was denied because Orange Lake is hydrologically connected upstream and downstream, allowing grass carp to move out of Orange Lake and into other water bodies.

Strategies for Invasive Exotic Plant Management

In Newnans, Lochloosa, and Orange lakes, FWC's goal is to manage water lettuce and water hyacinth at the lowest feasible level, maintaining maintenance control. FWC manages hydrilla on a lake-by-lake basis using a risk-based approach that considers human safety issues, economic concerns, budgetary constraints, fish and wildlife values, and recreational use, with input from resource management partners and local stakeholders. Factors such as available control technology (e.g. herbicides), current lake condition, and activities occurring within the basin also influence timing and level of hydrilla management. FWC maintains hydrilla at levels compatible with primary uses and functions of the lake and with fish and wildlife. The FWC statewide position on hydrilla management provides more information.

The District and Alachua County Environmental Protection Department are concerned that large-scale herbicide treatment of aquatic plants can contribute to long-term degradation of water quality and increase in lake sediments in Newnans, Lochloosa, and Orange lakes. To avoid those negative impacts to the lakes, SJRWMD recommends that FWC manage water lettuce and water hyacinth in Newnans, Lochloosa, and Orange lakes at the lowest feasible level, maintaining maintenance control. Preventative management involves frequent and regular plant surveys combined with application of contact herbicides to even small infestations. Surveillance-based preventative management has achieved maintenance control of hydrilla in lakes Apopka, Harris, Eustis and Griffin (Crew et al. 2010a, Crew et al. 2010b). This approach avoids application of systemic herbicides such as Fluridone that can cause non-target damage, and avoids treatment of large areas of aquatic vegetation at one time, which can degrade water quality.

SJRWMD recognizes that hydrilla in all three lakes is sufficiently Fluridone-resistant to prevent effective use of this herbicide. SJRWMD therefore recommends that FWC manage hydrilla at the lowest feasible level, maintaining maintenance control in Newnans and Lochloosa lakes using a surveillance-based approach. In Orange Lake, abundance of hydrilla vegetative propagules (turions) throughout most or all of the lake makes maintenance control currently impractical due to limited resources and in the absence of a selective herbicide to replace Fluridone. On Orange Lake, the SJRWMD recommends that FWC manage hydrilla to address public recreation, fisheries, and waterfowl goals, while developing projects to limit hydrilla dispersal from Orange Lake to other water bodies. One recommended project is the maintenance of a 1,000 foot radius around all boat ramps on Orange Lake maintained free of hydrilla.

The issue of invasive exotic plant management, especially hydrilla management, and effects on water quality and lake sediments could be addressed and resolved most effectively through regular meetings of a new OCB Lake Management Interagency Working Group.

Island Apple Snail Eradication Effort

Island Apple Snails (*Pomacea insularum*) were discovered in Newnans Lake in 2007, the first occurrence of this non-native snail in the Orange Creek Basin. A cooperative control effort by the District, FWC, FDEP, and University of Florida in 2007 and 2008 using copper sulfate, hand-harvesting of egg masses, and traps was not successful in eradicating the snail. Egg masses of Island Apple Snails were observed in Prairie Creek, the downstream outlet of Newnans Lake, in 2010.

Management of Floating Vegetation

<u>Issue</u>

Formation of Floating Vegetation

In response to public concerns about impeded boat access to Orange Lake due to the extent of floating vegetation, the District conducted several studies of floating vegetation in Orange Lake. A study of formation of floating vegetation in Orange Lake based on analysis of plant fragments in sediment cores and radiocarbon dating of cores found that floating marshes existed in Orange Lake 1,300 years ago and floating marshes moved around the lake (Clark and Reddy 1998). Floating vegetation was reported by observers as a common feature in Orange Lake as early as the 1800s (Warr et al. 2001). Comparison of aerial photographs showed that vegetation cover in Orange Lake between 1937 and 1998 was cyclical and that there was no trend toward a more vegetated lake. Floating vegetation cover fluctuated based on the magnitude and timing of water level fluctuations (Warr et al. 2001). Marsh cover is unchanged and cyclical but composition has changed from deep marsh to tussocks, which are extensive floating mats of vegetation (FWC, personal communication).

Further analysis of floating and emergent marsh vegetation in Orange Lake concluded that floating vegetation is highly dynamic and forms due to interaction of factors such as sediment depth, drought, rate of water level rise after drought, excess nutrients, winds, freezing temperatures, marsh fires, increase in exotic plants, and human interference (Bryan and Warr 1998).

Accelerated deposition of organic sediments can lead to the formation of extensive mats of floating vegetation, particularly during cycles of extreme drought followed by flooding. Low dissolved-oxygen levels and increased organic matter deposition typically can occur underneath extensive mats of floating vegetation (Hujik 1994, Alam et al. 1996, Clark and Reddy 1998).

Habitat Value of Floating Vegetation

According to recent FWC draft guidelines for fish and wildlife habitat management in the Orange Creek Basin (FWC 2010), floating islands provide habitat for fish, wading birds, reptiles, amphibians, and round-tailed muskrats. FWC recommends managing floating island habitats for these animals by maintaining a full range of normal water level fluctuations, spot treatment of woody vegetation on floating islands, and burning.

The value of floating island habitats in Orange Lake is supported by an assessment of non-game and juvenile fish use of floating vegetation, shallow emergent marshes, and deep marshes (Williams 1997). Floating marshes showed a greater species diversity of non-game and juvenile fish than emergent marshes. Additionally, reptiles and amphibians were collected, identified, and counted during FWC's project to remove floating vegetation on Orange Lake in 1997–1998 (Bryan and Warr 1998). Data showed that floating marshes were inhabited by a high diversity and abundance of reptiles and amphibians, with an average of 18,160 individuals per acre of floating marsh.

Fish often associated with extremely dense mats of floating vegetation and mud tussocks (floating marshes) are generally small bodied, stress tolerant species capable of surviving in environments with low dissolved oxygen (Bunch et al. 2008). Suitability of floating marsh communities for a broader range of fish species is likely influenced by other habitat characteristics such as dominant plant species, vegetation density and/or biomass, and spatial complexity (edge, patch size, proximity to other habitat types). Dissolved oxygen generally decreases in the interior of large tussocks and is higher near edges due to the influence of water turbulence. Higher edge complexity also creates more open water and habitat complexity capable of providing additional benefits such as increased coverage of submersed aquatic vegetation, higher dissolved oxygen, and increased potential for public access. Research suggests that, while tussocks and dense vegetation provide habitat for some species of non-game fish and wildlife, limiting tussock size and maximizing edge complexity and interspersion of tussock habitats in relation to other habitat types may improve overall wildlife utilization (Rogers and Allen 2009).

Large-Scale Removal of Floating Vegetation

Forty-four percent of the floating and rooted emergent vegetation in Orange Lake, approximately 5,272 acres, was removed by the FDEP Invasive Plant Management program and the FWC Aquatic Habitat Restoration/Enhancement (AHRE) program from 2003 through 2005. The primary purpose was to restore selected deep marsh habitat displaced by extensive floating mats of vegetation, also known as tussocks, following the period's drought and subsequent refill (Mallison et al. 2010), with the additional benefit of improving boat access on Orange Lake. FWC/AHRES activities generally do not specify total elimination of tussocks as a management objective. The spatial extent and distribution of tussock communities is manipulated to maximize habitat diversity on a lake-wide scale.

Vegetation removal on Orange Lake consisted of scraping, herbicide application, mechanical shredding with in-lake disposal, and mechanical harvesting with upland disposal. Deep marsh habitat, characterized by emergent water lilies and submersed aquatic vegetation, was restored in approximately 70% of the area where floating vegetation was removed (FWC personal communication). Removal of some floating vegetation mats can aid in decreasing chlorophyll a, total nitrogen and total phosphorus concentrations (Alam et al. 1996). Appendix D details the FWC AHRE projects.

At meetings of the FDEP Orange Creek Basin Working Group, the District expressed concern about the effect of large-scale removal of floating vegetation in Orange Lake on long-term degradation of water quality and loss of habitat for fish, amphibians, and reptiles. From 1994-2010 there was a significant increasing trend in total phosphorus concentration in Orange Lake, independent of changes in water level (Figure 27). Degradation of water quality in an Outstanding Florida Water such as Orange Lake is a violation of rule 62-320.700 F.A.C. To address these concerns, in 2008 and 2010 SJRWMD notified FDEP and FWC that mechanical shredding of lake vegetation, with in-lake disposal, which is performed by boats called ―cookie cutters", will require prior review for an Environmental Resource Permit, which considers water quality impacts of proposed activities.

Potential Projects
(See Table 16 for schedule and estimated costs)

FWC
- Coordinate through a new OCB Lake Management Interagency Working Group to manage water lettuce and water hyacinth in Newnans, Lochloosa, and Orange lakes at the lowest feasible level, maintaining maintenance control using a surveillance-based approach
- Coordinate through a new OCB Lake Management Interagency Working Group to manage hydrilla in Newnans Lake at the lowest feasible level, maintaining maintenance control using a surveillance-based approach
- Coordinate through a new OCB Lake Management Interagency Working Group to manage hydrilla in Orange and Lochloosa lakes to address public recreation, fisheries and waterfowl goals
- Coordinate through a new OCB Lake Management Interagency Working Group to manage aquatic and wetland vegetation as needed

WATER QUALITY

Lake Trophic State Conditions and Trends

Issue

Water Quality and Plankton Monitoring

The Orange Creek Basin SWIM program monitors water quality at approximately 24 stations sampled monthly (Figure 26). These include 7 open-water stations in Newnans, Lochloosa, and Orange lakes and 18 tributary stations (Appendix E). Water samples are collected using FDEP Standard Operating Procedures for surface water sampling. At each station field parameters are measured and recorded (Appendix F). Light extinction is measured at open-water stations. Water quality samples are collected at each station and taken to the District lab for analysis (Appendix F). In addition to the stations sampled by the OCB SWIM program, the District's Environmental Assessment group samples a station on Orange Creek at County Road 21 (OR006) every month.

Samples for phytoplankton and zooplankton analysis are collected at all open-water stations except the P-G Run station in Orange Lake (OLSW) and are stored for later analysis when funds are available.

Alachua County Environmental Protection Department monitors water quality in some Gainesville urban creeks and small lakes in the Orange Creek Basin. Water quality monitoring includes quarterly sampling for nutrients and fecal coliform bacteria at selected ambient stream sites and two small lakes - Bivens Arm and Lake Wauberg. All water quality data are uploaded to Florida STORET. Alachua County Environmental Protection Department also monitors fecal coliform at ―hot spot" locations throughout the Gainesville urban area and in selected rural creeks, and is investigating sources of coliform bacteria. Additionally, the Alachua County Environmental Protection Department conducts hydrologic monitoring (rainfall and streamflow or water level measurement) in the urban area as part of the Gainesville Clean Water Partnership between the City of Gainesville, Alachua County and Florida Department of Transportation to reduce pollutants in stormwater in the Gainesville urban area. Station location information, recent water quality data and rainfall and streamflow data can be obtained at www.AlachuaCountyWater.org.

Other water bodies in the Orange Creek Basin are sampled by either the City of Gainesville or Alachua County Environmental Protection Department. Descriptions of those water quality sampling programs are in the Orange Creek Basin Management Action Plan and its supporting documents, which can be downloaded at www.dep.state.fl.us/water/watersheds/bmap.htm (FDEP 2008).

Status of Lake Water Quality

Analysis of mean monthly water quality data from January 1994 through August 2010 for Newnans, Lochloosa, and Orange lakes showed elevated concentrations of chlorophyll-a (a measure of phytoplankton abundance), total phosphorus, and total nitrogen (Table 4) relative to target concentrations defined by FDEP's Total Maximum Daily Load rule, discussed later in this chapter. Phosphorus availability is the nutrient regulating phytoplankton biomass in these 3 lakes, because the dominant phytoplankton (cyanobacteria) can supplement their nitrogen needs through fixation of atmospheric nitrogen.

Trophic State Index (TSI) is a measure of water quality calculated using monthly averages of chlorophyll-a, total phosphorous, and total nitrogen. TSI values above 70 are considered indicators of poor lake water quality, while values less than 60 are indicative of good water quality. Median TSI values from 1994-2010 were 85 in Newnans Lake, 70 in Lochloosa Lake and 67 in Orange Lake (Table 4).

Table 4. Median values of water quality metrics from January 1994 through August 2010 in Newnans, Lochloosa, and Orange lakes. Numbers in parentheses are TMDL targets, discussed later in this chapter.

	Newnans Lake	Lochloosa Lake	Orange Lake
Chlorophyll-*a* (µg/L)	142	55	35
Total Phosphorus (mg/L)	0.179 (0.062)	0.068 (0.047)	0.064 (0.031)
Total Nitrogen (mg/L)	3.93 (0.97)	1.89 (1.04)	1.83
Trophic State Index	85.4 (65.4)	70 (60)	67 (60)

Through 2003, dominant phytoplankton in Newnans, Lochloosa, and Orange lakes were cyanobacteria, which comprised about 92% of total phytoplankton biomass for Newnans and Lochloosa lakes, and 87% in Orange Lake. The cyanobacterium *Cylindrospermopsis raciborskii* was the dominant phytoplankton species in all three lakes, with the highest biovolume and percentage in Newnans Lake (Di et al. 2006).

Trends in Lake Water Quality

Lochloosa and Orange Lakes have a special designation as Outstanding Florida Waters, recognizing their need for special protection and intended to protect existing good water quality (62-302.700 F.A.C.) It is the policy of FDEP to afford the highest protection to Outstanding Florida Waters. Consequently, no degradation of ambient water quality after March 1, 1979, other than that allowed in subsections 62-4.242(2) and (3), F.A.C., is permitted in Outstanding Florida Waters. Statistical trend analyses are a metric of change of water quality.

Total Phosphorus Trends

In trend analyses using simple linear regression, there were statistically significant increasing trends in total phosphorus concentration from 1994-2010 in Newnans Lake ($p = 0.003$), Lochloosa Lake ($p = 0.002$), and Orange Lake ($p < 0.001$) (Figure 27; Table 5). Omitting years with atypical hydrologic conditions is one way to evaluate overall robustness of TP trends. Increasing TP trends were also statistically significant when the years 2000, 2004, 2005 and 2006 were omitted from the analysis for Newnans ($p < 0.001$) and Orange lakes ($p < 0.001$) but not Lochloosa Lake ($p = 0.073$).

Total Phosphorus and Lake Level
In Newnans and Orange lakes from 1994-2010, TP and lake level were significantly correlated ($p < 0.001$) but not in Lake Lochloosa ($p = 0.678$) (Table 5). Another way to evaluate robustness of temporal trends is to include both time and lake level as independent variables in multiple regression analyses. When lake level and time are included in multiple regression analyses, significant increasing TP trends persisted for Newnans Lake ($p < 0.001$) and Orange Lake ($p < 0.001$) and appeared in Lochloosa Lake ($p = 0.002$). In multiple regression analyses, when the years 2000, 2004, 2005 and 2006 were omitted, significantly increasing TP trends over time persisted in Newnans Lake ($p < 0.001$) and Orange Lake ($p = 0.002$) but not in Lochloosa Lake ($p = 0.456$). These analyses indicate that phosphorus concentrations are clearly increasing in Newnans and Orange lakes and likely in Lochloosa Lake.

Trophic State Index Trends
In simple linear regression analyses of TSI, Newnans Lake had a decreasing TSI trend from 1994-2010 ($p = 0.016$), while there was no statistically significant trend in TSI in Lochloosa Lake ($p=0.344$), and Orange Lake had an increasing trend ($p < 0.001$) (Figures 28, 29, 30; Table 5). The same analyses omitting the years 2000, 2004, 2005, 2006 revealed a significant increasing trend in Orange Lake ($p < 0.001$) but no significant trends in Newnans and Lochloosa lakes ($p = 0.921$ and $p = 0.332$, respectively).

Trophic State Index and Lake Level
When lake level was included in multiple regression analyses of TSI, none of the three lakes showed a significant trend in TSI (Newnans $p = 0.283$, Lochloosa $p = 0.344$ and Orange $p = 0.094$). All three lakes showed a significant negative relationship between lake level and TSI, that is, water quality was poorer as lake level declined (Table 5).

Table 5. Trends in Total Phosphorus (TP) and Trophic State Index (TSI) in Newnans, Lochloosa and Orange Lake from 1994-2010.

	TP trend (simple regression)	TP trend minus '00, '04, '05, '06	TP trend including lake level (multiple regression)	TP trend including lake level minus '00, '04, '05, '06	TSI trend (simple regression)	TSI trend including lake level (multiple regression)
Newnans Lake	increasing	increasing	increasing	increasing	decreasing	no trend over time; increase with decreasing lake level
Lochloosa Lake	increasing	no trend	increasing	no trend	no trend	no trend over time; increase with decreasing lake level
Orange Lake	increasing	increasing	increasing	increasing	increasing	no trend over time; increase with decreasing lake level

Overall water quality in the OCB lakes is influenced by phosphorus concentrations and lake level. In addition, water color and abundance of submerged plants help regulate phytoplankton abundance. Newnans Lake has the highest phosphorus concentrations and TSI values and it is likely that there are periods when phosphorus concentrations so greatly exceed phytoplankton needs that phytoplankton become self-limiting by shading themselves. In Orange Lake, and to a lesser extent in Lochloosa Lake, hydrilla can compete for space and nutrients and result in decreased phytoplankton. Trend analyses are further complicated by seasonal patterns and periods of atypical hydrology (droughts and heavy rain) and lead to strong relationships with lake level. From a management perspective, it is essential that phosphorus concentrations in Newnans, Lochloosa, and Orange lakes be reduced to reduce phytoplankton abundance. None of the analyses conclude that phosphorus concentrations are declining and most showing increasing trends.

Evidence of Past Water Quality

A study of past sediment and water quality in Newnans Lake based on lake sediment cores showed that the rate of nitrogen, phosphorus, and carbon accumulation in lake sediments increased since about 1900 (Brenner and Whitmore 1998), likely because of higher rates of nutrient loading from the lake basin and more effective nutrient sequestering in the lake sediments. Deeper sediments in Newnans Lake have a relatively high ratio of carbon to nitrogen compared to surface sediments, indicating a relative decrease in macrophyte production and increase in phytoplankton production, likely at the expense of submersed vegetation, since 1900 in Newnans Lake

A similar study of past water quality in Lochloosa Lake based on lake sediment cores indicated that cyanobacteria have been a component of the phytoplankton community in the lake during last 100-plus years and that abundance of cyanobacteria fluctuated considerably during that time (Brenner et al. 2009). Cyanobacteria concentration in Lochloosa Lake peaked in the 1980s. Subsequent decline in cyanobacteria may have been due to shifting dominance of phytoplankton species or increasing dominance of invasive exotic plants such as hydrilla in Lochloosa Lake.

A study of historical nutrient accumulation rates and past water quality in Orange Lake based on sediment cores found that accumulation rates for total phosphorus, carbon, and total nitrogen increased through time (Brenner and Whitmore 1996). Phosphorus sequestration in Orange Lake sediments has increased since about 1990, which probably reflects greater phosphorus loading to Orange Lake or more efficient immobilization of incoming phosphorus. Before 1900 deeper sediments in Orange Lake had a relatively high ratio of carbon to nitrogen and contained abundant large plant fragments with ample support tissue. More recent lake sediments typically had lower ratios of carbon to nitrogen and appeared to be composed of fine-grained organic matter.

Unlike Newnans Lake where the lower ratio of carbon to nitrogen (C:N) in newer sediments was due to higher phytoplankton production in the water column, in Orange Lake the lower ratio of carbon to nitrogen in newer sediments was probably due to increases in algae. One result of routing Prairie Creek's discharge from Paynes Prairie to Camps Canal and into Orange Lake in the 1920s was a change from more wetland vegetation with higher C:N ratios to more lake-like conditions with lower C:N ratios. A high percentage of planktonic diatoms in Orange Lake sediments were deposited around 1900, indicating open-water conditions and a water column that mixed frequently. Since the 1930s Orange Lake gradually shifted from being predominantly open-water to a lake where submersed plants were increasingly important in primary production.

Verification of Water Body Impairment

In 2003 the Florida Department of Environmental Protection (FDEP) adopted into rule a list of Orange Creek Basin water bodies considered impaired because they did not meet state standards for water quality based on criteria in the Impaired Waters Rule (Table 6; Figure 31). When this list was updated in 2009, FDEP delisted OCB water bodies for which a Total Maximum Daily Load (TMDL) had been adopted by rule, although these water bodies still do not meet state water quality standards (Table 6; Figure 32). FDEP also delisted water bodies for which additional data analyses determined that impairment did not exist (Table 6; Figure 32). Details of FDEP verification of impairment for these water bodies in 2009 can be found at www.dep.state.fl.us/water/watersheds/assessment/adopted_gp1-c2.htm.

Table 6. List of selected water bodies in the Orange Creek Basin verified as impaired in 2003 and 2009, and parameters resulting in impairment listing.

Verified Impaired Water Body	Impairment Parameter 2003 LIST (Cycle 1)	Impairment Parameter 2009 LIST UPDATE (Cycle 2)	Delisted* in 2009 (Cycle 2) because FDEP adopted a TMDL for:
NEWNANS LAKE	Nutrients Unionized Ammonia	Dissolved Oxygen	Nutrients Unionized Ammonia
LOCHLOOSA LAKE	Nutrients	Nutrients (TMDL adopted by EPA, not FDEP, so not delisted in 2009)	
ORANGE LAKE	Nutrients Dissolved Oxygen Lead	Dissolved Oxygen	Nutrients
ALACHUA SINK	Nutrients	Fecal Coliform Dissolved Oxygen	Nutrients
ALACHUA SINK OUTLET		Dissolved Oxygen, Fecal Coliform	
PRAIRIE CREEK		Dissolved Oxygen	
CAMPS CANAL		Dissolved Oxygen	
RIVER STYX		Dissolved Oxygen	
LAKE WAUBERG	Nutrients		Nutrients
SWEETWATER BRANCH	Nutrients Fecal and Total Coliform		Fecal Coliform Total Coliform (withdrawn from state criteria)
HOGTOWN CREEK	Fecal Coliform		Fecal coliform
POSSUM CREEK		Fecal Coliform	
ORANGE CREEK		Dissolved Oxygen	
TUMBLIN CREEK	Fecal Coliform Total Coliform Dissolved Oxygen Biological Oxygen Demand		
BIVENS ARM	Nutrients	Nutrients Turbidity Dissolved Oxygen	
HATCHET CREEK	Fecal and Total Coliform Dissolved Oxygen Iron	Nutrients Fecal Coliform	Fecal Coliform Total Coliform (withdrawn from state criteria) Iron

Verified Impaired Water Body	Impairment Parameter 2003 LIST (Cycle 1)	Impairment Parameter 2009 LIST UPDATE (Cycle 2)	Delisted* in 2009 (Cycle 2) because FDEP adopted a TMDL for:
LITTLE HATCHET CREEK	Dissolved Oxygen	Fecal Coliform	
PRAIRIE CREEK	Nutrients	Dissolved Oxygen	
CROSS CREEK	Nutrients Dissolved Oxygen Biological Oxygen Demand Total Suspended Solids	Nutrients Dissolved Oxygen (TMDL adopted by EPA, not FDEP, so not delisted in 2009)	Total Suspended Solids (not impaired)
LITTLE ORANGE CREEK		Fecal Coliform	
*These delisted water bodies in the OCB still do not meet state water quality standards.			

Sources of Pollution

Issue

Models for Watershed Assessment

Since 1996 a major effort for the Orange Creek Basin program was developing models to create water and nutrient budgets for Newnans, Lochloosa, and Orange lakes. The first was a spreadsheet model developed by the District based on land uses in the Newnans Lake basin. The second was a Hydrological Simulation Program–Fortran (HSPF) model recommended by the U.S. Environmental Protection Agency for watershed assessment (Lin and Clapp 2008, Lin 2011). The HSPF model is the primary watershed model used by the District for estimating water and nutrient budgets for water bodies and for developing Pollutant Load Reduction Goals (PLRGs).

The spreadsheet model's nutrient runoff component was calibrated using data collected within the basins of Newnans Lake. Water and nutrient loads to Newnans Lake were estimated by the spreadsheet model and incorporated into the U.S. Army Corps of Engineers' Bathtub model (Walker 1999) and used in the District's development of PLRGs for Newnans Lake (Di et al. 2008).

The OCB HSPF model produced water budgets for Newnans, Lochloosa, and Orange lakes and is being refined to produce nutrient budgets for these lakes.

The Orange Creek Basin HSPF model complements the SSARR hydrologic model described earlier, developed to determine effects of water management alternatives on lake levels and wetlands (Robison et al. 1997). Outputs from the SSARR hydrologic model were used to evaluate proposals to plug sinkholes in Orange Lake and to reserve surface water for Paynes Prairie.

Lake Water Budgets

Since cyanobacteria that dominate the OCB lakes can supplement their nitrogen needs by utilizing atmospheric nitrogen through nitrogen fixation, the key nutrient limiting algal abundance in Newnans, Lochloosa, and Orange lakes is phosphorus. Excess phosphorus flowing into Newnans, Lochloosa, and Orange lakes from their basins has resulted in excess phytoplankton growth in these lakes.

In an early effort, the District developed an external nutrient budget to determine sources of phosphorus and nitrogen to Orange Lake (Lasi 1999). More recently, the HSPF model for the Orange Creek Basin was used to develop water budgets for Newnans, Lochloosa, and Orange lakes (Table 7). These budgets identify sources of water to each lake. The HSPF model is being refined to produce nutrient budgets for the 3 lakes.

Table 7. Water budgets for Newnans, Lochloosa, and Orange lakes for 1995-2004 based on the OCB HSPF model.

Unit	Average Annual Inflow Sources				Average Annual Outflow Sources				
NEWNANS LAKE									
	Direct Rainfall	Watershed Runoff			Evaporation	Outflow via Prairie Creek	Groundwater Loss	**Total Inflow**	**Total Outflow**
acre-ft/yr	21,100	32,083			21,400	27,000	3,320	**53,183**	**51,720**
cfs	29	44			30	37	5	**73**	**71**
LOCHLOOSA LAKE									
	Direct Rainfall	Watershed Runoff	Groundwater Input		Evaporation	Outflow via Cross Creek	Outflow via Lochloosa Slough		
acre-ft/yr	28,100	19,342	3,642		29,300	16,800	3,010	**51,084**	**49,110**
cfs	39	27	5		40	23	4	**71**	**68**
ORANGE LAKE									
	Direct Rainfall	Cross Creek	River Styx	Lake Vicinity	Evaporation	Outflow via Hwy 301 weir	Groundwater loss via sinkhole		
acre-ft/yr	37,700	17,000	18,600	8,945	38,000	16,000	25,900	**82,245**	**79,900**
cfs	52	23	26	12	52	22	36	**114**	**110**

Water and nutrient budgets based on the HSPF model will be used to develop Pollutant Load Reduction Goals for Lochloosa and Orange lakes and to refine existing Pollutant Load Reduction Goals for Newnans Lake. Water budgets produced by the HSPF model differ significantly from those based on the earlier SSARR hydrologic model (see page 22 of the 1996 Plan).

Groundwater-Surface Water Connections

Investigations into groundwater contribution to Newnans, Lochloosa, and Orange lakes aided in development of water budgets for Newnans, Lochloosa, and Orange Lakes. In 2006 Jeff Davis in the District's Groundwater Division conducted thermography surveys of Newnans and Lochloosa lakes for sources of groundwater, using infrared aerial photography that detects warm spots in the lake on cold days. The surveys indicated the possibility of significant groundwater contribution to Lochloosa while there was little evidence for significant groundwater contributions to Newnans Lake. Investigations into nutrient sources to Newnans Lake revealed little evidence for groundwater contribution to Newnans Lake (Cohen et al. 2008, Cohen et al. 2010).

Geologic Source of Phosphorus

In portions of the Orange Creek Basin, the Hawthorn Group, a phosphorus-rich geologic layer, is close to or at the land surface (Figure 33; Cohen et al. 2008 and 2010; FDEP unpublished data). The Hawthorn Group is characterized by sandy clays or clayey sands with phosphate grains and limestone or dolomite, and is estimated to be over 100 feet thick in the upper reaches of the Hatchet Creek basin, thinning toward Newnans Lake and dipping toward the northeast (Clark et al. 1964; Scott et al. 1988; Baker et al. 2005). This geologic phosphorus contributes to the naturally elevated historic trophic state of Newnans Lake compared to similar Florida lakes. While this abundant phosphorus source is a natural condition within the OCB, there are areas in the Newnans Lake basin where human activities have increased weathering, erosion, and runoff of Hawthorn-derived phosphorus into tributaries of the lake. Some of these areas include ditched segments of Little Hatchet Creek at Gainesville Regional Airport and dredged portions of Hatchet Creek (Cohen et al. 2008, Cohen et al. 2010).

In 2010 the District and FDEP collaborated on a geologic mapping project to better determine depth to the Hawthorn Group in the Newnans Lake basin. These data resulted in a more accurate and higher resolution map showing where the Hawthorn Group was nearest to the land surface (Figure 33).

Pollutant Loading Reduction Goals and Total Maximum Daily Loads

Since 1996 most of the District's work related to water quality in the Orange Creek Basin focused on development of Pollutant Load Reduction Goals (PLRGs) for Newnans Lake, the upstream lake in the basin and the most eutrophic. PLRG diagnostic work included a preliminary assessment of pollution sources such as septic systems in the Newnans Lake basin (Dyer, Riddle, Mills, and Precourt 2003).

The District developed Pollutant Load Reduction Goals (PLRGs) for Newnans Lake (Di et al. 2009) as defined by Florida's Water Resources Implementation Rule (62-40, F.A.C.). PLRGs can be used to assist FDEP in development of TMDLs. The first step in the District's PLRG development for Newnans Lake was determining restoration target concentrations for total nitrogen (TN) and total phosphorus (TP) using four lines of evidence. Next, current loading rates of TN and TP to the lake were estimated. Finally, the allowable pollutant load and load reductions needed to reach desired target concentrations were determined.

The District agreed with FDEP's TMDL analysis (Gao and Gilbert 2003) on a restoration target of .068 mg/l TP for Newnans Lake. The District's TN concentration target was 1.294 mg/l. Allowable TN and TP loads were estimated using a Bathtub model (Walker 1999) for Newnans Lake (Table 8). Also estimated was the TN load reduction needed to reach the target if nitrogen fixation was eliminated by reducing the TP concentration to decrease reduce dominance of nitrogen-fixing phytoplankton (Table 8).

Table 8. Pollutant Load Reduction Goals for Newnans Lake

	Mean Annual Loading Rate (lb/year)	Target Loading Rate (lb/year)	Reduction Needed (lb/year)	Percent Reduction Needed to Achieve Target
Total Phosphorus	28,349	14,778	13,572	48%
Total Nitrogen	52,1839	177,926	343,912	66%
Total Nitrogen (without N-fixation)	260,463	177,926	82,537	32%

The Florida Watershed Restoration Act of 1999 directed FDEP to implement the Total Maximum Daily Load (TMDL) component of the federal Clean Water Act. In the Orange Creek Basin, FDEP developed Total Maximum Daily Loads of pollutants for water bodies that they verified as impaired (Table 9; Gao and Gilbert 2003A and B, Gao et al. 2006). The US Environmental Protection Agency adopted TMDLs for Lochloosa Lake and Cross Creek based on draft TMDLs developed by FDEP (EPA 2005). FDEP did not adopt TMDLS for Lochloosa Lake and Cross Creek because of problems balancing the water budget for Lochloosa Lake and high variation in chlorophyll levels and TSI concurrent with aquatic plant management activities.

Table 9. Target concentration and reduction needed for parameters causing impairment in lakes in the Orange Creek Basin. (TP = total phosphorus, TN = total nitrogen, TSI = trophic state index).

Water Body	Parameter Resulting in Impairment Verification	Target Concentration or Target TSI for Parameter	% Reduction in Parameter Needed to Meet Target
Newnans Lake	TP TN	TP 0.062 mg/L TN 0.97 mg/L TSI 65.4	TP 59% TN 74%
Lochloosa Lake (adopted by EPA based on FDEP draft TMDL)	TP TN TSI	TP 0.047 mg/L TN 1.044 mg/L TSI 60	TP 60% TN 38%
Orange Lake	TP	TP 0.031 mg/L TSI 60	TP 45%
Alachua Sink	TN	TN 1.14 mg/L dry year TN 1.01 mg/L wet year TSI 73.04 dry year TSI 70.86 wet year	TN 45%

FDEP considered preliminary findings from the District's analysis of Pollutant Load Reduction Goals during their development of the TMDL for Newnans Lake. The District did not have Pollutant Load Reduction Goals completed in time to be considered by FDEP in development of TMDLs for Lochloosa or Orange lakes.

FDEP's TMDL for Newnans Lake acknowledged considerable uncertainty in external phosphorus load estimates (Gao and Gilbert 2003A). The FDEP estimate suggested that Newnans Lake should have in-lake phosphorus concentrations close to the restoration target concentration. The observed in-lake levels were, however, considerably greater than expected based upon the FDEP external load estimate. The uncertainty in external load and disparity between predicted and observed in-lake phosphorus concentrations led FDEP to hypothesize that internal phosphorus loading was a significant portion of the Newnans Lake phosphorus budget. FDEP's uncertainty regarding external phosphorus loading and assumption of significant internal phosphorus loading from sediments implied that there was no clear need to reduce external phosphorus loads to Newnans Lake.

Another study measured greater phosphorus export from Newnans Lake's single surface outlet, Prairie Creek, than was measured entering the lake (Nagid et al. 2001). This imbalance led to the hypothesis that internal phosphorus loading was a significant portion of the Newnans Lake phosphorus budget. As with FDEP's external load estimate, this study's estimate was limited by available data - only two of the several tributaries entering the lake - thus underestimating the total external phosphorus load.

To reduce uncertainty in the Newnans Lake phosphorus budget, the District since 2003 collected water quality data from previously unsampled sites. Nutrient loading from tributaries of Newnans and Lochloosa Lakes was measured in 2007-2008 (ECT 2008). Water quality samples were collected at base flow and during storm flow from 4 tributaries to Newnans Lake (Hatchet Creek, Little Hatchet Creek, North and South Creeks in the ungauged drainage area on the northeast side of Newnans Lake) and from Lochloosa Creek, a tributary of Lochloosa Lake. Discharge from the tributaries was calculated for base flow and storm flow events.

The District also contracted with the University of Florida to collect additional data and analyze patterns in surface and surficial ground water phosphorus loading to Newnans Lake (Cohen et al. 2008, Cohen et al. 2010). This work verified the importance of external phosphorus loading, especially during storms, from minor tributaries to Newnans Lake, and significant phosphorus loads from sub-basins adjacent to the lake.

The District utilized water and nutrient budgets derived from a spreadsheet model and a water budget derived from the OCB HSPF model in development of a PLRG for Newnans Lake. As noted earlier, the District's PLRG analysis and FDEP's TMDL analysis substantially agreed on the in-lake restoration target for Newnans Lake. Additional water quality data collected in the Newnans Lake basin since 2003 verified that external loads of phosphorus to Newnans Lake are excessive. The District's current estimates of external phosphorus load explain in-lake phosphorus concentrations and preclude the need to balance the lake's phosphorus budget by assuming internal phosphorus loading. In subsequent discussions, FDEP agreed to accept the external phosphorus load estimated by the District's PLRG analysis. FDEP is in the process of working with local governments through the OCB Working Group to incorporate into the Orange Creek Basin Management Action Plan (OCBMAP) projects to reduce external phosphorus loading to Newnans Lake.

Orange Creek Basin Management Action Plan

In 2004 the Florida Department of Environmental Protection formed the Orange Creek Basin Working Group, a diverse stakeholder group including the St. Johns River Water Management District that met almost monthly from August 2004 through September 2007 while developing the Orange Creek Basin Management Action Plan (OCBMAP). The OCBMAP addresses reductions in external pollutant loads needed to restore water quality to state standards in surface water bodies listed by FDEP as impaired and for which FDEP had developed a Total Maximum Daily Load. The Orange Creek Basin Management Plan was adopted by Order of the Secretary of FDEP in 2008 and thus is legally enforceable (FDEP 2008; www.dep.state.fl.us/water/watersheds/bmap.htm).

The Orange Creek Basin Management Action Plan includes a list of projects to reduce pollutant loads to impaired water bodies, a monitoring plan, and reporting process. District projects in the Orange Creek Basin Management Action Plan are land acquisition and development of Pollutant Load Reduction Goals for Newnans, Lochloosa and Orange lakes. The District also committed in the OCBMAP to regular monitoring of water quality in Newnans, Lochloosa, and Orange lakes and their tributaries.

Projects described in the OCB SWIM Plan support implementation of the OCBMAP. FDEP convenes the Basin Working Group twice a year to review progress on projects listed in the plan. FDEP intends to revise TMDLs and BMAPs every 5 years if warranted by new information.

Point Sources of Pollutant Loading

The National Pollutant Discharge Elimination System (NPDES) stormwater program authorized by the federal Clean Water Act designates certain stormwater discharges, known as Municipal Separate Storm Sewer Systems" (MS4s), as point sources of pollution. These are publicly owned conveyances that discharge stormwater to surface water. MS4 discharges encompass existing discharges associated with certain industrial and construction activities and master drainage systems of certain local governments.

Alachua County, City of Gainesville, and Florida Department of Transportation each have MS4 permits in the Orange Creek Basin. Because their stormwater infrastructure is interconnected, these MS4 permit holders formed the Gainesville Clean Water Partnership in 2001. The Gainesville Clean Water Partnership works to collectively address requirements of the NPDES program in the Gainesville urban area through public outreach and participation, illicit discharge detection and elimination, construction site stormwater controls, post construction stormwater controls and good housekeeping in municipal operations. A portion of the Gainesville MS4 urban area drains to Newnans Lake (Figure 34). The University of Florida has an MS4 permit and is not part of the Gainesville Clean Water Partnership.

Marion County has an MS4 permit administered by the Office of the County Engineer's Stormwater Section, which conducts public outreach and education programs, an illicit discharge detection and elimination program, mapping and modeling efforts, a construction site pollution prevention program, a municipal operations pollution prevention program. This program is funded by the Marion County Clean Water Assessment.

In the Orange Creek Basin in Alachua, Marion and Putnam counties, there are currently 36 wastewater treatment facilities permitted by the Florida Department of Environmental Protection (Appendix G). Twelve of these, in Alachua and Marion counties, have NPDES permits.

Non-Point Sources of Pollutant Loading

Stormwater runoff outside of MS4 areas is a significant source of non-point pollution. Other sources of non-point loading of nutrients are on-site sewage and disposal systems, commonly known as septic systems. The Florida Department of Health (FDOH) reported 6,779 inspected septic systems in the Orange Creek Basin as of October 2010 (www.doh.state.fl.us/Environment/programs/EhGis/EhGisDownload.htm). Of these, the Newnans Lake basin contains 786 inspected septic systems, while there are 261 inspected septic systems in the Lochloosa Lake basin and 1,263 in the Orange Lake basin (Figure 35).

Sources of Nutrients to Newnans Lake

An analysis of spatial nutrient loading and sources of phosphorus in the Newnans Lake watershed concluded that phosphorus loading to Newnans Lake is dominated by geologic phosphate derived from the phosphorus-rich Hawthorn Group in surficial groundwater flowing via bank seepage into tributaries of the lake (Cohen et al. 2008 and 2010, unpublished data). The greatest longitudinal phosphorus enrichment in tributaries of Newnans Lake was at locations where the Hawthorn Group is naturally or artificially exposed, particularly in Little Hatchet Creek between Waldo Road and State Road 26, which includes the Gainesville Regional Airport. Poor stormwater infrastructure in the urbanized portion of the Newnans Lake basin, and developments constructed prior to stormwater management rules are likely to have artificially increased creek incision into the Hawthorn Group, accelerating phosphorus runoff. The significance of Hawthorn-derived phosphorus loading is sufficient in the Newnans Lake watershed to overwhelm the typical observation that increasing land use intensity is positively related to increased phosphorus runoff (Cohen et al. 2008). The fact that the Hawthorn Group is enriched with phosphorus but not nitrogen is reflected in the observation that nitrogen runoff conformed with typical land use patterns.

Groundwater seepage along the shoreline as well as via the lake bottom appears to be a negligible source of water, and therefore phosphorus, to Newnans Lake (Cohen et al. 2010). The water budget for Newnans Lake, based on the District's HSPF model, shows a close balance between inflows and outflows of water (Table 7). Additionally, elemental budgets for calcium and chloride indicate that there is no significant source or sink of groundwater in Newnans Lake (Cohen et al. 2010). However, most baseflow in the creeks consists of seepage from the surficial aquifer, and there is not a significant contribution from either the intermediate or Floridan aquifers.

To address the concern that there was significant wind-drive resuspension of phosphorus from Newnans Lake sediments, the University of Florida installed a tower in Newnans Lake to gather wind and weather data and water velocities below the surface. Water quality and sediment data from this study indicated that wind did not play a significant role in resuspending sediments in Newnans Lake and that there was no significant correlation between wind speed and nutrient or concentration of total suspended solids (Jain et al. 2005).

Additional analysis of phosphorus loading to Newnans Lake showed that approximately 7% originates from the Gainesville Regional Airport property. The likely source for most of this phosphorus is erosion of Hawthorn-derived phosphorus from ditches excavated to deepen and reroute Little Hatchet Creek when airport runways were constructed by the military in the 1940s. The airport management has expressed interest in cooperating to reduce this erosion, contingent upon such work not violating Federal Aviation Administration regulations regarding safety for air traffic.

Another identified source of phosphorus loading to Newnans Lake is a 235-acre blueberry farm located on the northeast side of Newnans Lake near Windsor. The 1,000-acre basin containing the blueberry farm is 1.5% of the Newnans Lake basin, yet contributes about 6% of the phosphorus load to the lake. Two intermittent creeks drain from the blueberry farm into Newnans Lake, passing through forested land in the District's Newnans Lake Conservation Area. Total phosphorus concentration in one of these creeks is over twice as high as other tributaries of Newnans Lake. The creeks flow when the farm is irrigating or spraying for freeze protection. The blueberry farm contains 18 groundwater wells permitted by the District to pump a total of 169 mgd for irrigation and 95 mgd for freeze protection.

After several meetings with the farm owner and managers, it does not appear that current farming practices are the primary source of phosphorus runoff to Newnans Lake. Newer plantings use a cropping system that result in lower water and fertilizer use and less fertilizer loss. They plan to convert the entire farm to this new system over the next 7 years.

The primary source of phosphorus runoff appears to be ―legacy" phosphorus from dairy cow manure. The site was previously a dairy farm and the former dairy milking barn is still in place, with a partially buried manure-holding tank discharging to a ditch that drains to a creek that flows to Newnans Lake. Manure can release phosphorus for centuries (Graetz and Nair 1995, Nair et al. 1995). Soil samples analyzed by Dr. Vimala Nair at the University of Florida showed that the soil in the ditch draining the abandoned manure holding tank is highly saturated with phosphorus and has a high capacity to release phosphorus. Phosphorus release could be to surface runoff or leaching to the surficial aquifer. Soil in a nearby field of the blueberry farm showed similar phosphorus characteristics, possibly due to use of manure for fertilizer when the farm was a dairy.

The farm owner is willing to work cooperatively with the District to reduce phosphorus runoff to Newnans Lake. As well, there may be opportunities to further reduce phosphorus loading to the lake by holding creek water in existing forested wetlands in the Newnans Lake Conservation Area.

Portions of Hatchet Creek were ditched in the past, especially where the creek flows into Newnans Lake. These ditches may intersect the Hawthorn Group. The District will be investigating opportunities to reduce phosphorus loading from ditched portions of Hatchet Creek.

The City of Gainesville Public Works Department is beginning a Little Hatchet Creek and Lake Forest Creek Watershed Management Plan that will encompass all of both sub-basins of Newnans Lake. The plan will address flooding and water quality by identifying projects to reduce pollutant loading to Newnans Lake. The City constructed a regional stormwater pond in the Lake Forest Creek watershed, which drains to Newnans Lake.

Newnans Lake Shad Harvest

Removing large numbers of bottom-feeding gizzard shad may improve water quality by reducing resuspension of lake sediments, reducing recycling of nutrients from the lake bottom, and removing nutrients contained in the fish bodies. Shad harvests remove phosphorus from the lake, and reduce recycling and availability of phosphorus to promote algal growth (Schaus 2008, Schaus et al. 2010). The District incorporated shad harvesting in restoration programs in lakes Apopka and Griffin in the upper Ocklawaha River basin. Since shad harvesting began in lakes Apopka and Griffin, concurrent with external nutrient load reductions and other projects, phosphorus concentration declined substantially, at times nearing or reaching the TMDL target. In both of these lakes, algal biomass also declined and growth of submersed plants increased.

In 2010 the District completed the first season of a three-year experimental harvest of gizzard shad from Newnans Lake. Fishers harvested 205,188 pounds of rough fish: 97% gizzard shad and 3% gar and bowfin. Additional harvests are planned for 2011 and 2012 if there are sufficient numbers of larger shad and funding. Shad harvesting should accelerate the lake’s response to efforts in the future to reduce external phosphorus loading. There are currently no projects being implemented to reduce phosphorus loading to Newnans Lake.

With funding from the District, FWC evaluated the black crappie (*Pomoxis nigromaculatus*) (known locally as speckled perch) fishery in Newnans Lake in 2009 and 2010 to determine the potential effect of the District’s rough fish removal project on the black crappie population in Newnans Lake. The FWC reported that as permitted, the District’s shad harvest was unlikely to harm the black crappie fishery (Tuten et al. 2010).

The District’s outreach for the Newnans Lake gizzard shad harvest included development of interpretive materials three interpretive kiosks, a fact sheet, a question and answer sheet, and boater caution sign. The District held briefings with Alachua County legislative delegation members, City of Gainesville and Alachua County commissioners and staff, Paynes Prairie Preserve State Park, shoreline property owners, and representatives of the recreational fishing community, environmental organizations, and other key stakeholders. Media outreach included a press release and briefing for the editor for the Gainesville Sun, and participation in videos by Alachua County and the local public television station.

Paynes Prairie Restoration

The City of Gainesville is constructing the Depot Avenue Stormwater Park in downtown Gainesville. Regional stormwater treatment ponds in this park will capture runoff from downtown Gainesville, improving the quality of water flowing via Sweetwater Branch into Paynes Prairie Preserve State Park. The District provided $1,065,500 in cost-share funds for this project. Completed City of Gainesville projects to improve water quality in Paynes Prairie are construction of a trash trap and stormwater retention pond on Rosewood Branch, a tributary of Sweetwater Branch, and construction of a regional stormwater pond in the Tumblin Creek watershed, which drains to Paynes Prairie. The City of Gainesville has a stormwater management utility that provided funding for these projects.

The District provided $1,343,653 to the City of Gainesville for the Paynes Prairie – Sweetwater Branch Sheetflow Restoration Project to improve water quality in Sweetwater Branch before it discharges into Paynes Prairie. The project will improve water quality in Alachua Sink, a small lake in Paynes Prairie, and restore hydrology in 1,300 acres of degraded wetlands in Paynes Prairie. The District's cost-share funds were for purchase of land in the Paynes Prairie basin and design of a 125-acre treatment wetland to improve water quality in Sweetwater Branch before it enters Paynes Prairie.

As part of the Paynes Prairie Sheetflow Restoration Project, the City of Gainesville and its partners propose filling Sweetwater Canal, which carries flow from Sweetwater Branch, including discharge from the City's water reclamation facility, into Alachua Sink, a conduit to the Floridan aquifer. Filling this 10,000-foot 2-mile-long drainage canal will allow for restoration of 33 acres of wetlands. Filling of Sweetwater Canal will occur after construction of the treatment wetland and other upstream water improvement projects on Sweetwater Branch. Filling of Sweetwater Canal will enhance sheetflow hydrology in adjacent wetlands, reducing nitrogen flow into Alachua Sink, required to meet its TMDL.

Alachua County Stormwater Management Program

Alachua County included guidelines in their 2001-2020 Comprehensive Land-Use Plan (adopted 2005) to better manage stormwater, resulting in implementation of a Stormwater Management Program within the Public Works Department. In 2010 the County completed a Stormwater Master Plan for unincorporated areas of Alachua County in support of the development of a Stormwater Management Program. The master planning process provided an opportunity to assess stormwater management in the county, focusing primarily on water quantity and partly on identifying needs to address water quality. The Alachua County Stormwater Master Plan includes data on hydrology, topography, an inventory and assessment of major drainage facilities, and information on water quality problem areas. A preliminary county-wide Hydrologic and Hydraulic Model was developed to qualitatively evaluate performance of major drainage conveyance and storage pathways. The Hydrologic and Hydraulic Model can be refined for design of stormwater retrofit and other water quality improvement projects.

The Alachua County Stormwater Master Plan identified 19 stormwater basins and 12 county-maintained roads where immediate water quality improvements are required to meet current regulatory requirements. The Alachua County Stormwater Master Plan recommended a public education program dedicated to stormwater management, funding alternatives, external funding options, and recommendations for Stormwater Management Program implementation. The estimated average annual cost of implementing the Alachua County Stormwater Management Program was $6,108,648.

Marion County Watershed Management Program

As part of Marion County's efforts to identify and address water quality issues, a county-wide Watershed Management Program (WMP) was initiated in August 2006, including the Orange Creek Planning Unit. The Watershed Management Program involves creation and maintenance of a comprehensive geodatabase for Marion County storm sewer system data, watershed boundaries and hydrologic features. Through the WMP, corrective actions are identified and implemented that address water quality issues. Corrective actions may involve structural and non-structural projects. Projects involving structural retrofits are then prioritized in the Stormwater Capital Project Prioritization Report (CPPR) which is updated annually. Projects are designed and constructed based on their ranking in the CPPR. Non-structural projects, such as public education and outreach strategies, are identified separately in the Stormwater Education Plan. All are incorporated into the Stormwater Implementation Program, a five-year plan presented to the Marion County Board of County Commissioners (BCC) annually.

In addition to the WMP, other steps have been taken by the BCC to protect water resources in Marion County. In 2005, the BCC adopted Resolution 05-R-106 which declared support for the protection of Marion County springs and directed staff to develop recommendations for springs protection. A fertilizer ordinance was adopted in November, 2008. An irrigation ordinance was adopted in April, 2008, and subsequently amended in ordinance 09-13 in May, 2009. In June 2009, a Marion County springs protection ordinance was adopted that included amendments to the County land development code and regulations directed at springs protection and water conservation.

Potential Projects
(See Table 16 for schedule and estimated costs)

<u>SJRWMD</u>

- Collect and analyze monthly water quality and plankton samples in Newnans, Lochloosa and range lakes and their major inflow tributaries
- Perform QA, archive, and analyze water quality and plankton data
- Refine HSPF model for the OCB, incorporating recent stormwater sampling data and UF Newnans Lake study findings
- Update water budgets and produce nutrient budgets for Newnans, Lochloosa and Orange lakes using refined HSPF model
- Develop integrated surface-groundwater models for Newnans, Lochloosa, and Orange lakes
- Evaluate and revise Pollutant Load Reduction Goals for Newnans Lake
- Coordinate with FDEP and OCB Working Group to revise Orange Creek BMAP to reduce external phosphorus loading to Newnans Lake
- Develop Pollutant Load Reduction Goals for Lochloosa Lake

- Identify sources of nutrients to Lochloosa Lake
- Develop Pollutant Load Reduction Goals for Orange Lake
- Identify sources of nutrients to Orange Lake
- Quantify phosphorus load to Newnans Lake from tributaries and wetlands by determining phosphorus content and speciation in a range of soil and sediment types and sizes including suspended solids entrained during storm events
- Assess nitrogen fixation by phytoplankton in Newnans Lake, including determining timing, magnitude, and transformations of nitrogen fixed and assessing fate of fixed nitrogen in Newnans Lake and Prairie Creek
- Determine phosphorus speciation in Newnans Lake sediment cores and pore water to distinguish phosphorus recycling from apatite mineralization
- Conduct Newnans Lake shad harvest to improve water quality and increase rate of phosphorus deposition to lake sediments
- Evaluate effects of Newnans Lake gizzard shad harvest on water quality and phosphorus sedimentation rate
- Evaluate potential for restoration of phosphorus attenuation in wetlands the Little Hatchet Creek basin including Gum Root Swamp
- Evaluate potential for use of an chemical-based water quality treatment system downstream of Gainesville airport
- Cooperate with land owner to develop a phosphorus-load reduction plan and projects for the Windsor blueberry farm on Newnans Lake
- Evaluate potential for hydrologic restoration of modified tributaries of Newnans Lake in proximity to the Hawthorn Group, to reduce phosphorus loading
- Restore historic basin hydrology by installing low-water crossings in roads on District-managed lands to reduce erosion in tributaries and drainage of surficial soils and wetlands, to reduce phosphorus loading to Newnans, Lochloosa, and Orange lakes; proposed FWC cost share
- Repair and stabilize unimproved roads on District-managed lands to reduce surface runoff and sediment and phosphorus loading to Lochloosa Lake; proposed FWC cost-share
- Provide cost-share funding to Alachua County and City of Gainesville for implementation of their projects in the Orange Creek BMAP
- Provide cost-share funding (as a legislative appropriation) to City of Gainesville for implementation of Sweetwater Branch / Paynes Prairie Sheetflow Restoration Project, for construction of the enhancement wetland, water control structures, and sheetflow distribution channel.

<u>Florida Department of Agriculture and Consumer Services</u>

- Develop, adopt, implement, and monitor compliance with agriculture and silviculture Best Management Practices in the Orange Creek Basin

<u>Alachua County</u>

- Assess shoreline septic tank systems near Newnans, Lochloosa, and Orange lakes

City of Gainesville

- Complete a Little Hatchet Creek and Lake Forest Creek Watershed Management Plan to reduce pollutant loads to Newnans Lake
- Fill and restore wetland in Sweetwater Canal in Paynes Prairie
- Connect properties along Gainesville urban creeks to municipal wastewater treatment to reduce fecal coliform contamination
- Improve quality of water discharging to Paynes Prairie by removing trash and enhancing wetland treatment along Tumblin Creek.

University of Florida

- Quantify fluxes of phosphorus from Newnans Lake sediments over diurnal, seasonal and shad-harvest time frames to determine how to reduce phosphorus recycling to the water column
- Assess Newnans Lake metabolism (productivity and respiration) by measuring diel oxygen dynamics at the sediment/water interface to understand the level at which ecosystem phosphorus limitation would be reestablished

LAKE SEDIMENTS

Organic Sediment Accumulation In Lakes

Issue

Bathymetry Maps

Bathymetry maps of Newnans Lake, Lochloosa, and Orange lakes were created based on bathymetric surveys (ECT 2002, Wattles 1990, ECT 2007; Figures 36, 37, 38). Bathymetry data shown on the figures are in the older NGVD 1929 datum. If converted to the newer NAVD 1988 datum, the elevations would be slightly lower, as indicated on each figure.

Surface area and volume of Newnans, Lochloosa, and Orange lakes at median water level (NAVD 1988) were calculated based on the bathymetry data and 2001 LIDAR contours obtained from Alachua County (Table 10).

Table 10. Surface area and lake volume at median lake level, based on bathymetry data.

	Median Lake Level (ft NAVD 1988)	Period of Record	Surface Area	Lake Volume
Newnans Lake	65.07	1936-8/10/2010	6,589 acres	26,996 acre-ft
Lochloosa Lake	56.31	1936-8/3/2010	6,907 acres	50,587 acre-ft
Orange Lake	56.68	1933-8/5/2010	11,964 acres	62,336 acre-ft

Newnans Lake Sediments

A bathymetry and sediment thickness survey of Newnans Lake showed that unconsolidated soft sediments covered the lake bottom at an average thickness of 8.2 ft and maximum thickness of over 16 ft (ECT 2002). An appendix to that report examined settling velocity and other sediment properties in Newnans Lake (Gowland and Mehta 2002). Wind-induced wave resuspension and consolidation of cohesive sediment in Newnans Lake was the topic of a Masters of Science thesis project at the University of Florida (Gowland 2002).

A study of historic sediment and nutrient accumulation rates and past water quality in Newnans Lake based on sediment cores showed that the sediments in Newnans Lake are higher in organic matter (>600 mg/g) relative to most similar Florida lakes. Sediment accumulation rate increased over time, with an average annual accumulation rate of 0.56 cm/year over the 100 years prior to the study (Brenner and Whitmore 1998).

Excessive external loading of nutrients results in increased accumulation of lake sediments. The District’s Pollutant Load Reduction Goals for Newnans Lake determined that phosphorus loading from the watershed was the cause of the lake’s poor water quality and high biomass of phytoplankton, which contribute to accumulation of flocculent organic sediments in the lake (Di et al. 2009). However, net phosphorus retention in Newnans Lake's sediments is low likely due to a combination of factors: the lake's shallow depth, relatively low calcium and high dissolved organic carbon (Weilenmann et al. 1989) and high sediment bioturbation by gizzard shad (Schaus et al. 2008, Schaus et al. 2010).

Subsequent investigations into nutrient sources to Newnans Lake produced water and nutrient budget for the lake (Cohen et al. 2008 and 2010; Table 7). These investigations identified the Hawthorn Group as an important source of phosphorus loading from the Newnans Lake basin, and indicated that soils/sediments in Gum Root Swamp do not retain phosphorus throughout the year. Seasonal release of phosphorus by Gum Root Swamp was hypothesized to be the result of long-term over loading from the Little Hatchet Creek basin and seasonal redox changes that resulted in release of iron-bound phosphorus. Additionally, the top 10–15 m of surficial sediments in Newnans Lake had porewater phosphorus concentrations similar to overlying lake water, an unusual occurrence, suggesting high levels of bioturbation of lake sediments. Frequent sediment disturbance is consistent with high abundance and sediment feeding by gizzard shad in Newnans Lake (Schaus et al. 2010) and would result in lower net phosphorus sedimentation.

The sole surface water outlet from Newnans Lake is Prairie Creek. In 1999, the Florida Department of Transportation, during construction of the new State Road 20 bridge, removed the concrete base of a weir that extended across Prairie Creek, removing this potential impedance to downstream sediment transport.

Record low levels in Newnans Lake in 2000-2001 resulted in the discovery of 87 ancient canoes buried in sediments along the north shore. Radiocarbon dating by archeologists revealed that the canoes range in age from 500 to 5,000 years old (Florida Division of Historical Resources 2004). In 2001 the Newnans Lake canoe site was listed on the National Register of Historic Places in recognition of the outstanding significance of the buried ancient canoes (National Register of Historic Places 2001, Lake Pithlachocco Canoe Site, NRIS Reference # 01000303). This listing was done at the request of the Florida State Historic Preservation Officer of the Florida Division of Historical Resources. Consequently, proposals to dredge sediments from Newnans Lake require review by the Florida Division of Historic Resources and the US Department of the Interior.

In 2001, the FWC did not implement a project to dredge Newnans Lake sediments near Powers Park, on recommendation of the Florida Division of Historical Resources and after verification of ancient canoes buried in that part of the lake's sediments.

In 2007, the owners of Kate's Fish Camp on Prairie Creek asked an Alachua County Commissioner to investigate the feasibility of dredging Prairie Creek. At the request of the Commissioner, an interagency group consisting of Alachua County Environmental Protection Department, Alachua County Public Works Department, St. Johns River Water Management District, Florida Fish and Wildlife Conservation Commission, Florida Department of Transportation, and Florida Department of Environmental Protection discussed the dredging proposal. The interagency group determined that dedicating public funding to dredge Prairie Creek into Newnans Lake did not provide sufficient public benefits to offset potential environmental impacts and agency resources required to address permitting issues, and voted unanimously to not dredge Prairie Creek.

Orange Lake Sediments

Sediment cores from Orange Lake indicate that during extreme droughts over the past several thousand years, fire at times burned peat across much of the bottom of Orange Lake (ECT 1997). Since the 1920s, however, Orange Lake has received more surface water via Camps Canal, due to pumping to dewater Paynes Prairie for ranching (until acquisition by the state park in 1971) and rerouting of Prairie Creek flow to Orange Lake. Also, Orange Lake has retained more water since construction of the Highway 301 weir in 1963. Consequently, there are fewer drought-driven opportunities for burns in the dried littoral zone of Orange Lake, as historically occurred (Warr et al., 2001). Furthermore, the Florida Division of Forestry is reluctant to issue permits to conduct prescribed burns in wetlands where peat fires could ignite because peat fires are difficult to extinguish and can burn for months, generating smoke that can cause safety risks.

Drought alone, without fire, can result in sediment consolidation and oxidation. A study was conducted of sediment consolidation in Orange Lake in 2001-2002 when Orange Lake reached a record low lake level in May 2001 due to drought (ECT 2002). The data show a mean reduction in sediment elevation of 15.5 inches at 31 sites in P-G Run and 16.6 inches at 39 sites in River Styx due to sediment compaction and oxidation.

The artificial increase in Orange Lake water level and absence of peat fires have likely accelerated deposition of organic sediments, which may have changed plant community composition and succession, limited permanent rooting of aquatic vegetation, and increased turbidity through sediment re-suspension (Warr et al. 2001).

During record low lake levels in 2001-2002 in Orange Lake, the Aquatic Habitat Restoration/Enhancement (AHRE) program of the FWC scraped 175 acres of organic sediment and associated vegetation in Orange Lake. The scraped material was used to create seven 1-acre wildlife islands in the lake. Appendix D details the AHRE projects.

Large-scale in-lake treatment of floating vegetation may contribute to accumulation of organic sediments in lakes. Alternatively, excessive accumulating of tussocks, floating vegetation, and floating islands may cause accumulation of organic sediments and contribute to poor water quality (Alam et al. 1996, Bigham 2009, Clark and Reddy 1998, Hujik 1994). From 2005-2008, FWC treated 4,401 acres of floating vegetation in Orange Lake. Most of the vegetation treatment consisted of mechanical shredding with in-lake disposal and herbicide application.

Lochloosa Lake Sediments

A study in Lochloosa Lake based on 3 sediment cores determined that mean linear sediment accumulation rate at each site since the earliest reliable date in the 20^{th} century was 0.48 cm/yr, 0.60 cm/yr, and 0.83 cm/yr (Brenner et al. 2009).

Phosphorus Accumulation in Lake Sediments

Based on analysis of lake sediment cores, the rate of phosphorus accumulation in lake sediments from 1950–2000 in Newnans Lake was twice that in Orange and Lochloosa lakes (Table 11; Brenner and Whitmore 1996 and 1998; Brenner et al. 2009). The phosphorus accumulation rate in Newnans Lake was similar to the 0.118 mg/cm^2/year average for 11 Florida lakes (Knight et al. 2003). The phosphorus accumulation rate in Orange and Lochloosa lakes was lower than average.

Table 11. Phosphorus accumulation rate (mg/cm^2/year) from 1950–2000 based on analysis of lake sediment cores.

	Mean	Minimum	Maximum	Standard Deviation
Newnans Lake	0.111	0.022	0.256	0.069
Lochloosa Lake	0.052	0.014	0.113	0.031
Orange Lake	0.052	0.023	0.103	0.021

Sediment Removal for Water Quality Restoration

The District completed a review of dredging as a restoration tool for lake water quality improvement, based on evaluation of available literature on dredging and its effects on water quality (Mactec 2007). The review concluded that dredging should be seen as an additional tool for water quality management and not as a primary method of restoration. Failure of projects to restore lake water quality was the result of inadequate pre-dredging studies, continuation of external nutrient loading, high sediment resuspension rates, and the misunderstanding that dredging alone can restore water quality. Studies have shown that most of the nutrient content can be found in the top 30-40 cm of lake sediments and removal of this sediment layer can be effective in substantially reducing total in-lake nutrient content and ultimately improving lake plant communities and even water quality (Cooke et al. 1986). Other studies indicate that dredging alone will not provide long-term restoration (Mactec 2007). The District’s position is that sediment removal after source control, and potentially followed by other restoration techniques, offers the most reliable and cost-effective route to long-term restoration of water quality in lakes.

In 1993 FWC evaluated dredging portions of the littoral zone of Newnans Lake as part of a proposed project to conduct an artificial drawdown of the lake to improve sport fisheries by consolidating lake sediments. FWC estimated that removal of 6 miles of shoreline sediments above the 63-ft contour, totaling 703,800 cubic yards, would cost $4,522,800, which is $6.43 per cubic yard (FGFWFC 1993).

In light of these findings, the District’s initial focus for water quality restoration to state standards in Newnans, Lochloosa, and Orange lakes is on reducing external loading of nutrients from the lake basins and increasing ability of lake sediments to store phosphorus. The District could consider removal of lake sediments or other sediment-nutrient inactivation techniques if significant external load reductions did not result in reduced in-lake concentrations in five years.

Potential Projects
No projects are proposed that address organic sediment accumulation in lakes.

FISH AND WETLAND-DEPENDENT WILDLIFE HABITATS AND COMMUNITIES

This chapter includes the issue from the 1996 Plan titled ―Protection and Restoration of Native Aquatic Plant Populations" because of similarity of content.

Management and Enhancement of Fish and Wetland-Dependent Wildlife Habitats

Issue

The Florida Fish and Wildlife Conservation Commission is authorized to manage fish and wildlife in Newnans, Lochloosa, and Orange lakes through regulation and permitting of fishing and hunting, augmenting stocks of sport fish, and manipulating habitats for fish and wildlife. In Newnans, Lochloosa, and Orange lakes and their basins, FWC regulates and permits fishing, hunting of waterfowl and alligators, and commercial hunting of frogs. FWC permits collection of alligator eggs and/or hatchlings on Orange Lake above the elevation of sovereign submerged lands.

The Florida Fish and Wildlife Conservation Commission manages available habitats in the Orange Creek Basin to benefit fish and wetland-dependent wildlife populations. FWC mapped littoral zone vegetation in 2007 around Newnans, Lochloosa, and Orange lakes (Figures 39, 40, 41). FWC is now drafting fish and wildlife habitat management guidelines for Newnans, Lochloosa, and Orange lakes (FWC 2011). This document represents FWC's proposed management guidelines, by habitat types. Habitat objectives for the Orange Creek Basin were derived by examining significant fish and wildlife focal taxa and evaluating their habitat needs. The habitat requirements for each focal taxon, or taxa group, were defined by species specialists through reviews of available biological literature, combined with professional judgment. The selected focal taxa groups include wading birds, waterfowl, bald eagles, centrarchid fish (represented by largemouth bass and black crappie), reptiles and amphibians, and round-tailed muskrats.

A broad range of management strategies is proposed by FWC (FWC 2011) to maintain or increase availability of high-quality fish and wildlife habitats in the Orange Creek Basin. These management strategies include but are not limited to:

- Tree island - burning and herbicide application
- Shrub swamp - burning, maintaining natural water fluctuations, herbicide application
- Shallow marsh - shredding, harvesting, burning, rotovating, herbicide application
- Floating marsh - maintaining a full range of normal water level fluctuations, spot treatment of woody vegetation, burning
- Deep marsh - shredding, harvesting, herbicide application, planting desirable native rooted emergent vegetation
- Floating island - maintain a full range of normal water level fluctuations, spot treatment of woody vegetation, burning.
- Open water - shredding, harvesting, burning, rotovating, herbicide application

Centrarchid Fish. Primary sport fisheries in Newnans, Lochloosa, and Orange lakes since 1996 are sunfish or bream (*Lepomis spp.*), black crappie(*Pomoxis nigromaculatus*), and largemouth bass (*Micropterus salmoides floridanus*). Angler success rate is measured as the number of fish caught per angler hour, based on creel surveys conducted by FWC. In 2009, sunfish (bream) were the fish most caught per hour of fishing in Florida water bodies where creel surveys were conducted, followed by black crappie and largemouth bass (Figures 42, 43, 44; http://research.myfwc.com/features/view_article.asp?id=34099). In 2009 statewide creel surveys, Newnans Lake ranked in the bottom third for angler success for these three sport fish species. Lochloosa ranked in the middle third statewide for sunfish and black crappie, and in the top third for largemouth bass. Orange Lake ranked in the middle third for black crappie and in the top third for sunfish and largemouth bass.

Angler success for largemouth bass, black crappie and sunfish in Newnans, Lochloosa, and Orange lakes was calculated for years since 1996 when FWC conducted creel surveys (Figures 45, 46, 47). Based on these data, an average of 0.35 fish were caught in Newnans Lake per hour of fishing. An average of 0.62 fish were caught in Lochloosa Lake per hour of fishing. An average of 1.23 fish were caught in Orange Lake per hour of fishing.

Since 1996, FWC augmented stock of sport fish in Newnans and Lochloosa lakes and did not stock any fish in Orange Lake. FWC added over 200,000 large mouth bass of various sizes to Newnans Lake for 3 years from 2007-2009 (Table 12). FWC added over half million black crappie to Lochloosa Lake over 4 years from 1998-2001 (Table 12). According to FWC, this stocking had minimal benefit to the black crappie fishery in Lochloosa Lake, presumably due to limiting food resources in the lake at the time.

Table 12. Sport fish stocked in Newnans and Lochloosa Lakes by FWC since 1996.

Year	Lake	Sport Fish Species Stocked	Number of Fish Stocked
2007	Newnans	largemouth bass (4.7-8.1 in.)	7,500
2008	Newnans	largemouth bass (3.5-4.4 in.)	60,000
2009	Newnans	largemouth bass (2.9-3.1 in.)	135,000
		Newnans Lake total	**202,500**
1998	Lochloosa	black crappie	124,800
1999	Lochloosa	black crappie	74,400
2000	Lochloosa	black crappie	199,611
2001	Lochloosa	black crappie	151,226
		Lochloosa Lake total	**550,037**

Waterfowl. FWC does not have check stations for waterfowl hunters on Newnans, Lochloosa or Orange Lakes. Mid-winter waterfowl surveys conducted by FWC from 1972-2003 on Orange and Lochloosa indicate that the most common waterfowl species were green-winged teal, blue-winged teal, American widgeon, ring-necked ducks, ruddy ducks, and lesser scaup. According to FWC, duck hunters on Orange and Lochloosa lakes target teal, ring-necked ducks, and wood ducks.

Reptiles and Amphibians. This group includes turtles and snakes, as well as frogs and other amphibian species. These species collectively are important components of the food web in these habitats. Frogs, primarily pig frogs (*Lithobates grylio*), are hunted recreationally. This group also includes alligators. Eight percent of all alligators harvested in Florida from 2000-2009 were taken from Newnans, Lochloosa, and Orange lakes (Figure 48). In 2009, a record high of 438 alligators were harvested from Orange Lake. Approximately 3,000 alligator eggs per year have been collected from wetlands in the Orange Creek Basin since 2004.

Hunting of alligators and frogs is done at night from airboats, the operation of which should have minimal effects on habitats in Orange Lake according to FWC. In November 2010 Alachua County citizens adopted an ordinance by popular referendum prohibiting operation of airboats in Alachua County between the hours of 7:00 PM and 7:00 AM effective January 1, 2011, with exceptions for government airboats operated in the line of duty by authorized personnel and private airboats authorized by law enforcement personnel during specific rescue incidents. Proponents of the ordinance cited nocturnal noise disturbance by airboats on the diversity of wildlife living in wetlands.

Wading birds. Bird Island and Redbird Island in Orange Lake both have historically supported important rookeries for approximately 20 species of birds, mostly wading birds such as egrets and herons. In some years, Bird Island has been estimated to support over 5,000 nesting pairs and Redbird Island over 1,000 nesting pairs of herons and other species of colonial nesting wading birds (Runde et al. 1991). Bird Island has been recognized as an important heron and egret rookery since at least 1910 when it was purchased by the predecessor of the National Audubon Society (Pearson 1941).

Shrub swamp is the dominant habitat type on both Bird Island and Redbird Island. That habitat consists of dense elderberry (*Sambucus canadensis*), buttonbush (*Cephalanthus occidentalis*), and coastal plain willow (*Salix caroliniana*). Wading birds construct their nests in these woody plants. Both islands are surrounded by deep marsh composed of rooted emergent and/or floating-leaved vegetation, often including cow lily (*Nuphar lutea*), which provides a buffer area for nesting birds and benefits other birds, wildlife and fish species. Buffer habitats may also include shallow marsh and floating marsh.

In the early 1990s four bald cypress trees on Bird Island died and areas of the woody shrub cover present there also declined (KBN 1996). The reasons for the deaths of the bald cypress trees and decline of the shrubs were not identified. However, lightning strikes, diseases, insects, guano buildup from the rookery (on the shrubs), water level fluctuations, and herbicide applications have been suggested as possible causes (KBN 1996). Alachua Audubon Society and FWC have proposed working together to enhance or restore woody vegetation on Bird Island to improve the suitability of that site as a wading bird rookery.

Other smaller wading bird rookeries sometimes form in other parts of Orange Lake including PG Run and Cane Hammock. Those rookery sites occur primarily in small patches of shrub swamp habitat isolated from the shoreline that also usually have fringing areas of deep marsh, floating marsh and shallow marsh associated with them.

FWC limits harvesting and other mechanical management procedures, as well as herbicide application, close to Bird Island and Redbird Island to maintain the buffer habitats. The same thing is also done at other, smaller active wading bird rookery sites to prevent negative impacts to those sites.

Bald eagles. Bald eagle nests are monitored annually by FWC for standard eagle management. Bald eagle nests that occur in the Orange Creek Basin are mapped as one element of developing aquatic habitat management guidelines for this area (FWC 2011).

Bald eagles use forested habitats for nesting and roosting. Nesting habitats generally consist of forested areas with mature trees that are isolated from human disturbance (FWC 2008). Expanses of shallow open water are primary sites for foraging on fish. For eagles, quality of aquatic foraging habitat is characterized both by availability of prey and availability of appropriate aquatic habitats, including open-water areas (FWC 2008).

The FWC has identified 16 ―core nesting areas” in Florida as areas where bald eagle nesting activity is concentrated. Habitats surrounding Newnans, Lochloosa and Orange lakes make up one of these core nesting areas (FWC 2008). The Orange Creek Basin core nesting area has been relatively stable for many years, which indicates the continued presence of high-quality breeding and foraging habitats.

Recommended habitat management practices for bald eagles include retaining large-diameter native pines to ensure the ongoing presence of sufficient numbers of suitable potential nest trees. Robust fish and waterfowl populations are integral components of suitable aquatic foraging habitats for bald eagles. The FWC will work to monitor aquatic habitats and to control aquatic plants as necessary through chemical, mechanical, or other appropriate management activities to maintain suitable bald eagle foraging habitats.

Round-tailed muskrats and other mammals. Several mammal species occur in the Orange Lake basin of which the round tailed muskrat (*Neofiber alleni*), marsh rabbit (*Sylvilagus palustris*), and various rodents (*Sigmodon hispidus*, *Peromyscus* spp., *Sorex* spp.) will be affected by management activities in the lake. These species contribute to nutrient cycling, being foragers of grain and insects and providing a prey base for predatory birds and reptiles.

The round-tailed muskrat was selected by FWC as a focal species for conservation emphasis because of its sensitivity to extreme water level fluctuations and habitat changes and concerns that the statewide population may be declining. Round-tailed muskrats occur typically in shallow freshwater marshes characterized by a sandy bottom and stands of maidencane (*Panicum hemitomon)* (FWC 2011). Muskrats construct dome-shaped lodges of aquatic plants, similar to that of the beaver (*Castor canadensis*), attaching them to emergent vegetation (Birkenholz 1972). Feeding platforms are also built near the lodge, consisting of a pad of plant material (Birkenholz 1963). Aquatic grasses make up the bulk of the round-tailed muskrat diet but stems, roots, and seeds are also eaten. Major predators of the round-tailed muskrat are herons, owls, hawks, snakes, and bobcats. Population densities can range from 25-100 individuals per acre in good habitat.

Shallow marshes are highly variable in plant composition. For round-tailed muskrats, areas of shallow marsh dominated by maidencane are considered primary or optimal habitat for nesting and foraging. Areas of shallow marsh, dominated by pickerelweed (*Pontederia cordata*), and mixed shallow marsh, where multiple species co-dominate, also are important for foraging and, to a lesser extent, nesting (FWC 2011). Floating marshes and floating islands also can provide important foraging habitat, especially at the margins near shallow marsh areas (FWC 2011). Prescribed fire, mechanical management strategies (including, but not limited to harvesting and rotovating) and herbicide application are important techniques to maintain and promote appropriate habitat characteristics for round-tailed muskrats.

FWC Habitat Enhancement Projects

The Aquatic Habitat Restoration/Enhancement (AHRE) program of the Florida Fish and Wildlife Conservation Commission spent $1,239,883 since 1996 on habitat restoration projects in Newnans, Lochloosa, and Orange lakes (Table 13). Details of the FWC AHRE projects are described in Appendix D. Additional information on FWC's Orange Lake projects can be found in Mallison et al. 1999, 2001, and 2010.

In 2011 FWC AHRE plans to plant approximately 5,000 knotgrass (*Paspalidium geminatum*) in the littoral zone of Newnans Lake if water level is low enough. The planting will be on the east side of Newnans Lake just north of the Windsor boat ramp. Also in 2011, FWC will apply herbicide to maintain areas where they planted knotgrass, maidencane and bulrush over the past several years. The FWC AHRE program proposes to apply herbicide to about 12 acres of littoral zone vegetation in Orange Lake to control frog's-bit, pennywort, Cuban bulrush, water hyacinth and water lettuce, cattail, primrose willow, and Carolina willow. The purpose is to maintain quality fish spawning and wading bird foraging habitat.

Table 13. FWC Aquatic Habitat Restoration/Enhancement (AHRE) projects and expenditures from 2000-2010 in Newnans, Lochloosa, and Orange lakes.

FWC Aquatic Habitat Restoration/Enhancement Project	Fiscal Year	FWC-AHRE Expenditures
Orange Lake: scraped 15-acres of sediment and vegetation in a pilot project	1997-1998	$75,000
Orange Lake: scraped 160-acres of sediment and vegetation and created 7 disposal islands	2001-2002	$573,402
Orange Lake: Mechanically harvested 14 acres of floating vegetation and deposited in disposal area; treated 4,387 acres of floating vegetation with herbicide applications or mechanical shredding	2004-2005	$524,057
Orange Lake: spread, disc and seed vegetative material previously deposited on shoreline	2005-2006	$23,370
Newnans Lake: 19.7 acres of vegetation removed to open access trails; planted 90,000 aquatic plants	2005-2006	$19,500
Orange Lake: reseeded vegetative material previously deposited on shoreline	2007-2008	$637

FWC Aquatic Habitat Restoration/Enhancement Project	Fiscal Year	FWC-AHRE Expenditures
Newnans Lake: planted 8,000 plants	2007-2008	$3,000
Newnans Lake: treated invasive Island Apple Snail	2007-2008	$7,658
Orange Lake: 3.5 acres of wetland trees planted on shoreline	2008-2009	$7,109
Newnans Lake: 7,500 plants planted over 2.5 acres	2008-2009	$2,250
Lochloosa Lake: 10,000 plants planted over 5 acres	2008-2009	$2,750
Orange Lake: herbicide applied to 5 acres of wetland and aquatic plants in areas previously dredged	2009-2010	$1,000
Orange Lake: herbicide applied to weeds among wetland trees planted previous year	2009-2010	$150
Total Expenditures =		**$1,239,883**

In 2002-03, FDEP and FWC applied herbicide to 400 acres of coastal plain willow (*Salix caroliniana*) in Orange Lake to restore deep marsh habitat displaced by expanding willow populations (FWC 2003). The report recommends a much more aggressive approach to achieve lake-wide control of coastal plain willow to prevent succession toward permanently established, undesirable plant communities.

Relevant Regulations

Review for an Environmental Resource Permit (ERP) from the Florida Department of Environmental Protection or the St. Johns River Water Management District is required for certain proposed activities on lakes (Chapter 40C-4, F.A.C.). New development within the lake basin that exceeds permitting thresholds, such as residential subdivisions, commercial areas, and roads, require ERP review. ERP review is also required for construction of docks and boat ramps, shoreline alteration such as seawall construction, canal excavation, and certain kinds of vegetation removal. Mechanical shredding of lake vegetation using a cookie cutter, a boat that shreds floating vegetation and deposits it in the lake, was determined in 2008 to require review for an Environmental Resource Permit. Depositing shredded vegetation in a lake constitutes filling of the lake with organic material that provides nutrients to fuel algae growth, inconsistent with state water quality standards.

Some activities may qualify for permit exemptions, depending on the size. Florida statutes provide an exemption from permitting for removal of aquatic plants, removal of tussocks, associated replanting of indigenous aquatic plants and associated removal from lakes of organic detrital material under certain circumstances and limitations [Part IV of Chapter 373, Section 403.813(2)(r) F.S.]. One of these limitations is that all material must be removed from the surface waters and wetlands and deposited in an upland site in a manner that will prevent the reintroduction of the material into waters in the state, except when the spoil material is used to create wildlife islands in freshwater bodies of the state when a governmental entity is permitted to create such islands as a part of a restoration or enhancement project. Another limitation is that all activities performed under the exemption must be performed in a manner consistent with state water quality standards.

Florida Fish and Wildlife Conservation Commission is given the authority to permit removal of aquatic vegetation under 68F-20 of the Florida Administrative Code. Riparian owners are allowed to remove vegetation along their shoreline in an access corridor that is 50 feet wide or 50% of their shoreline, whichever is less. For additional questions regarding aquatic plant management in Newnans, Lochloosa, and Orange lakes, contact the FWC regional office in Lake City at (386) 758-0525.

Alachua County regulates land uses and activities in and adjacent to surface waters and wetlands through application of comprehensive plan goals, objectives and policies and through implementation of land development regulations. The obligation/authority for such regulation results from requirements found in Chapter 163, F. S. and Rule 9J-5, F.A.C. Alachua County in their comprehensive plan has adopted policy language to regulate fill materials that may leach phosphorus and excavations that would lead to exposure of phosphorus-rich sediments that might adversely impact groundwater and/or surface water (Alachua County Comprehensive Plan Policy 4.6.16 5. and 6.).

Most comprehensive plan provisions regarding surface waters and wetlands are found within the Conservation and Open Space Element, particularly Section 4.6 (Surface Water Systems) and Section 4.7 (Wetland Ecosystems). Relevant land development regulations implementing comprehensive plan policies are found in Chapter 406 of the Unified Land Development Code, particularly Article 6 (Surface Waters and Wetlands). The comprehensive plan and land development regulations can be accessed through links found on Alachua County's website (www.alachuacounty.us).

Essentially, Alachua County's regulations prohibit alterations of surface waters, wetlands, and required upland buffers except for specific exempt activities, activities that result in minimal impact, or activities associated with an over-riding public purpose. Anyone contemplating impacts to these resources should contact the county's Environmental Protection Department at (352) 264-6800 to discuss applicable regulations.

The Alachua County Environmental Protection Department implements several codes that protect water resources: the Hazardous Materials Management Code, (Alachua County Code Ch. 353), the Water Quality Code (Ch. 77), the Fertilizer Standards and Management Code (Ch. 78), and the Landscape Irrigation Standards and Management Code (Ch. 79). The focus of the Hazardous Materials Program is to implement the code and provide business compliance assistance with local, state, and federal hazardous materials and hazardous waste regulations that protect groundwater and surface water quality. The Water Quality Code is implemented to reduce illicit discharges to groundwater and surface water and provides Alachua County the authority to enforce state water quality standards via local code. The code applies county-wide and provides a framework for local enforcement of these regulations. The Fertilizer Standards and Management Code adopted the state model ordinance and promotes efficient use of fertilizer and reduces the potential for landscape fertilizers to be improperly used, potentially leading to groundwater and surface water quality degradation. The City of Gainesville opted to adopt Alachua County's Fertilizer Standards and Management Code. The Landscape Irrigation Standards and Management Code adopts water management district standards so they are locally regulated and enforced to promote water conservation, which protects both water quality and quantity.

Potential Projects
(See Table 16 for schedule and estimated costs)

<u>FWC</u>

- Herbicide cattail monocultures in wetlands of Orange Creek Restoration Area to enhance habit for waterfowl, wading birds, fish and alligators; proposed SJRWMD cost-share
- Monitor black crappie fishery prior to shad harvest in Newnans Lake; funded by SJRWMD
- Reduce organic sediments by rotovating (plowing) 125 acres of shallow marsh in the littoral zone on the north side of Orange Lake to increase hard-bottom habitats favorable to fish spawning and to stimulate establishment of wetland plants
- Plant bald cypress trees on 50 acres on the south side of Orange Lake
- Mechanically harvest about 15 acres of floating vegetation on Orange Lake to maintain areas previously harvested and scraped
- Restore woody vegetation on Bird Island in Orange Lake suitable for potential support of a bird rookery as historically occurred on the island, in collaboration with Alachua Audubon Society

FUTURE PROTECTION OF THE ORANGE CREEK BASIN

Land Conservation and Restoration

Issue

Conservation Land Acquisition

Conservation lands are acquired by the District to help meet the following goals in the District's Land Acquisition and Management Five Year Plan and the District's Water Management Plan:

1. Restore, maintain, and protect native natural communities and diversity.
2. Improve water quality, restore and maintain natural hydrological regimes, and increase flood protection by preserving important wetland areas.
3. Provide opportunities for recreation where compatible with above listed goals.

The District acquired 49,823 acres of conservation lands in the OCB since 1989 (Figure 49). The District provided $32,603,566 towards these purchases, 63% of the total purchase price. Partners such as USDA Wetland Reserve Program, USDA Farm and Ranch Lands Protection Program, FDOT, Alachua County, and City of Gainesville provided $18,898,159. Land transactions were a combination of full fee, joint fee, and easements for conservation or flowage. Conservation lands acquired by the District since 1996 total 22,305 acres, which is 45% of all conservation lands acquired by the District in the OCB. Table 14 lists the District's more significant (i.e. larger) land transactions in the Orange Creek Basin and is not a list of all land transactions.

Table 14. Significant conservation land transactions of the St. Johns River Water Management District in the Orange Creek Basin since 1996. This is not a list of all District land transactions since 1996.

Year of Land Transaction	Name of Land Parcel	Acreage
1998	Orange Creek Muck Farm in the Orange Creek Restoration Area	3,418
1999	Conservation easements on Murphree wellfield for Gainesville Regional Utilities (partially outside the Orange Creek Basin)	4,018
2000	Additional land in Newnans Lake Conservation Area	3,395
2001	Additional land in Newnans Lake Conservation Area	964
2003	Lybass property in the Longleaf Flatwoods Preserve	1,347
2003	Additional land in and adjacent to Orange Creek Restoration Area	110
2005	Additional land in Newnans Lake Conservation Area	1,708
2007	Additional easements adjacent to Orange Creek Restoration Area	722
2008	Additional land or easements in Longleaf Flatwoods Preserve (1,469 acres) and in Newnans Lake Conservation Area (195 acres)	1,664
2009	Addition to Paynes Prairie Preserve State Park	184

Year of Land Transaction	Name of Land Parcel	Acreage
2009	Additional land or easements in Newnans Lake Conservation Area	64
2010	BJ Bar Ranch Conservation Easement	4,888

The District's 2011 acquisition map includes about 7,180 acres of potential acquisitions in the Newnans Lake basin (Figure 49). Total estimated purchase price for these lands is $17,950,000 at an estimated $2,500/acre. At this time, however, the District does not anticipate making any purchases in the Basin in the next five years.

In 2000 Alachua County instituted the Alachua County Forever Program to acquire, improve and manage environmentally significant lands to protect water resources, wildlife habitats and natural resources suitable for resource-based recreation. Thirteen acquisitions totaling 5,886 acres were acquired within the Orange Creek Basin by Alachua County through the Alachua County Forever Program since 2003 (Table 15). The District provided $3,400,718 in cost-share funding to Alachua County for purchase of 3,264 acres, 55% of the conservation land purchased by Alachua County. For more information go to http://www.alachuacounty.us/Depts/EPD/LandConservation/Pages/LandConservation.aspx.

Table 15. Conservation land transactions of the Alachua County's conservation land acquisition program, Alachua County Forever. Asterisk (*) notes cost-share funding provided by SJRWMD.

Year of Land Transaction	Name of Land Parcel	Acreage
2003	Lybass Longleaf *	1,388
2003	Beville Creek	23
2005	Rayonier - Newnans Lake *	1,708
2006	Phifer Flatwoods	634
2006	Sweetwater Limited	113
2006	Mill Creek – Halbrook & Steedley	36
2006	Henderson Tract East	25
2007	Lake Forest Creek - Wainberg	25
2008	River Styx - Rayonier	1,354
2008	Lochloosa Connector - F Wood Conservation Easement	136
2008	Austin Cary Forest - Bloom & Frank *	132
2009	Austin Cary – Gladstone *	36
2009	Edwards	276

Alachua Conservation Trust is a non-profit land trust incorporated in 1988 to protect the natural, historic, scenic and recreational land in and around Alachua County through land purchase, land donation, and conservation easements. Alachua Conservation Trust and its partners, including the District, acquired over 5,700 acres in the OCB, including Prairie Creek Preserve (368 acres), Lake Tuscawilla Preserve (379 acres), Phifer Flatwoods (643 acres), additions to Paynes Prairie State Preserve (more than 2,460 acres), Hogtown Creek Greenway (more than 900 acres), Newnans Lake-Gum Root Swamp (720 acres), and Prairie Creek (more than 230 acres). For information go to http://alachuaconservationtrust.org/

Management of District Lands

Conservation lands managed by the St. Johns River Water Management District in the Orange Creek Basin are Newnans Lake Conservation Area, Lochloosa Wildlife Conservation Area, Longleaf Flatwoods Reserve, and Orange Creek Restoration Area. This includes management of 4,618 acres of conservation land purchased with or by Alachua County.

The District's Department of Operations and Land Resources develops and regularly updates management plans for conservation lands managed by the District. Land management plans are available on the District website at floridaswater.com/landmanagementplans.

Land management goals for District-managed properties in the Orange Creek Basin include improving water quality, maintaining natural hydrological regime, and increasing flood protection by preserving important floodplain areas. District abides by silvicultural Best Management Practices on all lands that it manages in the Orange Creek Basin. As land management plans for Newnans Lake Conservation Area, Lochloosa Wildlife Conservation Area, Longleaf Flatwoods Reserve, and Orange Creek Restoration Area are updated, they will include opportunities for projects and activities that reduce loading of nutrients and other pollutants to downstream water bodies and improve habitats.

Newnans Lake Conservation Area (6,698 acres) occupies 9% of the Newnans Lake basin. Newnans Lake Conservation Area (NLCA) includes approximately 3 miles of Newnans Lake shoreline, 3 miles of Hatchet Creek, 2 miles of Little Hatchet Creek, and Gum Root Swamp (Figure 49). Water resource strategies in the District's land management plan for NLCA are to regularly monitor roads and bridges for erosion problems, and evaluate opportunities to restore a channelized portion of Hatchet Creek. The completion in 2009 of timber reservations in NLCA provides opportunities for the District to implement land management and restoration activities that could benefit water quality in Newnans Lake such as restoring logging roads and repairing stream crossings. Timber reservation areas have been clear cut and can now be replanted with more appropriate pine and understory species to improve habitat.

Lochloosa Wildlife Conservation Area (10,338 acres) occupies 18% of the Lochloosa Lake basin and less than 1% of the Orange Lake basin. FWC designated the property as a Wildlife Management Area. Water resource strategies in the District's land management plan for Lochloosa Wildlife Conservation Area are to regularly inspect roads, bridges, and crossings for erosion problems, and to evaluate options for improving roads in order to further reduce potential impacts from erosion.

The District does not manage the adjacent 16,610-acre Lochloosa Conservation Easement, which is managed by Plum Creek Timber Company as an industrial silvicultural site. The Lochloosa Conservation Easement occupies 9% of the Lochloosa Lake basin and 13% of the Orange Lake basin. The conservation easement is designed to afford long-term protection to wetlands on the site.

Longleaf Flatwoods Reserve (2,856 acres) occupies 3% of the Orange Lake basin. Camps Canal bisects the westernmost portion of the property and flows into a swamp forest called River Styx, which is partly contained in the Longleaf Flatwoods Reserve (LFR). Water in River Styx flows into Orange Lake. Water resource strategies in the District's land management plan for LFR are to regularly inspect roads, bridges, crossings, and trails for erosion problems; regularly inspect canals and ditches for erosion problems; install water bars, turn outs, and low water crossing; and when possible, remove beds from harvest areas.

Orange Creek Restoration Area (4,251 acres) occupies 5% of the Orange Creek sub-basin. This site was formerly shallow marsh at the downstream end of Orange Lake before it discharged into Orange Creek. The wetlands were drained in the 1930s and were farmed in row corps until the District acquired the farm in 1998. Most of the property is under a perpetual conservation easement with USDA Natural Resources Conservation Service's Wetland Reserve Program. The District removed berms and filled farm ditches to restore historic hydrology and shallow marsh wetlands in the former farm fields. Water resource strategies in the District's land management plan for Orange Creek Restoration Area are to monitor roads for erosion.

In 2007 owners of Crones Cradle Conserve, adjacent to the Orange Creek Restoration Area, donated a perpetual conservation easement on 178 acres and a flowage easement on 600 acres. As compensation for the easements, the District filled ditches and removed pump stations and associated piping to restore wetlands on the Conserve.

Potential Projects
(See Table 16 for schedule and estimated costs)

SJRWMD

- Acquire conservation lands in the Orange Creek Basin proposed in the District's 5-Year Acquisition Plan
- Include pollutant load reduction opportunities in updates to District land management plans for conservation lands in the Orange Creek Basin

PUBLIC OUTREACH

Public Participation Opportunities and Interagency Coordination

Issue

Organizations and agencies with current activities in the OCB and that were not included in the 1996 Plan are:

- Airboat clubs
- Conservation Trust for Florida
- Current Problems / Adopt a River
- Fishing clubs such as Eastside Garden Club, a long-standing fishing club
- Florida Division of Historical Resources (Newnans Lake ancient canoes)
- Florida Wildlife Federation
- Friends of Newnans Lake
- Gainesville Chamber of Commerce
- National Register of Historic Places (Newnans Lake ancient canoes)
- Putnam County Environmental Council
- Putnam Land Trust
- Seminole Tribe of Florida (Newnans Lake ancient canoes)
- Sustainable Alachua County
- Quiet Lakes of Alachua County
- Women for Wise Growth

Orange Creek Basin Advisory Council

The Governing Board of the St. Johns River Management District appointed members to the Orange Creek Basin Advisory Council in 1993 at the request of Florida Governor Lawton Chiles. Richard Hamann of the University of Florida Levin School of Law chaired the Advisory Council. Voting members represented a broad range of interests in the Orange Creek Basin.

The purpose of the Advisory Council was to provide guidance to the District in developing strategies for water body management, protection and restoration and to promote public awareness and intergovernmental cooperation regarding OCB issues. In 1995, the Council appointed a Scientific Advisory Committee to provide guidance on technical issues. In 1996, the OCB Advisory Council approved the Orange Creek Basin Surface Water Management Plan, which was then approved unanimously the Governing Board. The OCB Advisory Council convened regularly in publicly noticed meetings through 2001.

FDEP Orange Creek Basin Working Group

In 2004 the Florida Department of Environmental Protection formed the Orange Creek Basin Working Group, a diverse stakeholder group including the St. Johns River Water Management District that met almost monthly from August 2004 through September 2007 while developing the Orange Creek Basin Management Action Plan (OCBMAP). This plan addresses reductions in external pollutant loads needed to restore water quality to state standards in surface water bodies listed by FDEP as impaired. The Orange Creek Basin Management Plan was adopted by Order of the Secretary of FDEP in 2008 (FDEP 2008; www.dep.state.fl.us/water/watersheds/bmap.htm).

FDEP convenes the Basin Working Group twice a year to review progress on projects listed in the plan. At almost every meeting since the Basin Management Action Plan was adopted, the District makes presentations on topics such as status and trends in lake water quality and updates on District projects in the Orange Creek Basin. A Newnans Lake Water Quality Committee formed in 2011 to coordinate on projects to reduce phosphorus loading to Newnans Lake from its basin.

Outreach

The St. Johns River Water Management District’s Office of Communications and Governmental Affairs is responsible for ensuring that the public gets accurate and consistent information about the agency, its mission and its projects and programs. This includes all environmental education activities, such as water conservation and other water resource education; public information and media outreach activities; and outreach activities relating to local, regional, state and federal governmental staffs and elected officials.

District staff actively communicate about watershed projects and work to enhance water resource awareness through media and public outreach, including recognizing a new ―green” Florida Water Star-certified home in Gainesville (2009), bringing media and public attention to the District’s three-year experimental shad harvest (2010), and promoting youth education and volunteer activities, public lands, and public meetings on an ongoing basis.

The District also works with state, federal and local elected and appointed officials and their staffs to address and manage water resource issues on a local and regional level. District efforts in the Orange Creek Basin have included working with elected officials and staff on comprehensive planning and local land-use amendments to address water resource protection and water supply sustainability.

The District initiated a volunteer program in Alachua County in 1999. Over the past 11 years, 520 individuals and 173 groups have volunteered approximately 92,000 hours. These groups usually consisted of 20-60 people and represented Boy Scouts, Girl Scouts, environmental clubs, Rotary Clubs, men’s and women’s clubs, University of Florida clubs, kayak clubs, and gardening clubs. Local government partners have included the Alachua County Environmental Protection Department and the Gainesville Clean Water Partnership, a partnership between the City of Gainesville, Alachua County and the Florida Department of Transportation. District-led volunteer activities continue throughout the District, including Alachua County.

The District’s outreach program includes presentations on a variety of topics including water supply, water conservation and waterwise landscaping; participation in community events and waterway cleanups; and opportunities for community volunteers to participate in water resource protection. The Florida Water Star℠ program (launched in 2006), The Great Water Odyssey℠

(begun in 2005), and other in-school initiatives also continue to be implemented in Alachua County.

Alachua County Environmental Protection Department conducts public outreach activities in the Orange Creek Basin. The Alachua County Environmental Protection Department produced a series of Best Management Practices brochures, many of which deal with nutrient pollutants, which are distributed at various locations and public events. County staff give presentations at homeowners associations, schools, and local events. The Alachua County Environmental Protection Department coordinates targeted campaigns for influencing specific behaviors such as cleaning up pet waste and keeping grass out of street drains and stormwater collection systems. For more information please visit www.AlachuaCountyWater.org.

Orange Creek Basin Lake Management Interagency Working Group

The District convened a new –Orange Creek Basin Lake Management Interagency Working Group” on August 31, 2011 to better coordinate in-lake management activities in Newnans, Lochloosa and Orange lakes. This interagency group consists of state agencies and local governments with statutory responsibilities for in-lake management of Newnans, Lochloosa, and Orange lakes: the District, FWC, DEP (ERP permitting), and Alachua County. The purpose of this group is to regularly and informally communicate and collaborate on plans and activities in Newnans, Lochloosa, and Orange lakes.

The group plans to meeting at least twice a year to coordinate while in the planning phase on in-lake activities such as but not limited to gizzard shad harvests, invasive aquatic plant management, aquatic and wetland habitat management, lake sediment removal, lake access, and permitting of in-lake activities.

Potential Projects
(See Table 16 for schedule and estimated costs)

SJRWMD

- Actively participate in FDEP’s Orange Creek Basin Working Group to implement TMDLs for Newnans, Lochloosa and Orange lakes
- Participate in the new Orange Creek Basin Lake Management Interagency Working Group to coordinate in-lake management in Newnans, Lochloosa and Orange lakes

OCB SWIM PROGRAM MANAGEMENT AND SUPPORT

Full-Time Employee and Contract Staff Support

Issue

The Orange Creek Basin program budget and staffing peaked from 1996 through 2002, averaging $640,000 per year and including 4 full-time scientists in the Water Resources Department. Budget and full-time employee staffing in the Orange Creek Basin SWIM program decreased after 2002.

The FY 10-11 General Program budget for the OCB SWIM program was $23,178, which did not include salaries, with staffing for the Orange Creek Basin SWIM program at one FTE (full-time employee equivalent) divided among two scientists and one engineering modeler. Additional assistance was provided by five on-site contingent workers funded through other District programs to provide water quality and plankton sampling, data management and analysis; GIS management and analysis; water quality monitoring program management; and field data collection. One part-time consultant provided program management services since 2006. For FY 11-12, no OCB contingent workers or consultants are budgeted and no FTEs are assigned to the OCB SWIM program.

Potential Projects
(See Table 16 for schedule and estimated costs)

SJRWMD

- Retain support for field data collection and for ecological, hydrologic and GIS data management and analysis
- Retain support for OCB program and project management

SCHEDULE AND FUNDING NEEDS

Table 16 outlines 56 potential projects through FY 16 to address issues described in the previous chapter, with estimated annual costs and a total 5-year cost of $7,580,000. This list includes District-led projects as well as projects proposed by others in the Orange Creek Basin. These projects are not listed in priority. Implementation of projects depends on obtaining permits and funding.

Table 16. Schedule and estimated costs, where provided, for potential projects in the Orange Creek Basin. These projects are not prioritized. Project implementation depends on obtaining permits and funding.

ISSUE	LEAD AGENCY	POTENTIAL PROJECTS	FY12	FY13	FY14	FY15	FY16	Total 5-Year Cost
Hydrology	SJRWMD	Coordinate with Hydrologic Data Services Division to continue monitoring water level and discharge Newnans, Lochloosa, and Orange lakes and their basins, and in Paynes Prairie	District staff time	District staff time	District staff time	District staff time	District staff time	
	SJRWMD	Coordinate with Hydrologic Data Services Division to monitor hydrology sufficient to determine long-term average volume of water flowing through Camps Canal culverts into Paynes Prairie	District staff time	District staff time	District staff time	District staff time	District staff time	
	SJRWMD	Evaluate function and longevity of Camps Canal culverts to Paynes Prairie, in coordination with Paynes Prairie Preserve State Park	$50,000					**$50,000**
	SJRWMD	Reduce basal area of forest trees on District-managed lands around OCB lakes through thinning of dense stands, to increase downstream water yield	District staff time	District staff time	District staff time	District staff time	District staff time	
	FWC	Remove sections of berms on the shoreline of Orange Lake at Samson's Point to restore hydrology in 400 acres of littoral wetlands separated from the lake since the 1930s-40s. Proposed SJRWMD cost-share		$100,000	200,000			**$300,000**
Aquatic Species Management	FWC	Coordinate through a new OCB Lake Management Interagency Working Group to manage water lettuce and water hyacinth in Newnans, Lochloosa, and Orange lakes at the lowest feasible level, maintaining maintenance control using a surveillance-based approach						
	FWC	Coordinate through a new OCB Lake Management Interagency Working Group to manage hydrilla in Newnans Lake at the lowest feasible level, maintaining maintenance control using a surveillance-based approach						
	FWC	Coordinate through a new OCB Lake Management Interagency Working Group to manage hydrilla in Orange and Lochloosa lakes to address public recreation, fisheries and waterfowl goals						
	FWC	Coordinate through a new OCB Lake Management Interagency Working Group to manage aquatic and wetland vegetation as needed						

ISSUE	LEAD AGENCY	POTENTIAL PROJECTS	FY12	FY13	FY14	FY15	FY16	Total 5-Year Cost
Water Quality	SJRWMD	Collect and analyze monthly water quality and plankton samples in Newnans, Lochloosa and Orange lakes and their major inflow tributaries	Support staff time	Support staff time	Support staff time	Support staff time	Support staff time	
	SJRWMD	Perform QA, archive, and analyze water quality and plankton data	Support staff time	Support staff time	Support staff time	Support staff time	Support staff time	
	SJRWMD	Refine HSPF model for the OCB, incorporating recent stormwater sampling data and UF Newnans Lake study findings	District staff time					
	SJRWMD	Update water budgets and produce nutrient budgets for Newnans, Lochloosa and Orange lakes using refined HSPF model		District staff time				
	SJRWMD	Develop integrated surface-groundwater models for Newnans, Lochloosa, and Orange lakes			$100,000	$100,000		**$200,000**
	SJRWMD	Evaluate and revise Pollutant Load Reduction Goals for Newnans Lake		District staff time				
	SJRWMD	Coordinate with FDEP and OCB Working Group to revise Orange Creek BMAP to reduce external phosphorus loading to Newnans Lake	District staff time					
	SJRWMD	Develop Pollutant Load Reduction Goals for Lochloosa Lake	District staff time					
	SJRWMD	Identify sources of nutrients to Lochloosa Lake		$80,000				**$80,000**
	SJRWMD	Develop Pollutant Load Reduction Goals for Orange Lake		District staff time				
	SJRWMD	Identify sources of nutrients to Orange Lake			$80,000			**$80,000**
	SJRWMD	Quantify phosphorus load to Newnans Lake from tributaries and wetlands by determining phosphorus content and speciation in a range of soil and sediment types and sizes including suspended solids entrained during storm events	$50,000	$50,000				**$100,000**
	SJRWMD	Assess nitrogen fixation by phytoplankton in Newnans Lake, including determining timing, magnitude, and transformations of nitrogen fixed and assessing fate of fixed nitrogen in Newnans Lake and Prairie Creek	$100,000	$100,000				**$200,000**
	SJRWMD	Determine phosphorus speciation in Newnans Lake sediment cores and pore water to distinguish phosphorus recycling from apatite mineralization	$30,000	$30,000				**$60,000**
	University of Florida	Quantify fluxes of phosphorus from Newnans Lake sediments over diurnal, seasonal and shad-harvest time frames to determine how to reduce phosphorus recycling to the water column	$50,000	$50,000				**$100,000**

ISSUE	LEAD AGENCY	POTENTIAL PROJECTS	FY12	FY13	FY14	FY15	FY16	Total 5-Year Cost
	University of Florida	Assess Newnans Lake metabolism (productivity and respiration) by measuring diel oxygen dynamics at the sediment/water interface to understand the level at which ecosystem phosphorus limitation would be reestablished	$25,000	$25,000				**$50,000**
	SJRWMD	Conduct Newnans Lake shad harvest to improve water quality and increase rate of phosphorus deposition to lake sediments	$127,000					**$127,000**
	SJRWMD	Evaluate effects of Newnans Lake gizzard shad harvest on water quality and phosphorus sedimentation rate	District staff time	District staff time				
	City of Gainesville	Complete a Little Hatchet Creek and Lake Forest Creek Watershed Management Plan to reduce pollutant loads to Newnans Lake	$300,000					**$300,000**
	SJRWMD	Evaluate potential for restoration of phosphorus attenuation in wetlands the Little Hatchet Creek basin including Gum Root Swamp	District staff time	District staff time				
	SJRWMD	Evaluate potential for use of an chemical-based water quality treatment system downstream of Gainesville airport	District staff time	District staff time				
	SJRWMD	Cooperate with land owner to develop a phosphorus-load reduction plan and projects for the Windsor blueberry farm on Newnans Lake	District staff time	District staff time				
	SJRWMD	Evaluate potential for hydrologic restoration of modified tributaries of Newnans Lake in proximity to the Hawthorn Group, to reduce phosphorus loading	District staff time	District staff time				
	SJRWMD	Restore historic basin hydrology by installing low-water crossings in roads on District-managed lands to reduce erosion in tributaries and drainage of surficial soils and wetlands, to reduce phosphorus loading to Newnans, Lochloosa, and Orange lakes; proposed FWC cost share	$200,000					**$200,000**
	SJRWMD	Repair and stabilize unimproved roads on District-managed lands to reduce surface runoff and sediment and phosphorus loading to Lochloosa Lake; proposed FWC cost-share	$250,000					**$250,000**
	SJRWMD	Provide cost-share funding to Alachua County and City of Gainesville for implementation of their projects in the Orange Creek BMAP	$100,000	$100,000	$100,000	$100,000	$100,000	**$500,000**
	City of Gainesville	Improve quality of water discharging to Paynes Prairie by removing trash and enhancing wetland treatment along Tumblin Creek.	$250,000	$250,000				**$500,000**

ISSUE	LEAD AGENCY	POTENTIAL PROJECTS	FY12	FY13	FY14	FY15	FY16	Total 5-Year Cost
	SJRWMD	Provide cost-share funding (as a legislative appropriation) to City of Gainesville for implementation of Sweetwater Branch / Paynes Prairie Sheetflow Restoration Project, for construction of the enhancement wetland, water control structures, and sheetflow distribution channel.	$1,000,000	$1,000,000				**$2,000,000**
	City of Gainesville	Fill and restore wetland in Sweetwater Canal in Paynes Prairie		$500,000				**$500,000**
	City of Gainesville	Connect properties along Gainesville urban creeks to municipal wastewater treatment to reduce fecal coliform contamination	$225,000					**$225,000**
	Alachua County	Assess shoreline septic tank systems near Newnans, Lochloosa, and Orange lakes	$250,000					**$250,000**
	FDACS	Develop, adopt, implement, and monitor compliance with agriculture and silviculture Best Management Practices in the Orange Creek Basin	FDACS staff time	FDACS staff time	FDACS staff time	FDACS staff time	FDACS staff time	
Lake Sediment Accumulation		(no projects proposed)						
Fish and Wetland Wildlife Habitats and Communities	FWC	Herbicide cattail monocultures in wetlands of Orange Creek Restoration Area to enhance habit for waterfowl, wading birds, fish and alligators; proposed SJRWMD cost-share	$25,000	$10,000	$10,000	$10,000	$5,000	**$60,000**
	FWC	Monitor black crappie fishery prior to shad harvest in Newnans Lake; funded by SJRWMD	$6,000					**$6,000**
	FWC	Reduce organic sediments by rotovating (plowing) 125 acres of shallow marsh in the littoral zone on the north side of Orange Lake to increase hard-bottom habitats favorable to fish spawning and to stimulate establishment of wetland plants			$30,000			**$30,000**
	FWC	Plant bald cypress trees on 50 acres on the south side of Orange Lake		$50,000				**$50,000**
	FWC	Mechanically harvest about 15 acres of floating vegetation on Orange Lake to maintain areas previously harvested and scraped			$200,000			**$200,000**
	FWC	Restore woody vegetation on Bird Island in Orange Lake suitable for potential support of a bird rookery as historically occurred on the island, in collaboration with Alachua Audubon Society						

ISSUE	LEAD AGENCY	POTENTIAL PROJECTS	FY12	FY13	FY14	FY15	FY16	Total 5-Year Cost
Future Protection of the Orange Creek Basin	SJRWMD	Acquire conservation lands in the Orange Creek Basin proposed in the District's 5-Year Acquisition Plan						
	SJRWMD	Include pollutant load reduction opportunities in updates to District land management plans for conservation lands in the Orange Creek Basin	District staff time	District staff time	District staff time	District staff time	District staff time	
Public Outreach	SJRWMD	Actively participate in FDEP's Orange Creek Basin Working Group to implement TMDLs for Newnans, Lochloosa and Orange lakes	District staff time	District staff time	District staff time	District staff time	District staff time	
	SJRWMD	Participate in the new Orange Creek Basin Lake Management Interagency Working Group to coordinate in-lake management in Newnans, Lochloosa and Orange lakes	District staff time					
OCB Program Management and Support	SJRWMD	Retain support for field data collection and for ecological, hydrologic and GIS data management and analysis	$165,000	$173,000	$182,000	$192,000	$200,000	**$912,000**
	SJRWMD	Retain support for OCB program and project management	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
		TOTAL ESTIMATED COSTS	**$3,253,000**	**$2,568,000**	**$952,000**	**$452,000**	**$355,000**	**$7,580,000**

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APPENDIX A. LIST OF ACRONYMS

AHRE	Aquatic Habitat Restoration/Enhancement
cfs	cubic feet per second
EPA	U.S. Environmental Protection Agency
ERP	Environmental Resource Permit
FDEP	Florida Department of Environmental Protection
FDACS	Florida Department of Agriculture and Consumer Services
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
F.S.	Florida Statutes
FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
mgd	million gallons per day
MS4	Municipal Separate Storm Sewer System
N	nitrogen
NAVD	North American Vertical Datum of 1988
NGVD	National Geodetic Vertical Datum of 1929
NPS	Nonpoint Source
OCB	Orange Creek Basin
OCBMAP	Orange Creek Basin Management Action Plan
P	phosphorus
PLRG	Pollutant Load Reduction Goal
SJRWMD	St. Johns River Water Management District
SSARR	Streamflow Synthesis and Reservoir Regulation
SWIM	Surface Water Improvement and Management
TMDL	Total Maximum Daily Load
TSI	Trophic State Index
UF	University of Florida
WMP	Watershed Management Program
WWTF	Wastewater Treatment Facility

APPENDIX B. ELEMENTS OF A COMPREHENSIVE WATERSHED PLAN PER U.S. ENVIRONMENTAL PROTECTION AGENCY GUIDANCE

1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

2. An estimate of the load reductions expected for the management measures described under paragraph (c) below.

3. A description of the nonpoint source (NPS) management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

APPENDIX C. CHRONOLOGY OF PROJECTS, EVENTS, AND ACTIVITIES SINCE 1996

The 1996 Plan (page 60) included a chronology of important management events. This appendix continues with a list of Orange Creek Basin projects and other events and activities since 1996, with emphasis on those in which the St. Johns River Water Management District was involved. Some of these projects and other events and activities are described in more detail in this chapter of the OCB SWIM Plan.

1997

- Hydrilla covers 2,700 acres of Orange Lake

1998

- District purchased Orange Creek Restoration Area (3,418 acres)
- Near-record high lake level in Newnans and Orange Lakes
- Boards temporarily installed to stop flow through Camps Canal culverts into Paynes Prairie due to high water threatening closure of Highway 441
- FWC scraped 15 acres of sediment and vegetation in Orange Lake

1999

- District purchased conservation easements on Murphree wellfield for Gainesville Regional Utilities (4,108 acres)
- FDOT removed remainder of Prairie Creek weir during construction of new SR 20 bridge

2000

- District purchased additional land in Newnans Lake Conservation Area (3,393 acres)
- 87 ancient canoes discovered in sediments on north shore of Newnans Lake during drought
- Hydrilla covers 2,860 acres of Orange Lake

2001

- District purchased additional land in Newnans Lake Conservation Area (964 acres)
- Record low lake level in Newnans and Orange Lakes
- Newnans Lake canoe site listed on the National Register of Historic Places to recognize outstanding significance of buried ancient canoes
- FWC did not implement a project to dredge Newnans Lake sediments near Powers Park, on recommendation of the Florida Division of Historical Resources and after verification of ancient canoes buried there

2002

- Near-record low lake level in Lochloosa Lake
- FWC scraped 160 acres of sediment and vegetation and created 7 1-acre disposal islands in Orange Lake

2003

- District purchased Longleaf Flatwoods Preserve (1,347 acres)
- District received donation of 110 additional acres at Orange Creek Restoration Area
- SJRWMD denied permit to Marion County to plug an Orange Lake sinkhole at Heagy Burry Park
- Water hyacinth covers 410 acres of Newnans Lake, the most ever recorded

2004

- SJRWMD awarded $350,000 legislative appropriation and $715,500 stormwater grant to City of Gainesville for Depot Avenue Stormwater Park
- SJRWMD provided $50,000 to Paynes Prairie Preserve State Park for earthen berm removal for hydrologic restoration
- FDEP convened the Orange Creek Basin Working Group to develop a BMAP
- Near-record high lake level in Newnans

2005

- SJRWMD provided $550,000 to City of Gainesville for design of treatment wetland in Sweetwater Branch Sheetflow Restoration Project
- District purchased additional land in Newnans Lake Conservation Area (1,708 acres)
- Florida Land and Water Adjudicatory Commission supported denial of a permit to Marion County to plug an Orange Lake sinkhole
- FWC removed 4,401 acres of floating vegetation in Orange Lake using herbicide, mechanical harvesting, or mechanical shredding (work began in 2004)
- FDEP removed 2,500 acres of floating vegetation in Orange Lake by grinding and in-lake disposal using –cookie cutters" and 1,250 acres using herbicides
- Water lettuce covers 680 acres of Lochloosa Lake, the most ever recorded
- Boards temporarily installed to stop flow through Camps Canal culverts into Paynes Prairie due to high water threatening closure of Highway 441

2006

- SJRWMD provided $300,000 to City of Gainesville for design of treatment wetland in Sweetwater Branch Sheetflow Restoration Project
- FWC removed 20 acres of vegetation in Newnans Lake with herbicide to open access trails and planted 90,000 aquatic plants

2007

- Interagency group voted unanimously to not dredge Prairie Creek, as requested by Kate's Fish Camp on Prairie Creek
- District purchased conservation and flowage easement at Crones Cradle Conserve on Orange Creek (547 acres)
- Hydrilla covers 5,500 acres of Orange Lake
- Hydrilla covers 2,770 acres of Lochloosa Lake
- Water lettuce covers 680 acres of Newnans Lake, the most ever recorded
- Water lettuce covers 513 acres of Orange Lake, the most ever recorded
- SJRWMD, FWC, UF and FDEP began cooperatively treating Island Apple Snail in Newnans Lake with copper sulfate

2008

- District purchased additional land or easements in Longleaf Flatwoods Preserve (1,468 acres) and in Newnans Lake Conservation Area (195 acres)
- Orange Creek Basin Management Action Plan (BMAP) adopted by Order of FDEP Secretary
- Hydrilla covers 3,540 acres of Orange Lake
- FWC planted 8,000 aquatic plants in Newnans Lake
- SJRWMD, FWC, UF and FDEP continued treating Island Apple Snail in Newnans Lake with copper sulfate, which was determined to be ineffective in eradicating the snail

2009

- District purchased addition to Paynes Prairie Preserve State Park (184 acres) and additional land or easements in Newnans Lake Conservation Area (63 acres)
- Potano Paddling Trail authorized as an official component of Florida's statewide system of Greenways and Trails
- Hydrilla covers 4,225 acres of Orange Lake
- Cold weather and waterfowl control approximately 70% of hydrilla in Orange Lake by February 2010
- FWC planted 3.5 acres of wetland trees on Orange Lake, 7,500 aquatic plants in Newnans Lake, and 10,000 aquatic plants in Lochloosa Lake

2010

- District harvested shad from Newnans Lake in spring; year one of three-year experimental harvest
- Hydrilla covers 2,426 acres of Orange Lake
- Cold weather and waterfowl control approximately 99% of hydrilla in Orange Lake by February 2011
- Wildfire burned 2,616 acres in Lochloosa Wildlife Management Area
- FWC applied herbicide to 5 acres of aquatic and wetland plants in previously scraped portions of Orange Lake

APPENDIX D. FWC AQUATIC HABITAT ENHANCEMENT/RESTORATION PROJECTS IN THE ORANGE CREEK BASIN SINCE 1996

Excerpted from AHRE Annual Reports by Bruce Jaggers, FWC.

FY 2000/2001

Orange Lake (Alachua County; 15 acres)
Record-low water levels during 2001 on Orange Lake reduced the normally 12,355-acre lake to roughly 2,471 acres, exposing vast areas of organic sediments. The lake would greatly benefit from an exposed shoreline habitat enhancement project. Funding capabilities allowed for a small-scale demonstration project to be undertaken in cooperation with Florida Fish and Wildlife Conservation Commission (FWC) Fisheries personnel in Gainesville in 2001. A total of 50,000 yd^3 of aquatic plant material and associated organic sediments (muck) was removed from 15 acres of lake bottom at a cost of $75,000. As a special condition of the US Army Corps of Engineers (USACE) permit, an archaeological consultant was hired to conduct surveys of proposed work sites to determine if any significant archeological sites would be impacted by project. No significant sites were located in the proposed work areas. Based on water levels and if drought conditions persist, plans for fiscal year 2001-2002 on Orange Lake included removal of at least an additional 72,000 yd^3 of organic sediments.

Newnans Lake (Alachua County; 6,711 acres) – not implemented
A $100,000 habitat enhancement project had been cooperatively planned with the FWC Fisheries personnel in Gainesville for the drought-exposed littoral zone of Newnans Lake to improve aquatic habitat and decrease the probability of formation of floating vegetation in the Powers Park area of the lake. However, archaeological resources in and around Newnans Lake de-railed the project. As part of the permitting process for the proposed sediment removal project, Florida Department of State, Division of Historical Resources (DHR) was contacted for comment on the project. Due to the recent discovery of more than 100 prehistoric dugout canoes in a separate area of Newnans Lake and the likelihood of similar artifacts existing within the proposed work site, DHR recommended that the project proposal be withdrawn. As an alternative to complete abandonment of the project, ARES staff requested that DHR provide detailed sampling methodology that a contracted archaeologist could use to determine if artifacts existed within the proposed work site. In order to develop such a methodology, DHR and AHRE staff conducted an inspection of the proposed work site. During the inspection, remains of several prehistoric canoes were found lying on top of or just beneath the surface of the muck layer within the proposed work site. DHR again recommended the abandonment of the project. Given that the USACE permit necessary for the project would not have been issued due to DHR concerns, the permit application was withdrawn and the project was abandoned.

FY 2001/2002

Orange Lake - (Alachua County; 12,500 acres)
Near record-low water levels again facilitated habitat enhancement activities in the exposed dry littoral zone of Orange Lake. Water levels had begun to rise somewhat since the record lows of summer 2001 but the sinkhole in the Heagy-Burry Park area of Orange Lake became active again in April 2002. Enhancement activities began in March 2002 and consisted of removing 580,000 yd^3 of organic material from 160 acres of shoreline in four areas of Orange Lake at a

total cost of $573,402.84. Upland disposal sites were utilized for approximately 150,000 yd^3 of the scraped organics. The remainder was placed in seven 1-acre in-lake islands that had previously been permitted for in-lake disposal of floating vegetation. All permitted work was completed by the end of June 2002 and all permitted in-lake island sites have been utilized. Therefore, any further sediment removal will require new in-lake disposal permits or upland disposal.

FY 2004/2005

Orange Lake – (Alachua County; 12,706 acres)

Although Orange Lake has a history of tussock problems, extensive tussock formation occurred within the lake during refill after a severe drought that occurred between 1999 and 2002. Approximately 1235 acres of valuable fish and wildlife habitat was covered by tussock forming plant species such as frog's-bit (*Limnobium spongia)*. As of January 2004, there was an estimated 2,500 acres of open water in Orange Lake. Tussock material was breaking apart and hindering boat navigation, blocking boat ramps and negatively impacting fish camp businesses.

Staff developed an aquatic plant management plan designed to maintain aquatic habitat enhanced during fiscal year 2001/2002 that was conducted to improve fish and wildlife habitat. During plan development, AHRE staff consulted other personnel within the FWC who represent various biological guilds, to ensure that the final plan was as comprehensive as possible in addressing the biological needs of all fish and wildlife that use the aquatic resource. One of the primary goals was to encourage growth and expansion of maidencane (*Panicum hemitomon*) and spatterdock (*Nuphar luteum*), which provide important sportfish habitat in the lake. The plan also identified the need to reduce the surface coverage of frog's-bit.

Since the aquatic plant problem was so large, the Florida Department of Environmental Protection (DEP) agreed to manage the southern end of the lake while the FWC managed the northern end. The FWC spent $524,057 ($1,129/acre) controlling 337 acres of frog's-bit mats and 314 acres of floating tussock. The FDEP contractors controlled approximately 1,800 acres of invasive aquatic plants in Orange Lake at a cost of approximately $1,619,680.

Despite the aquatic plant problems, cursory observations revealed catch rates for bream (*Lepomis macrochirus* and *Lepomis microlophus)* and black crappie (*Pomoxis nigromaculatus)* were characterized as good during 2004 and 2005. The winter 2004 black crappie season was particularly impressive with good catches observed in angler's creels. Anglers successfully fished for black crappie well into late spring 2005. Warmouth (*Lepomis gulosus*) and catfish (*Ictalurus* spp.) was also a significant component of the spring 2005 anglers' creel.

Total FWC expenditure for herbicide and mechanical vegetation control during fiscal year 2004-2005 was $524,057 ($41.24/acre restored). The harvesting portion cost $346,500 and removed 36 acres of floating organic material from the lake ($9,625/acre removed). Volume of organic material removed was 58,000 y^3 at a cost of $5.97/$y^3$.

FY 2005/2006

Orange Lake – (Alachua County; 12,706 acres)

During May and June 2006 approximately 10,000 y^3 of tussock material harvested in 2005 was spread, disked and seeded on 7 acres of an upland disposal site for a total cost of $23,370.

Newnans Lake - (Alachua County; 7,428 acres)
Objectives for this project included herbicide maintenance of open trails through willow stands created in FY 04/05, new herbicide control of tussock forming vegetation in areas where firm substrate exists, and transplanting beneficial native vegetation in areas where littoral habitat is sparse. A total of 19.7 acres of new herbicide work was conducted to control dense mats of dollar weed and American cupscale grass (*Sacciolepis striata*). The first application was timed to take place in the fall in order to maximize translocation of herbicide to the root tissue. Excellent control was achieved and very little regrowth was observed. Water lettuce was a consistent problem in and around the trails through the willows throughout the year. Therefore, the trails were sprayed during regular nuisance aquatic plant maintenance operations conducted by FDEP. No FWC-directed herbicide applications were needed in these areas. A total of 90,000 plants, including 30,000 Egyptian Paspalidium, 30,000 maidencane and 30,000 giant bulrush, were introduced along a 1 mile stretch of shoreline.

Objectives for the following year (FY 06/07) included transplanting an additional 40,000 plants (giant bulrush, Egyptian Paspalidium and maidencane) and expansion of the existing trails through the willows. AHRE considered a proposal to widen the trails created in June 2005 to create a series of islands.

FY 2006/2007
A ―Beneficial Use of Organic Sediments" research contract was completed. Orange Lake was included in the sampling for this study. A copy of this report is available upon request.

FY 2007/2008
Orange Lake (Alachua County; 12,710 acres)
During 2006, an estimated 10,000 yd^3 of tussock material harvested from PG Run area of Orange Lake was spread, disked, and seeded with grass seed on an upland disposal site. Final seeding of the upland site was conducted during spring 2008 at a cost of $637.95.

Newnans Lake (Alachua County; 7,430 acres)
A total of 8,000 plants (3,000 giant bulrush and 5,000 Egyptian Paspalidium) were planted over 4.9 acres at a cost of $3,000 to improve aquatic habitat.

During fall 2007, an Alachua County bird watcher discovered an exotic population of Island Apple Snails (*Pomacea insularum*) in Newnans Lake. With the exception of a small pond near High Springs, this population represented the first record for the county and the Orange Creek Basin. FWC, SJRWMD, University of Florida, and Department of Environmental Protection worked cooperatively to develop an eradication plan. This plan consisted of physical egg removal and the killing of adult snails with copper sulfate. Beginning October 2007, SJRWMD staff removed egg masses approximately every 10 days. Copper sulfate treatments were performed in November 2007, February 2008 and April 2008 utilizing personnel from all of the involved agencies. The November treatment encompassed 4 acres; however, observations of egg clusters and adult snails outside this original treatment area led to a 35-acre treatment during

April 2008. In summary, these treatments were found to be only partially effective (e.g., dead snails were observed within the treatment areas) as Island Apple Snails presently infest an estimated 2 miles of Newnans Lake shoreline, albeit in small numbers. AHRE contribution to this project was $7,658.

FY 2008/2009

Orange Lake (Alachua County; 12,706 acres)
Two cypress strands totaling 3.5 acres were planted on the south end of Orange Lake within the Essen Run area to provide long-term fish and wildlife habitat benefits. FWC cooperated with the Alachua County Environmental Protection Department to complete this project. A total of 1,500 cypress (*Taxodium distichum*), 300 red maple, and 200 Carolina ash (*Fraxinus caroliniana*) trees were planted. Total AHRE funding for this fiscal year was $7,109.

Newnans Lake (Alachua County; 7,430 acres)
Beneficial emergent vegetation was planted in areas where littoral habitat was sparse and/or degraded to improve fish and wildlife habitat. A contractor planted 7,500 Egyptian Paspalidium over 2.5 acres. Total AHRE funding for this fiscal year was $2,250.

Lochloosa Lake (Alachua County; 5,705 acres)
Beneficial emergent vegetation was planted in areas where littoral habitat was sparse and/or degraded to improve fish and wildlife habitat. A contractor planted 5,000 giant bulrush and 5,000 Egyptian Paspalidium (Paspalidium geminatum) over a 5-acre area. Total AHRE funding for this fiscal year was $2,750.

FY 2009/2010

Orange Lake (Alachua County; 12,706 acres)
Four scrape areas totaling approximately 160 acres were created during FY 2001/2002 to improve fish spawning substrate within Orange Lake. These areas received herbicide maintenance during FY 2009/2010 and 5 acres of exotic or invasive plants were controlled in these sites at a cost of $1,000.

During FY 2008/2009 two cypress strands totaling 3.5 acres were installed on the south end of Orange Lake within the Essen Run area to provide long-term fish and wildlife habitat benefits. The FWC, cooperating with two landowners and the Alachua County Environmental Protection Department, planted 1,500 cypress trees, 300 red maple (*Acer rubrum*) and 200 Carolina ashes (*Fraxinus caroliniana*) to create these strands. During FY 2009/2010 0.25 acres of exotic invasive species were controlled within the restored cypress strands at a cost of $150. Total AHRE funding for this fiscal year was $1,150.

APPENDIX E. NAME AND LOCATION OF 24 WATER QUALITY STATIONS SAMPLED MONTHLY BY THE ORANGE CREEK BASIN SWIM PROGRAM IN FY 10-11

Station Name	Station Location
OPEN-WATER STATIONS	
NEWNLN	Newnans Lake; North
NEW	Newnans Lake; Center
OLN	Orange Lake; North
OLC	Orange Lake; Center
OLSW	Orange Lake; Southwest (P-G Run)
LOCHLN	Lochloosa Lake; North-center
LOL	Lochloosa Lake; Center
TRIBUTARY STATIONS	
HAT26	Hatchet Creek at SR 26 NR Newnans Lake
LHT26E	Little Hatchet Creek at CR26; east of CR222
GRSC	Gum Root Swamp creek NE of Gainesville Regional Airport
LHAT26	Little Hatchet Creek on SR26
LRC	Lake Ridge Creek
LHTNB	Little Hatchet Creek; North Branch
LHATWR	Little Hatchet Creek on Waldo Road
LFC329B	Lake Forest Creek at SR329B
PC20	Prairie Creek, north of SR 20 bridge SR20
CC234	in Camps Canal at CR 234
LOCH20	upper reach of Lochloosa Creek (SR20)
LC1LB	Lochloosa Creek above confluence with Lochloosa Lake
CELC	Creek East of Lochloosa Creek
CELCS	Creek east of Lochloosa Creek South
STX346	River Styx at SR346
OC301	Orange Lake outlet; west of US301
LLS	Lochloosa Slough
CCN325	Cross Creek about 50 ft north of bridge (CR325)

APPENDIX F. FIELD PARAMETERS AND WATER QUALITY ANALYTES MEASURED IN THE ORANGE CREEK BASIN SWIM PROGRAM IN FY 10-11.

Field Parameters	Water Quality	Chlorophyll	Metals	Other
Air temperature	Alkalinity	Chl-a	Ag-T	Fluoride
Conductivity	Color	Chl-a_Corr	Al-T	
Depth collection	Dissolved Organic Carbon	Chl-b	As-T	
Total depth	NH_4-D	Chl-c	Ba-T	
Dissolved oxygen	NO_x-D	Pheophytin_Corr	Ca-T	
Secchi	PO_4-D	Ratio_Chl-a/Pheo	Cd-T	
Water temperature	Cl		Cr-T	
Weather	SO_4		Cu-T	
Wind direction	Total Dissolved Solids (TDS)		Fe-T	
Wind speed	Dissolved Kjeldahl Nitrogen (TKN-D)		K-T	
Cloud cover	Total Kjeldahl Nitrogen (TKN-T)		Mg-T	
pH-field	Total Organic Carbon (TOC)		Mn-T	
	Dissolved Total Phosphorus (TP-D)		Mo-T	
	Total Phosphorus (TP-T)		Na-T	
	Total Suspended Solids (TSS)		Ni-T	
	Turbidity		Pb-T	
	Si-T		Se-T	
	SiO_2-D		Zn-T	
			Calculated Hardness	

APPENDIX G. WASTEWATER FACILITIES IN THE ORANGE CREEK BASIN PERMITTED BY THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (SORTED BY FACILITY TYPE AND NPDES STATUS).

FDEP FACILITY ID	FACILITY NAME	FACILITY TYPE	NPDES	FACILITY ADDRESS	CITY	PERMITTED CAPACITY (MGD)	PERMIT ISSUE DATE	PERMIT EXPIRATION DATE
FLA113204	Lussier Dairy Inc	Concentrated Animal Feeding Operation	Y	1 Mile N. Hawthorne On Hwy 301	Hawthorne	0.023	7/20/2006	7/19/2011
FLG110362	CEMEX LLC - Gainesville	Concrete Batch GP	Y	305 SW Depot Ave	Gainesville		12/10/2007	12/9/2012
FLG110513	CEMEX LLC - North Gainesville CBP	Concrete Batch GP	Y	6820 NW 53rd Avenue	Gainesville		11/16/2007	11/15/2012
FLG110100	Florida Rock Industries - Gainesville Plant	Concrete Batch GP	Y	924 S Main St	Gainesville		8/5/2009	8/4/2014
FLA010664	North Marion Middle School	Domestic Wastewater Program	N	2085 W County Road 329	Citra	0.0250	9/9/2010	9/8/2015
FLA010698	Phoenix Houses Of Florida	Domestic Wastewater Program	N	15681 N Hwy 301	Citra	0.0250	11/8/2006	11/7/2011
FLA010690	Sportsman Cove WWTF	Domestic Wastewater Program	N	5423 Ave F	Mcintosh	0.0150	2/15/2010	2/10/2015
FLA010790	State Fire College	Domestic Wastewater Program	N	11655 NW Gainesville Road (SR 25a)	Ocala	0.0200	2/16/2007	2/12/2012
FLA016154	TA Operating LLC	Domestic Wastewater Program	N	7401 West Hwy 318	Ocala	0.0500	3/7/2007	3/6/2012
FLA010737	Ocala Jai Alai - WWTF	Domestic Wastewater Program	N	S.R. 318, E Of Us Highway 441	Orange Lake	0.0100	1/9/2007	1/7/2012
FLA010770	Grand Lake RV Resort WWTF	Domestic Wastewater Program	N	4555 W Hwy 318	Orange Lake	0.0650	9/2/2010	9/1/2015
FLA010672	Reddick Collier Elementary School WWTF	Domestic Wastewater Program	N	4595 W Highway 316	Reddick	0.0100	7/7/2009	7/6/2014
FLA011307	Prairie View Apartments WWTF	Domestic WWTP	N	6315 SW 13th St	Gainesville	0.0042	9/10/2010	9/9/2015
FLA011312	Gainesville Raceway WWTF (NHRA)	Domestic WWTP	N	11211 N Cr 225	Gainesville	0.0083	12/19/2007	12/18/2012
FLA011322	University of Florida WWTF (FDOE)	Domestic WWTP	N	1070 Gale Lemerand Dr	Gainesville	3.1	4/22/2003	4/21/2008
FLA011291	Hawthorne WWTF	Domestic WWTP	N	23016 SE 65th Ln	Hawthorne	0.15	10/4/2010	10/3/2015

FDEP FACILITY ID	FACILITY NAME	FACILITY TYPE	NPDES	FACILITY ADDRESS	CITY	PERMITTED CAPACITY (MGD)	PERMIT ISSUE DATE	PERMIT EXPIRATION DATE
FLA011293	Camp Mcconnell YMCA WWTF	Domestic WWTP	N	210 SE 134th Ave	Micanopy	0.0075	3/16/2010	3/15/2015
FLA011317	Micanopy Inn WWTF (fka Knight's Inn WWTF)	Domestic WWTP	N	17110 SE County Road 234	Micanopy	0.015	4/26/2010	4/25/2015
FL0027251	GRU - Main Street WRF	Domestic WWTP	Y	200 SE 16th Ave	Gainesville	7.5	3/19/2010	3/18/2015
FL0040215	Brittany Estates Mobile Home Park WWTF	Domestic WWTP	Y	5010 NE Waldo Rd Lot 2	Gainesville	0.06	10/2/2006	10/1/2011
FL0112895	Kanapaha WRF	Domestic WWTP	Y	3901 SW 63rd Blvd	Gainesville	10	3/17/2003	3/16/2008
FLA381888	Deerhaven Citgo	Industrial Wastewater	N	9600 NW 13th St	Gainesville		7/22/2009	7/21/2014
FLA366781	Duval Motorcars of Gainesville, Inc.	Industrial Wastewater	N	3525 NW 97th Blvd	Gainesville		12/9/2009	12/8/2014
FLA635758	Florida Septic Truck Wash	Industrial Wastewater	N	5757 SE 211th Street	Hawthorne		8/1/2008	7/31/2013
FL0026646	John R Kelly Generating Station (Power Plant)	Industrial Wastewater	Y	605 SE 3rd St	Gainesville	0.005	10/22/2004	10/21/2009
FL0684937	Main Street Improveme nt - Depot to 3rd Ave	Industrial Wastewater	Y	Main Street from Depot Ave to 3rd Ave	Gainesville		1/8/2010	1/7/2011
FL0495182	Poole Roofing - CSX MGP Remediatio n	Industrial Wastewater	Y	200 SE Depot Ave	Gainesville		11/5/2009	11/4/2014
FLA279323	Davilta - Ocala North Kidney Center	Industrial Wastewater Program	N	2620 W Highway 316	Citra	0.0000	6/2/2008	5/23/2013
FLA011737	Florida Rock - Keuka Sand Plant	Industrial Wastewater Program	N	400 Keuka Road	Interlachen		6/27/2008	6/26/2013
FLA401897	Franklin Industries - Lowell Mine	Industrial Wastewater Program	N	11661 NW Gainesville Rd	Lowell	0.0000	8/18/2009	8/17/2014
FLA672106	SCI McKathan Mine	Industrial Wastewater Program	N	N of NW 130th Street, W of 32nd Court	Ocala	0.0000	5/20/2009	5/21/2014
FLA010753	Seyler's Car Wash Recycle	Industrial Wastewater Program	N	Cr 318 and Us Hwy 441	Orange Lake	0.0100	12/3/2009	12/2/2014

FDEP FACILITY ID	FACILITY NAME	FACILITY TYPE	NPDES	FACILITY ADDRESS	CITY	PERMITTED CAPACITY (MGD)	PERMIT ISSUE DATE	PERMIT EXPIRATION DATE
	System							
FLA010781	Lakeside Laundromat	Industrial Wastewater Program	N	18024 N Us Hwy 441	Orange Lake	0.0096	1/18/2005	1/17/2010
FLA316474	Premium Waters - Orange Spring Bottling Facility	Industrial Wastewater Program	N	24627 N Hwy 21	Orange Springs	0.0900	9/1/2009	8/30/2014
FL0028525	Edgar Minerals, Inc.	Industrial Wastewater Program	Y	County Road C20a	Edgar	8.18	1/16/2007	1/15/2012
FLG913770	Sunshine Food Mart #262	Petroleum Cleanup GP (long term)	Y	931 W University Ave	Gainesville		9/10/2009	9/9/2014

APPENDIX H. FIGURES

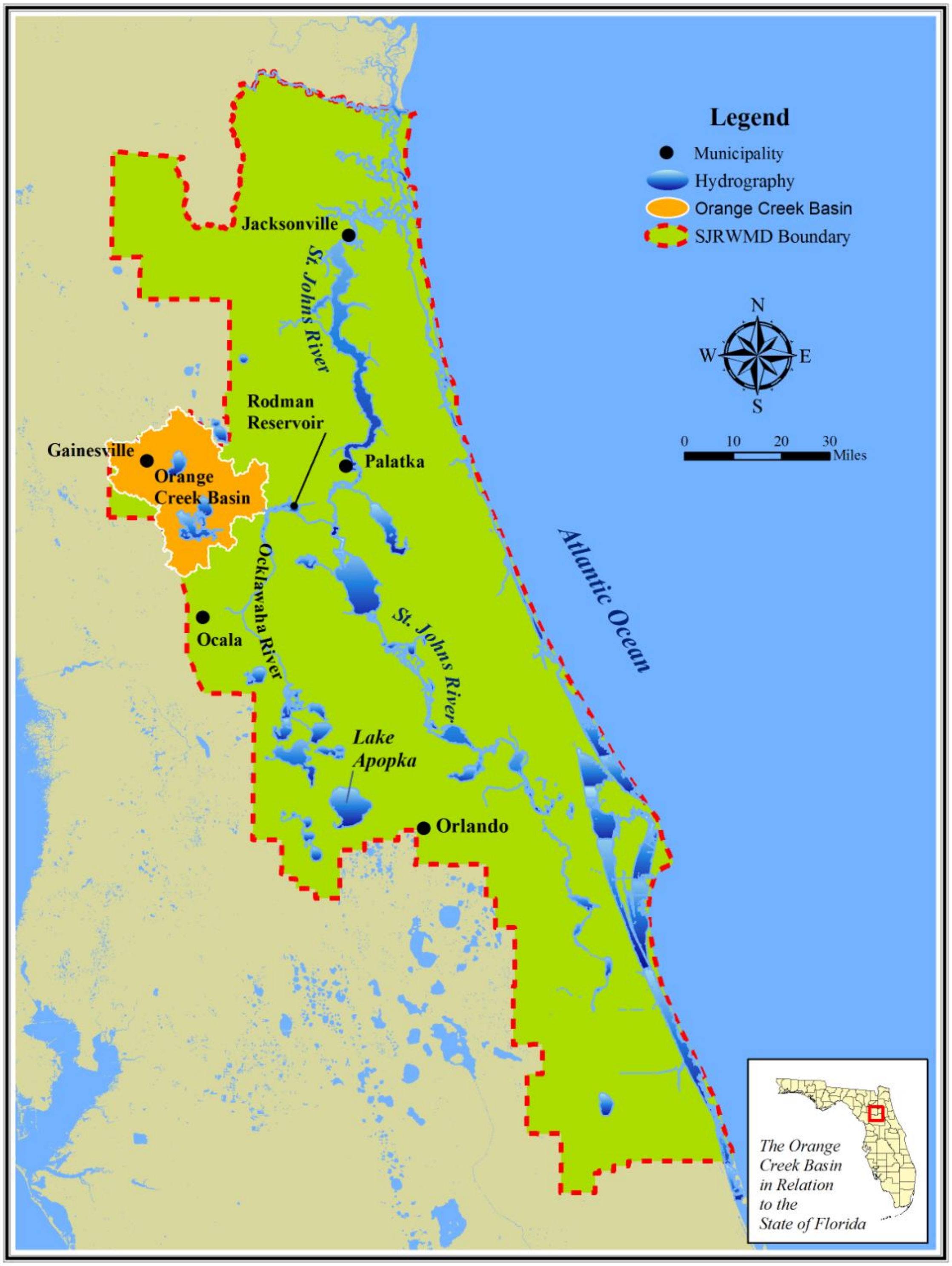

Figure 1. The Orange Creek Basin in relation to the St. Johns River.

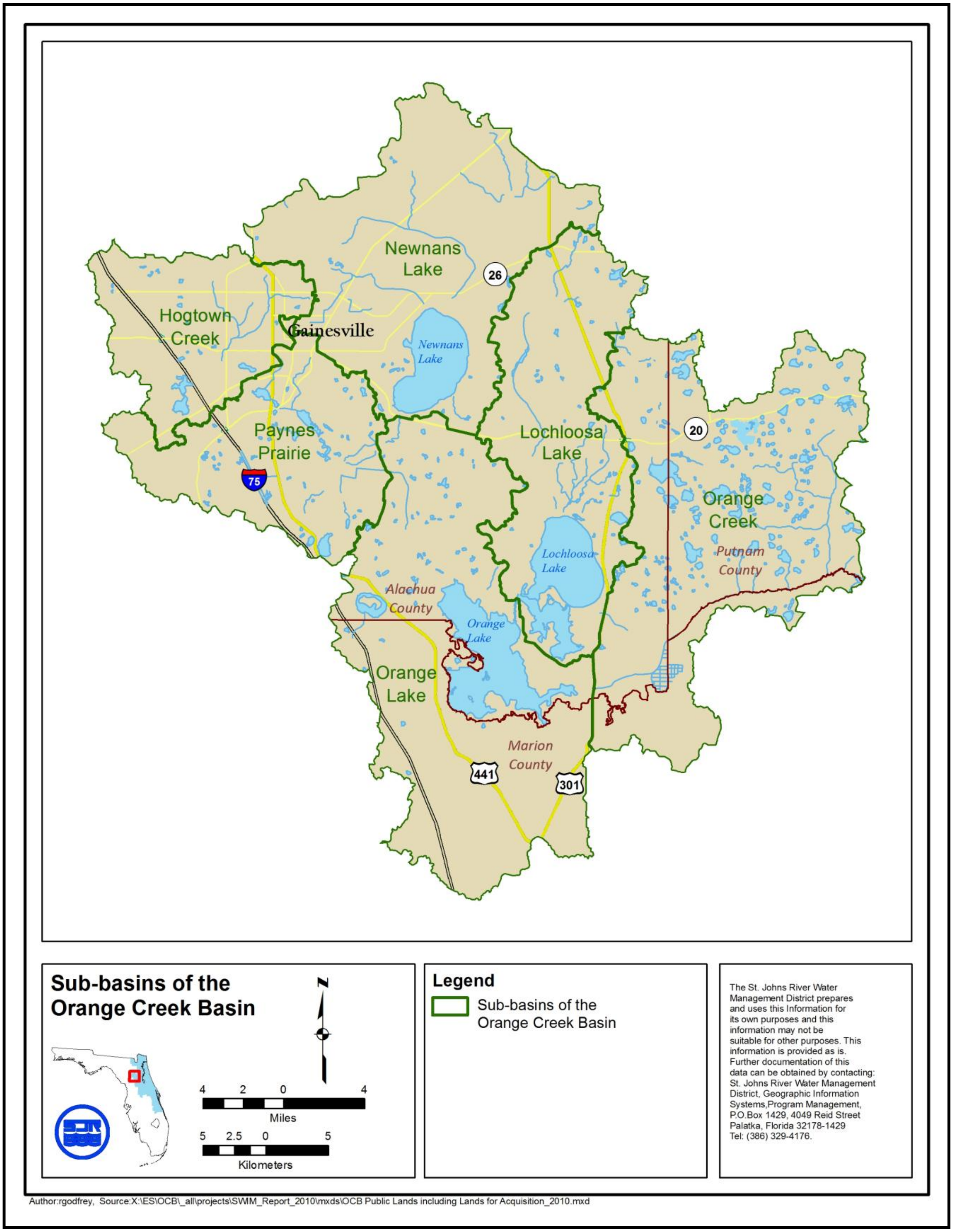

Figure 2. Sub-basins of the Orange Creek Basin.

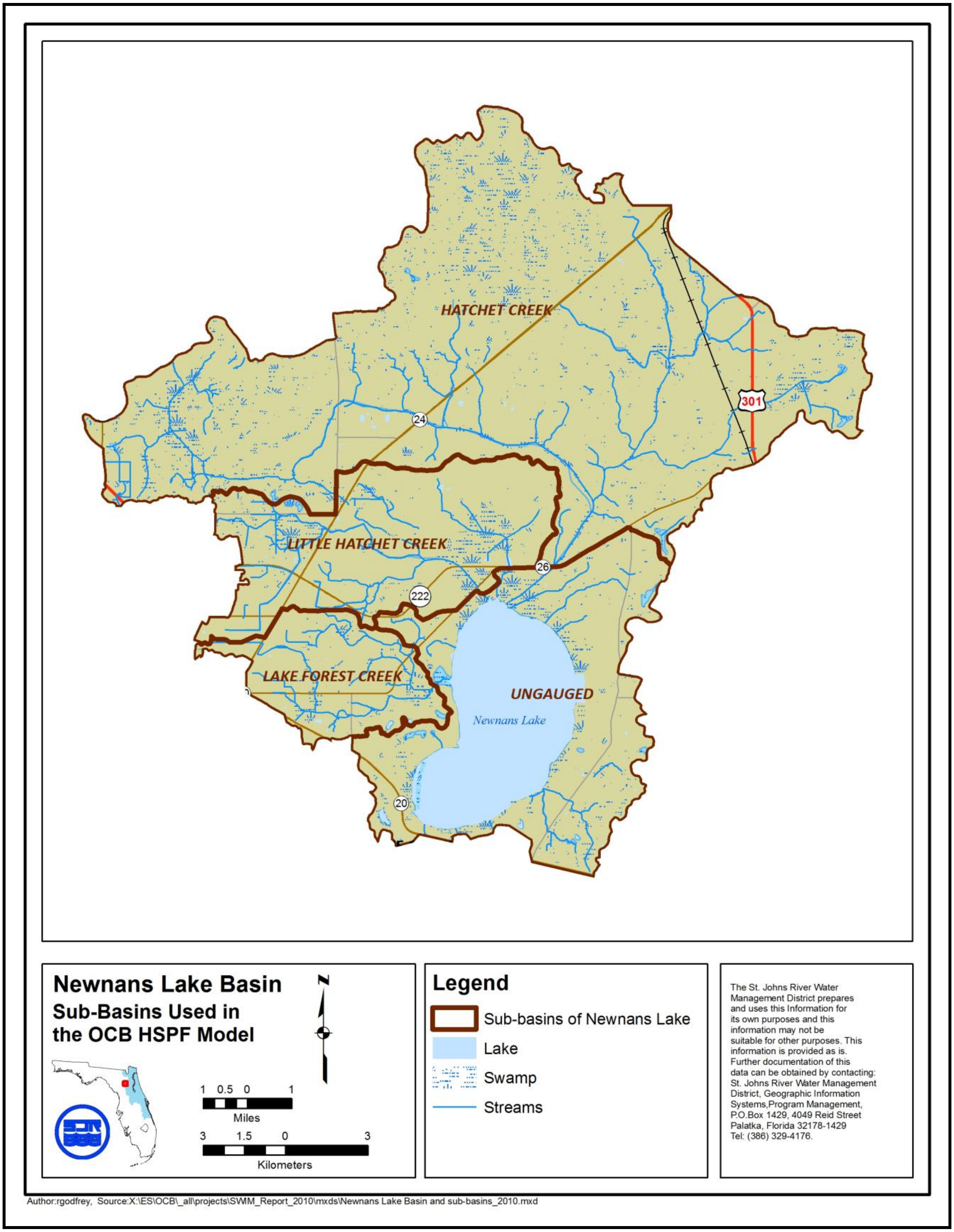

Figure 3. Newnans Lake sub-basins used in OCB HSPF model.

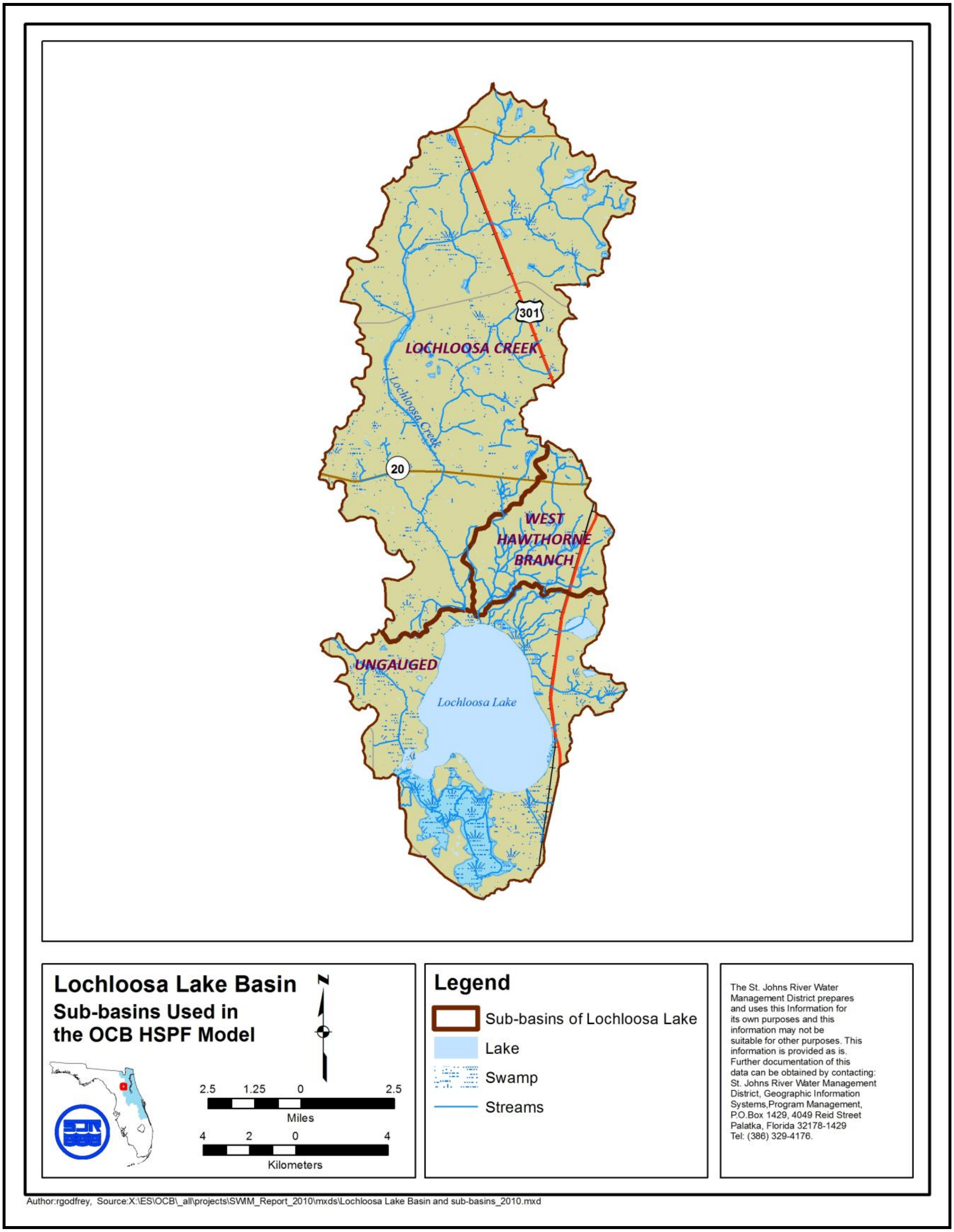

Figure 4. Lochloosa Lake sub-basins used in OCB HSPF model.

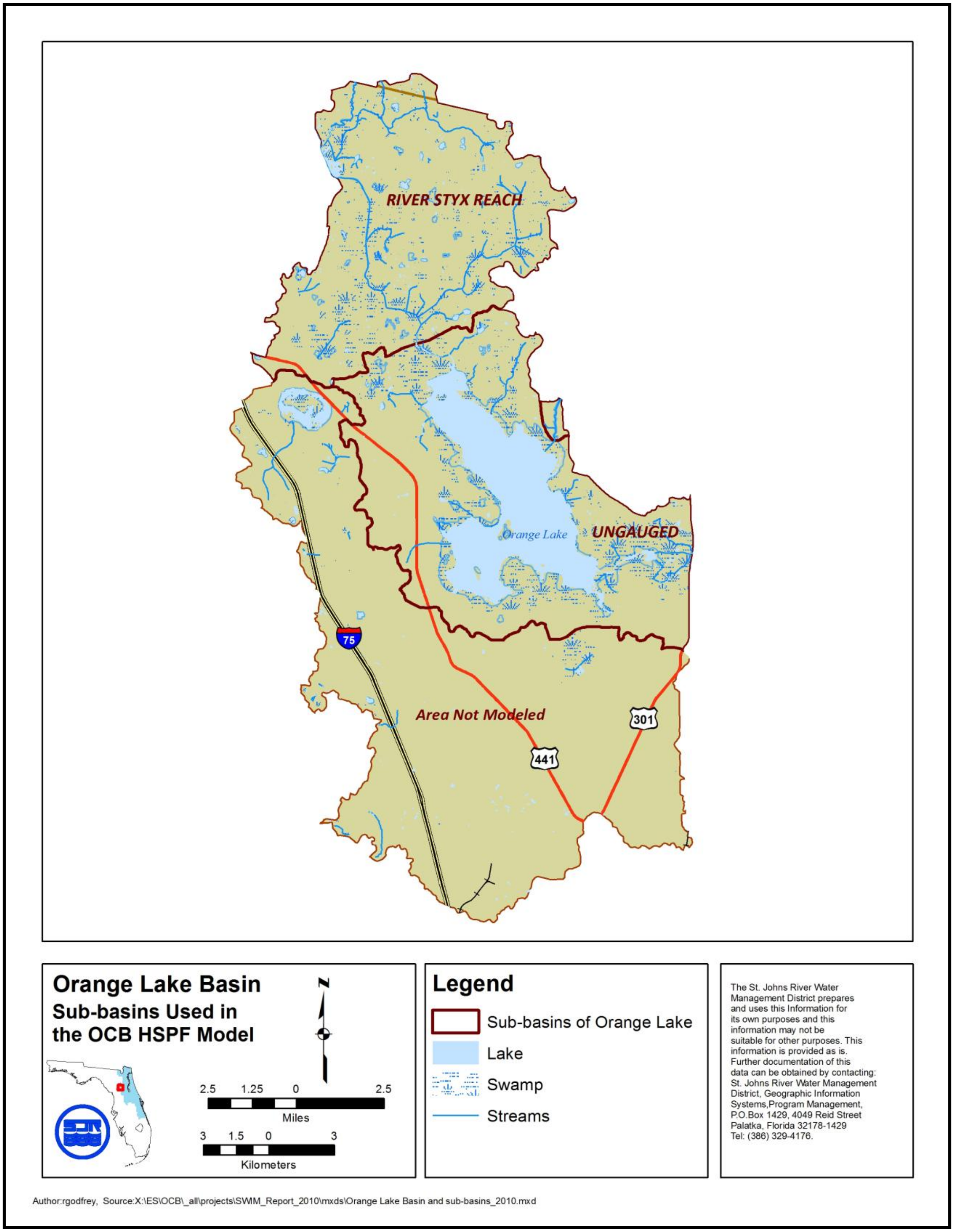

Figure 5. Orange Lake sub-basins used in OCB HSPF model.

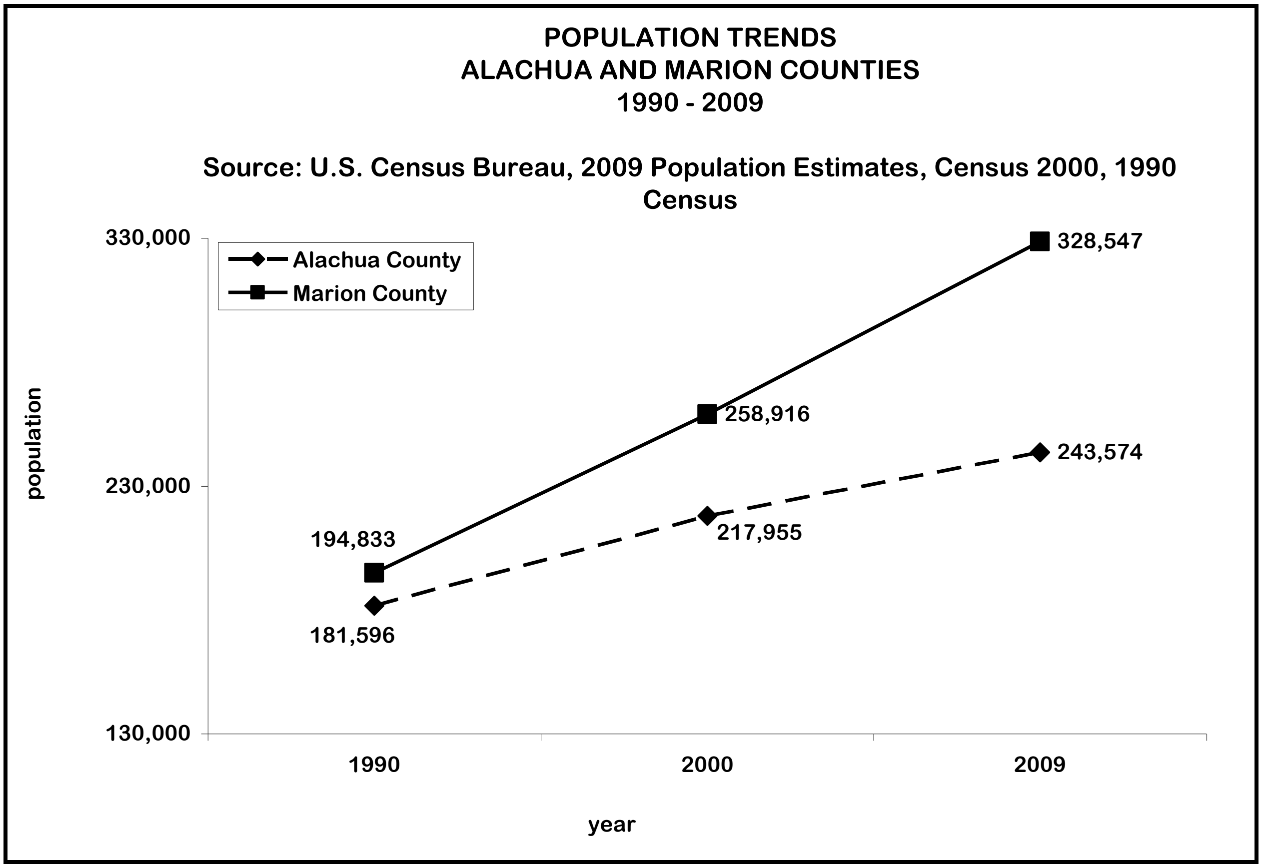

Figure 6. Population trends in Alachua and Marion Counties from 1990 through 2009.

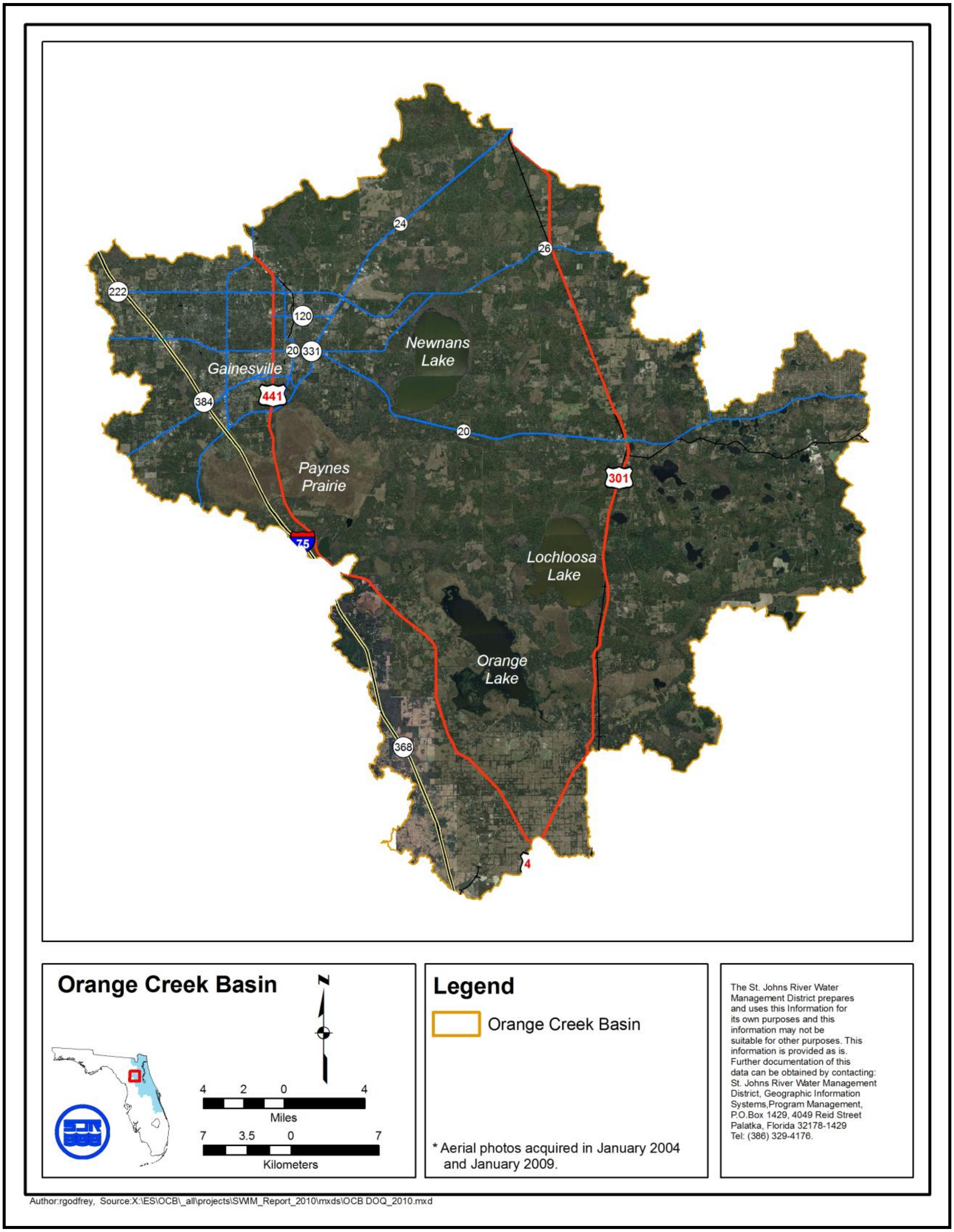

Figure 7. Land use in the Orange Creek Basin shown on a composite aerial digital photograph.

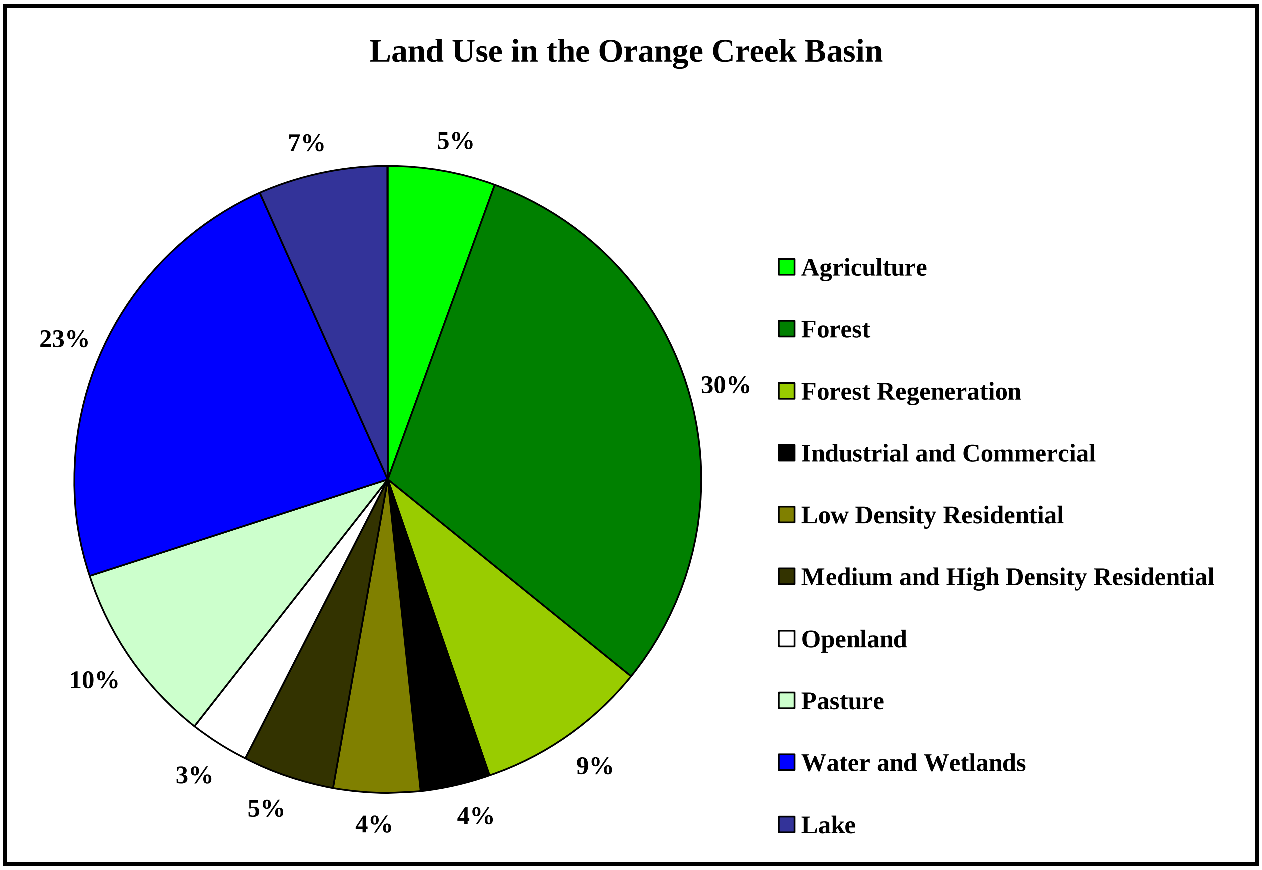

Figure 8. Land use in the Orange Creek Basin (2003-2004).

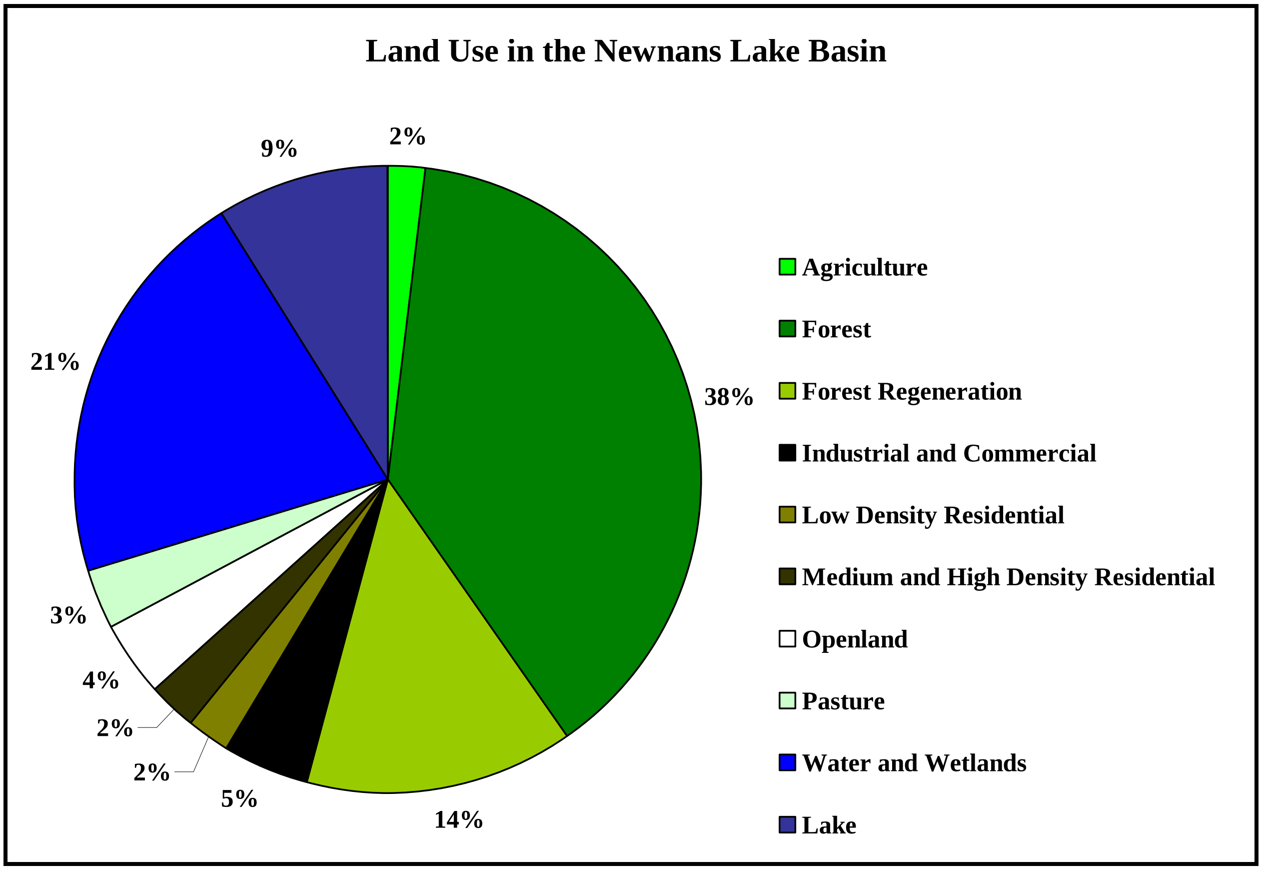

Figure 9. Land use in the Newnans Lake basin (2003-2004).

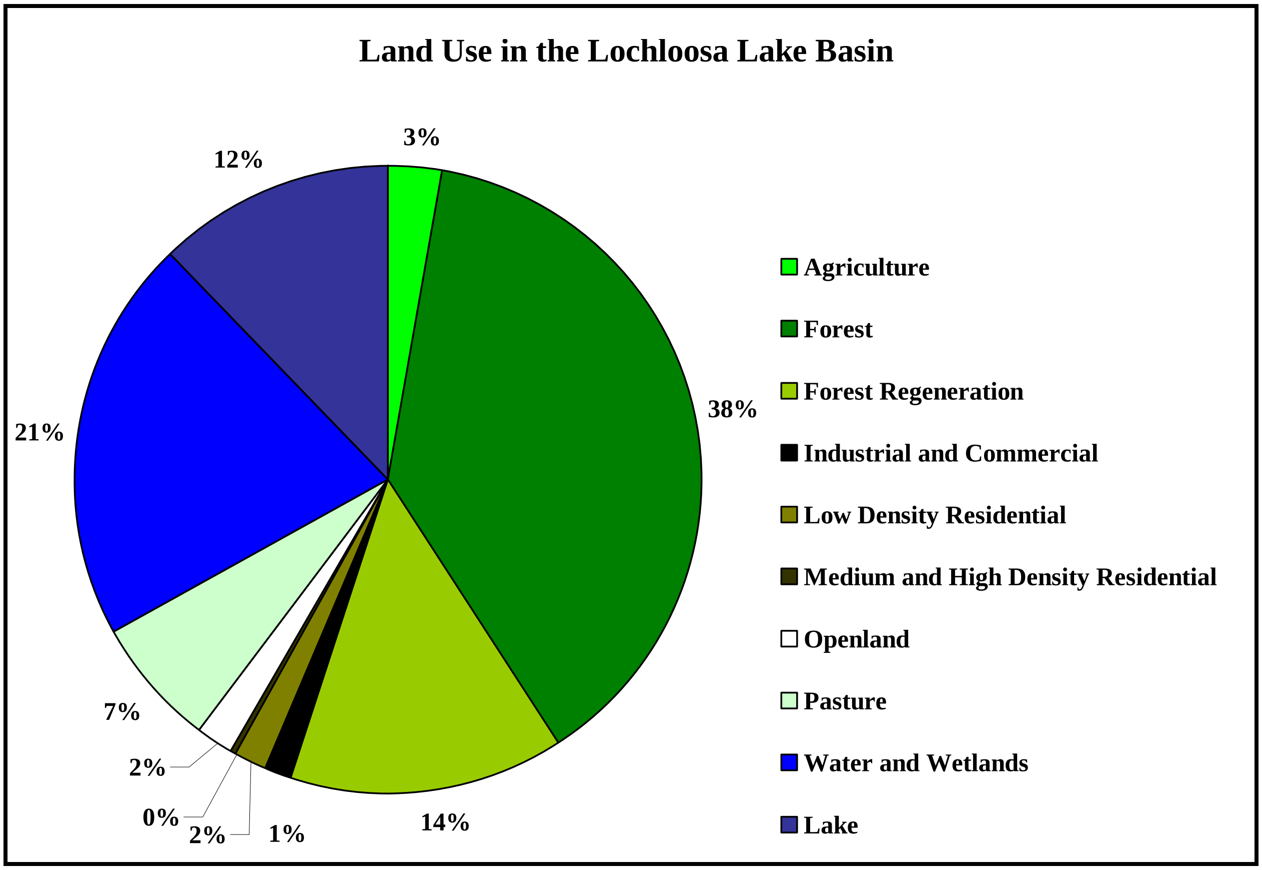

Figure 10. Land use in the Lochloosa Lake basin (2003-2004).

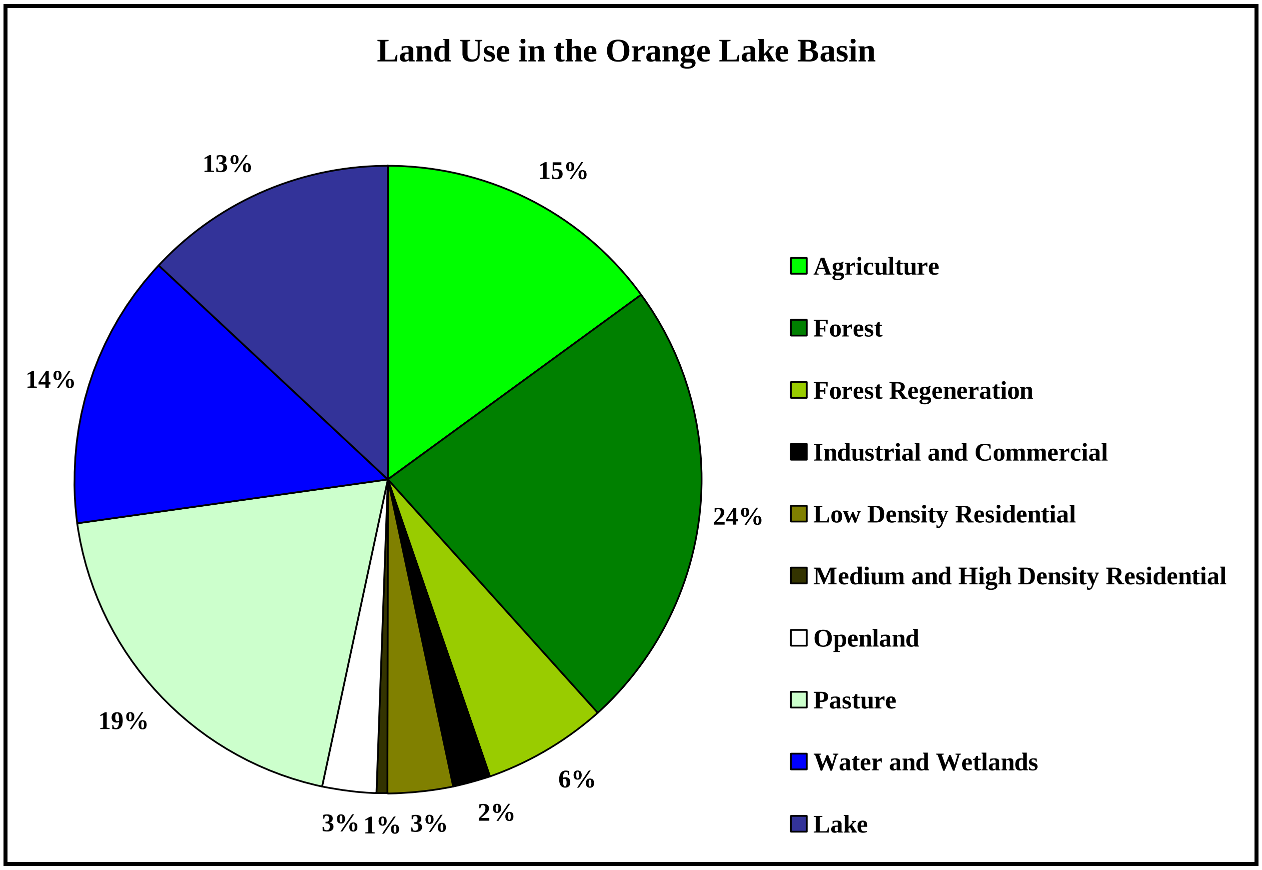

Figure 11. Land use in the Orange Lake basin (2003-2004).

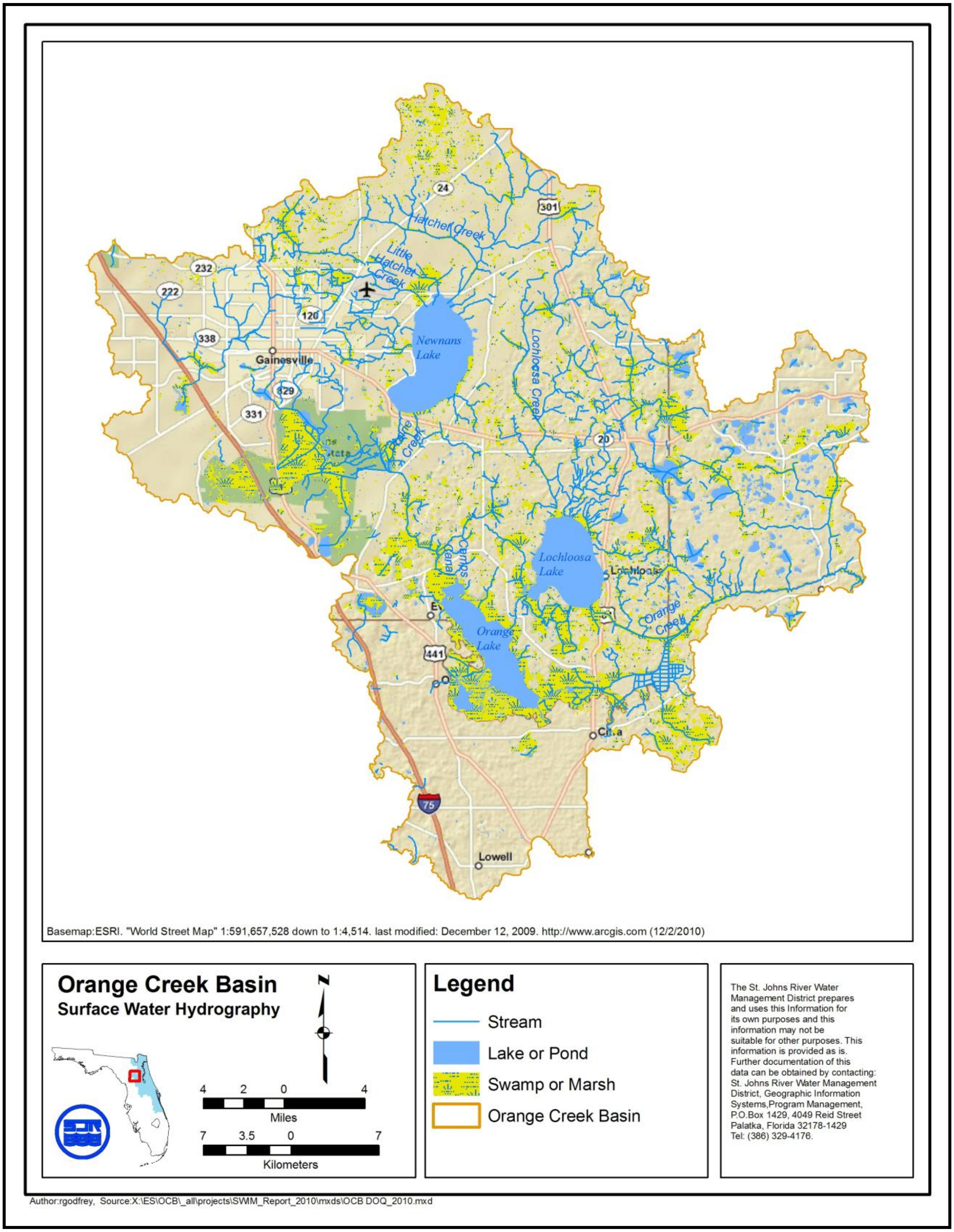

Figure 12. Surface water hydrography in the Orange Creek Basin.

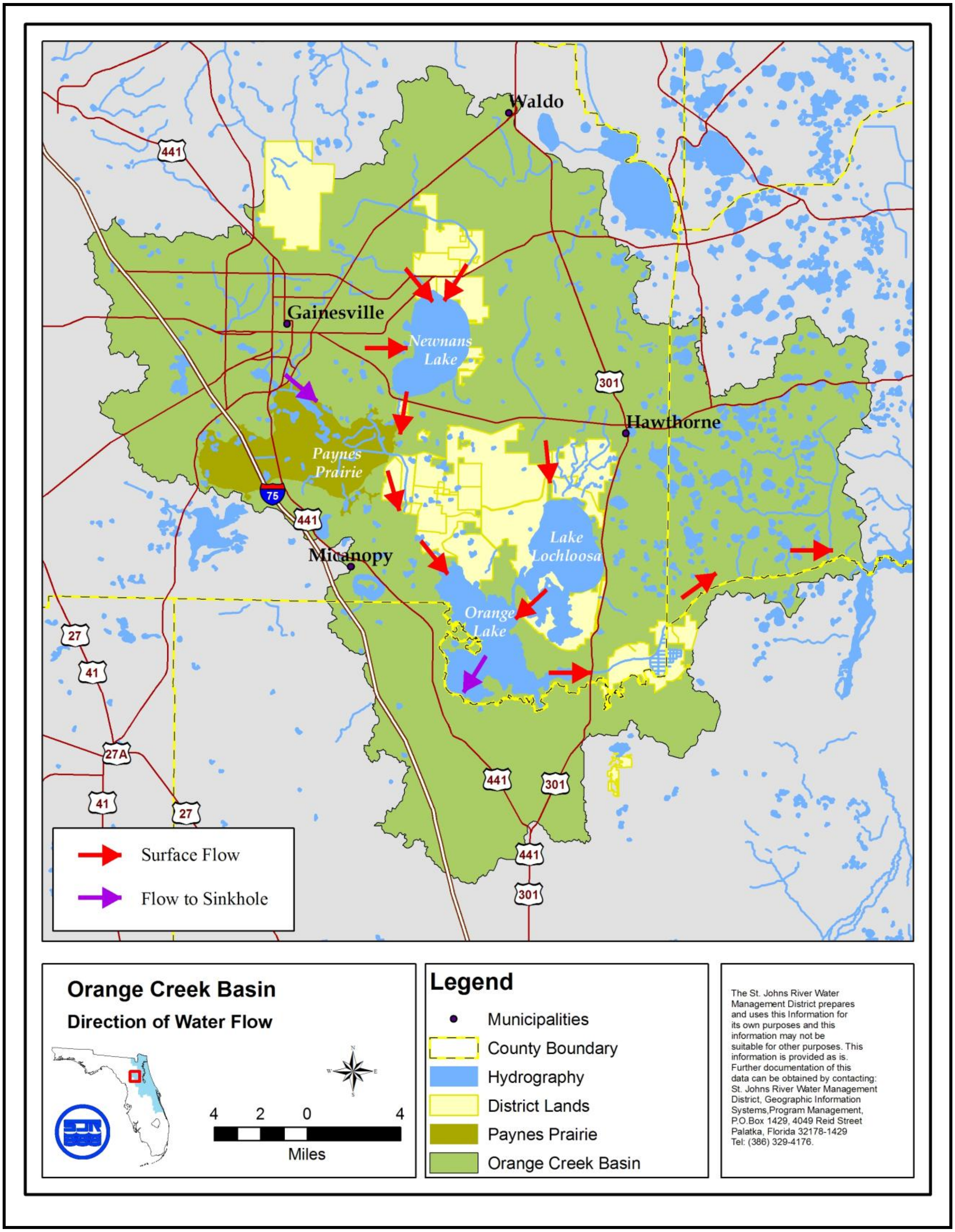

Figure 13. Direction of surface water flow in the Orange Creek Basin. Purple arrows indicate discharge to sinkholes.

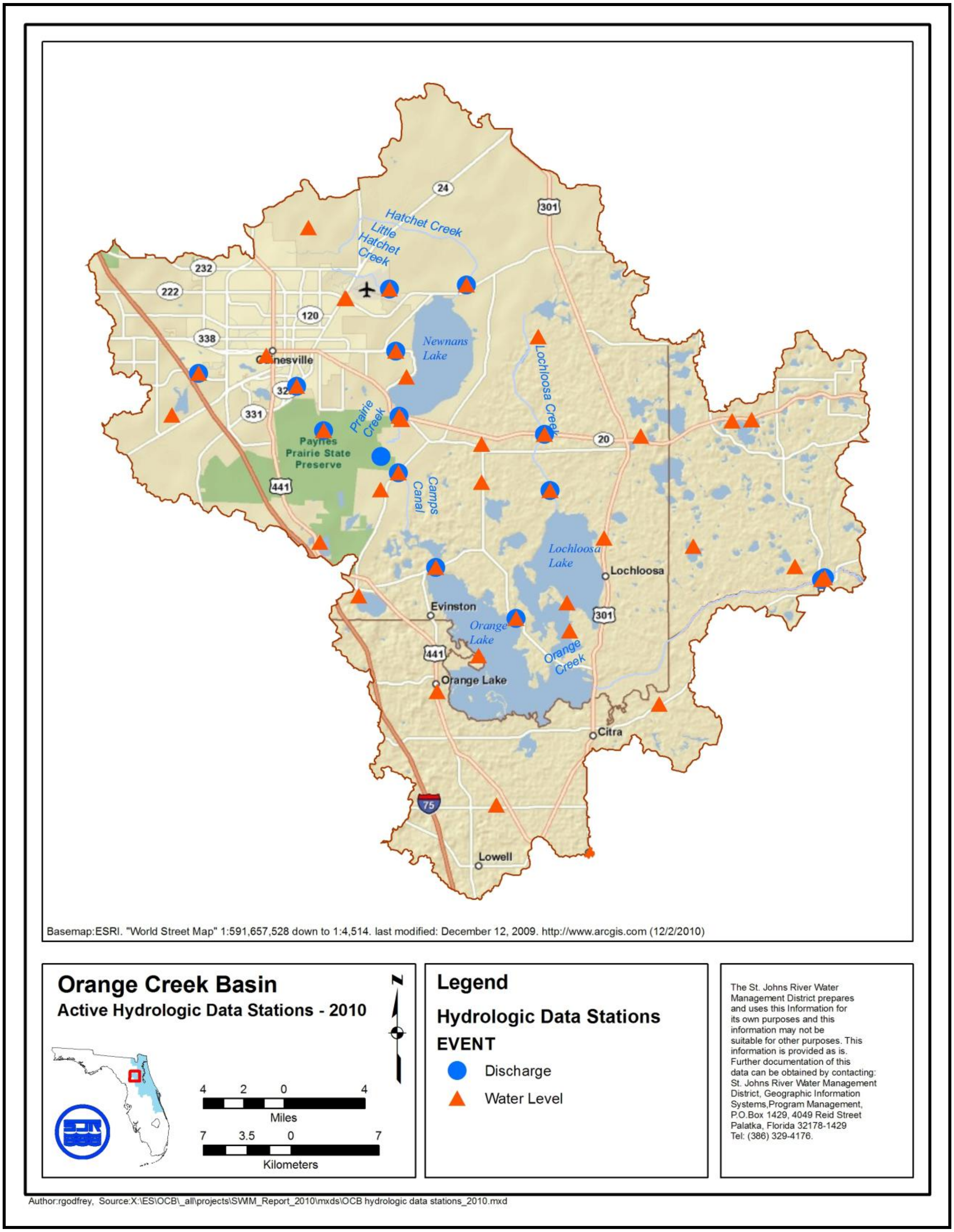

Figure 14. Hydrologic stations in the Orange Creek Basin monitored by the Hydrologic Data Services Division of SJRWMD.

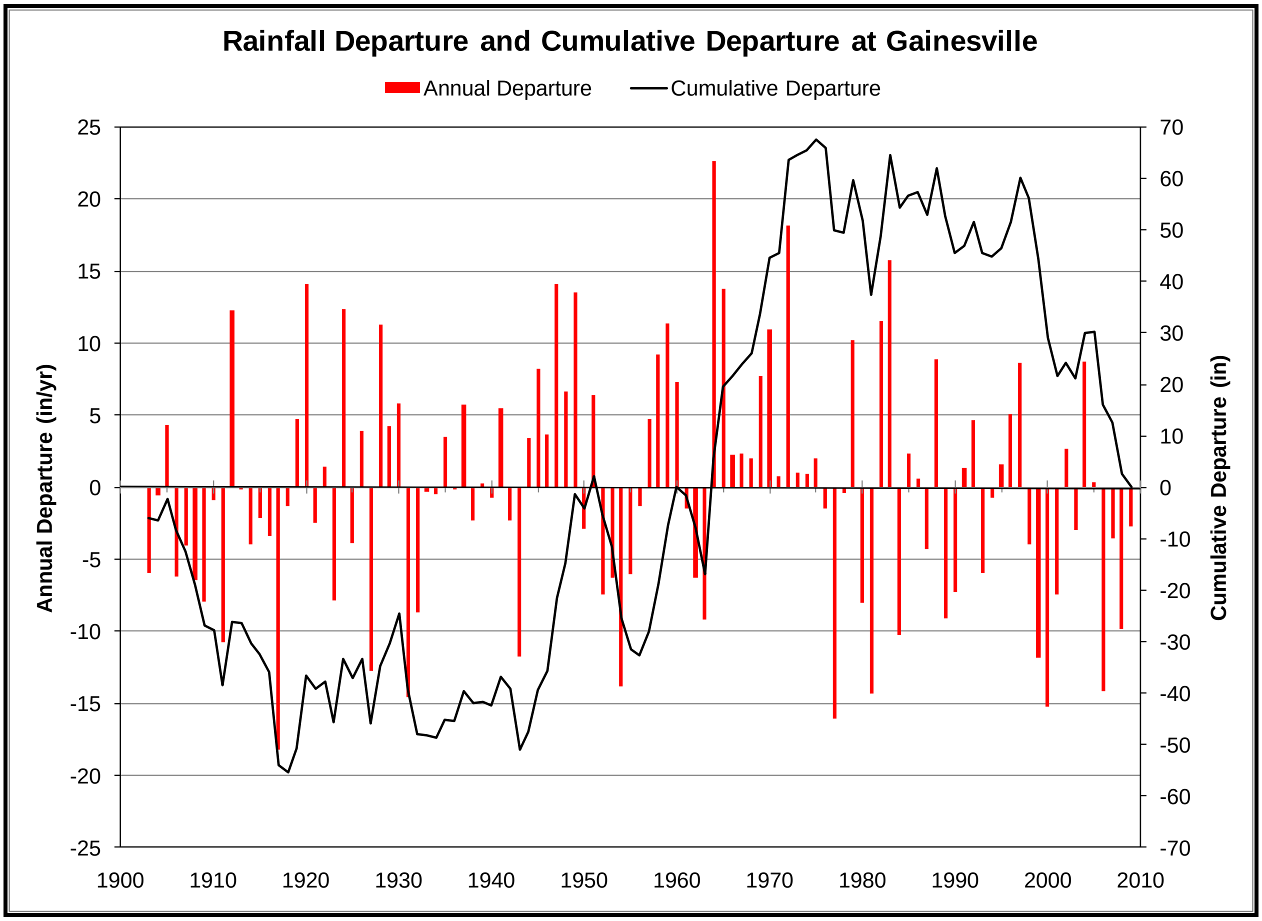

Figure 15. Annual rainfall departure from long-term mean, and cumulative departure from long-term mean in Gainesville.

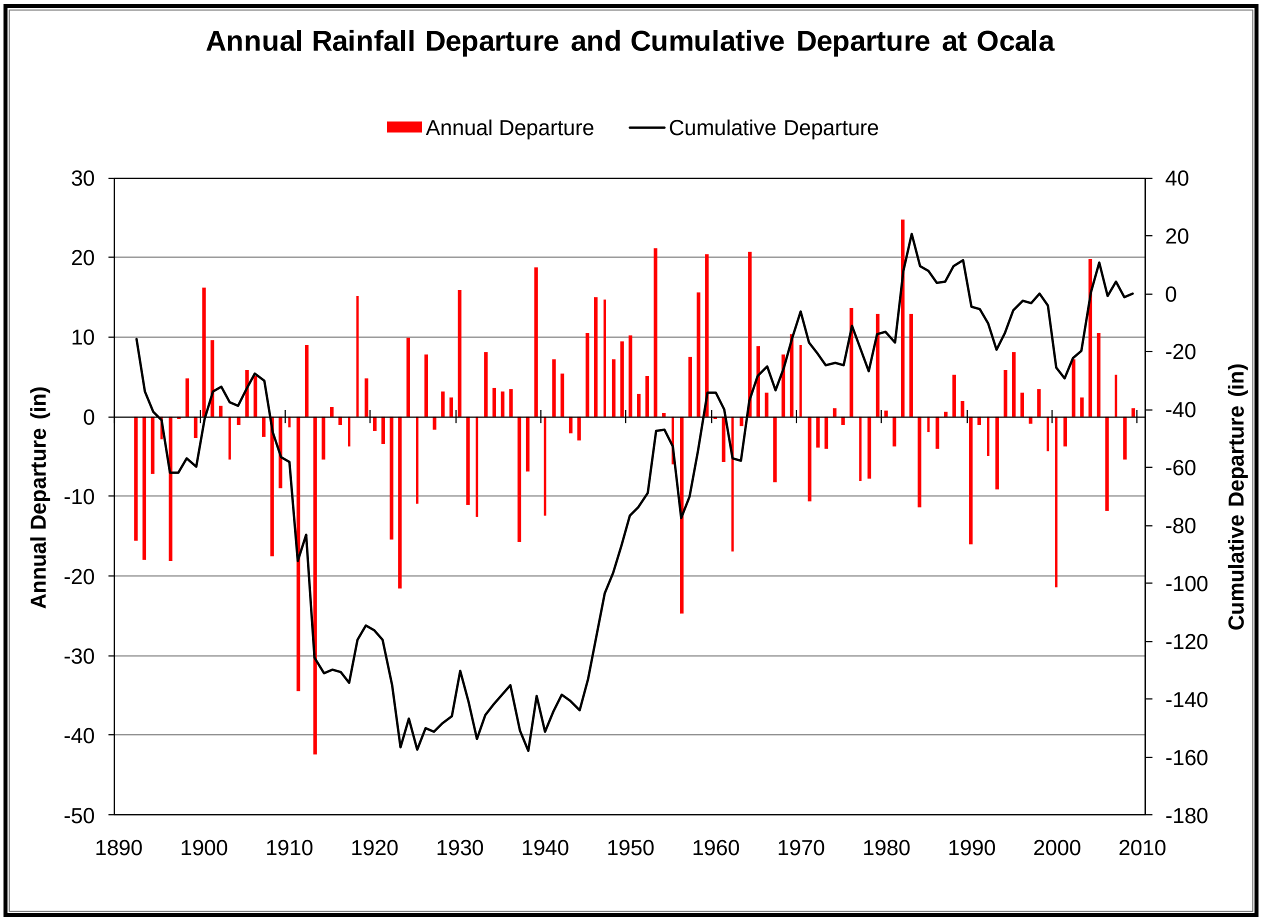

Figure 16. Annual rainfall departure from long-term mean, and cumulative departure from long-term mean in Ocala.

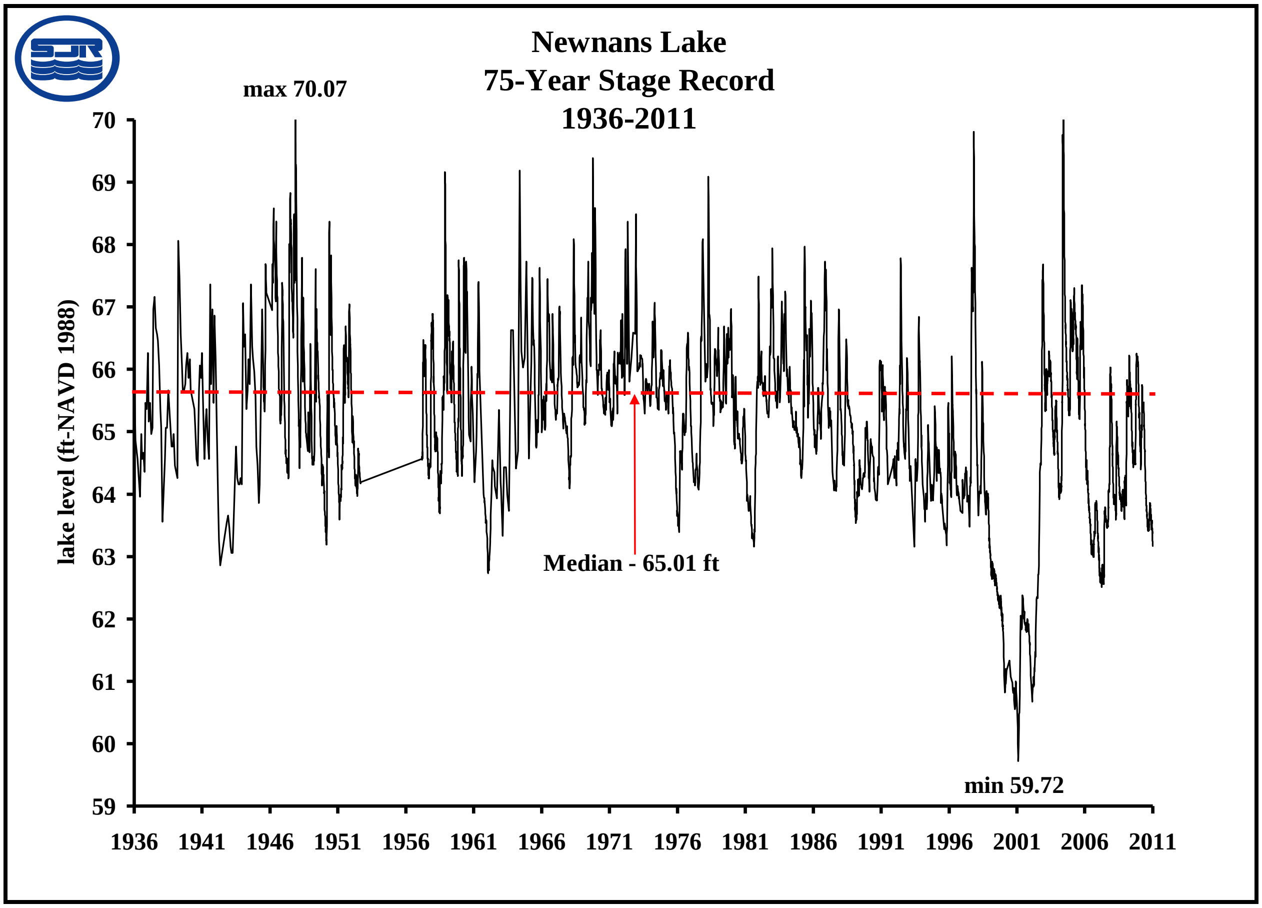

Figure 17. Daily lake level (stage) in Newnans Lake for the 75-year period of record (1936-2011).

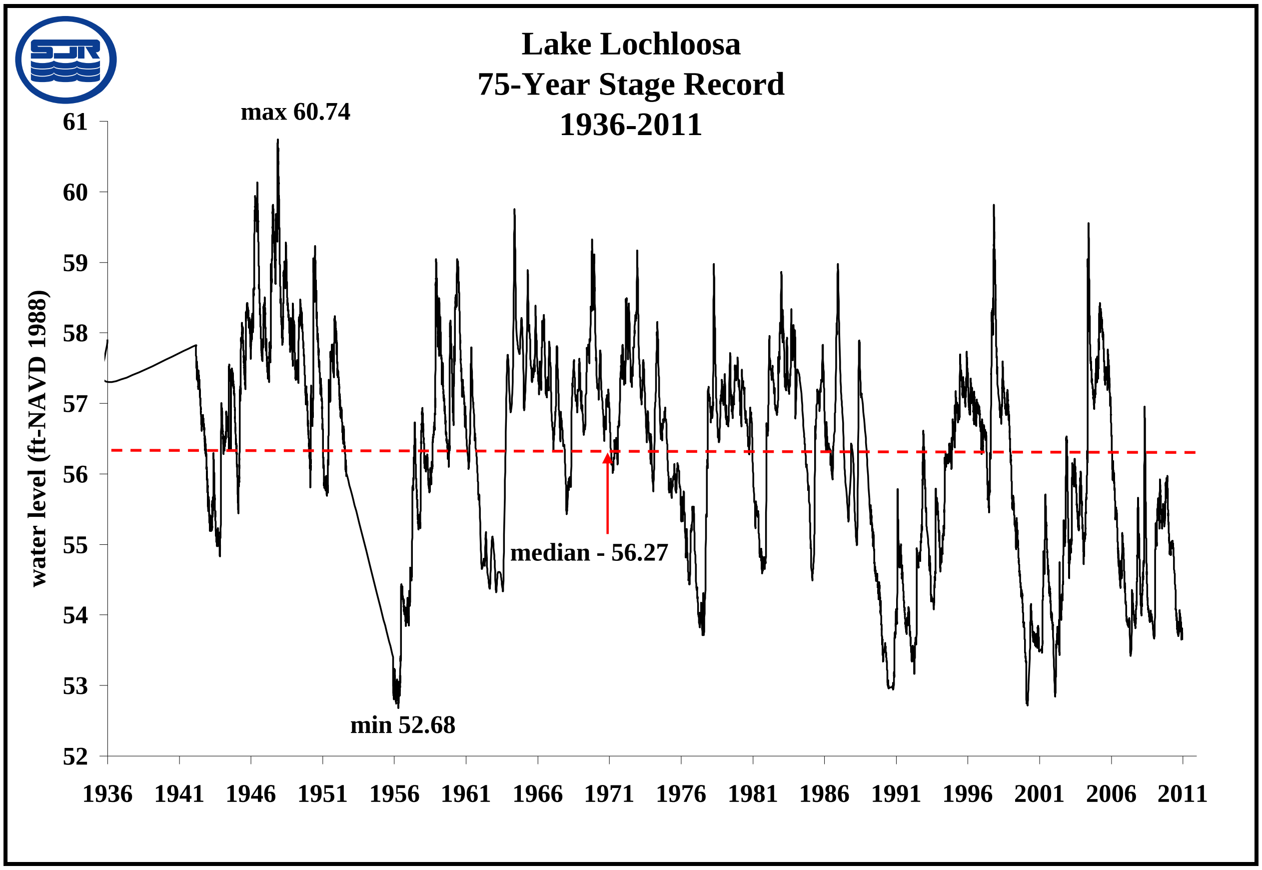

Figure 18. Daily lake level (stage) in Lochloosa Lake for the 75-year period of record (1936-2011).

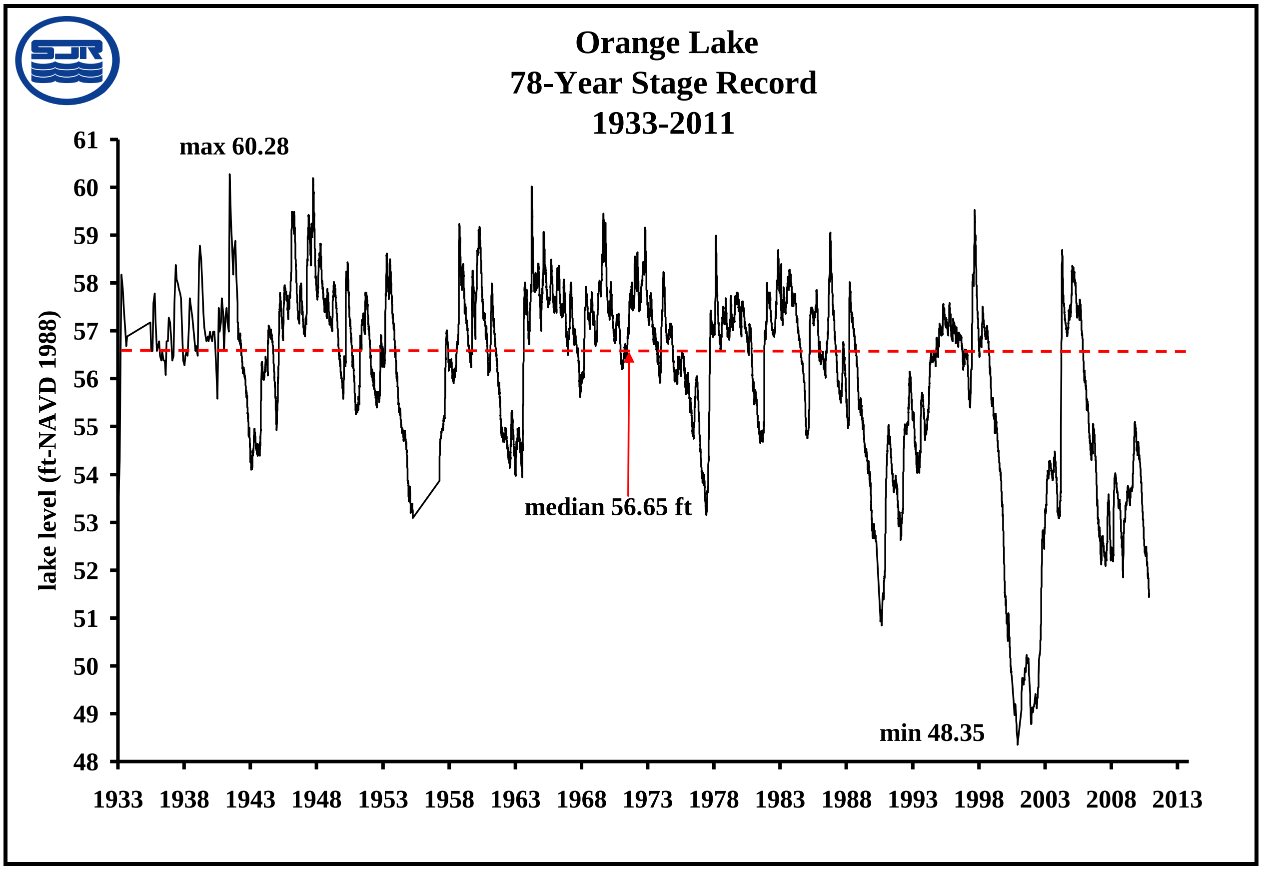

Figure 19. Daily lake level (stage) in Orange Lake for the 78-year period of record (1933-2011).

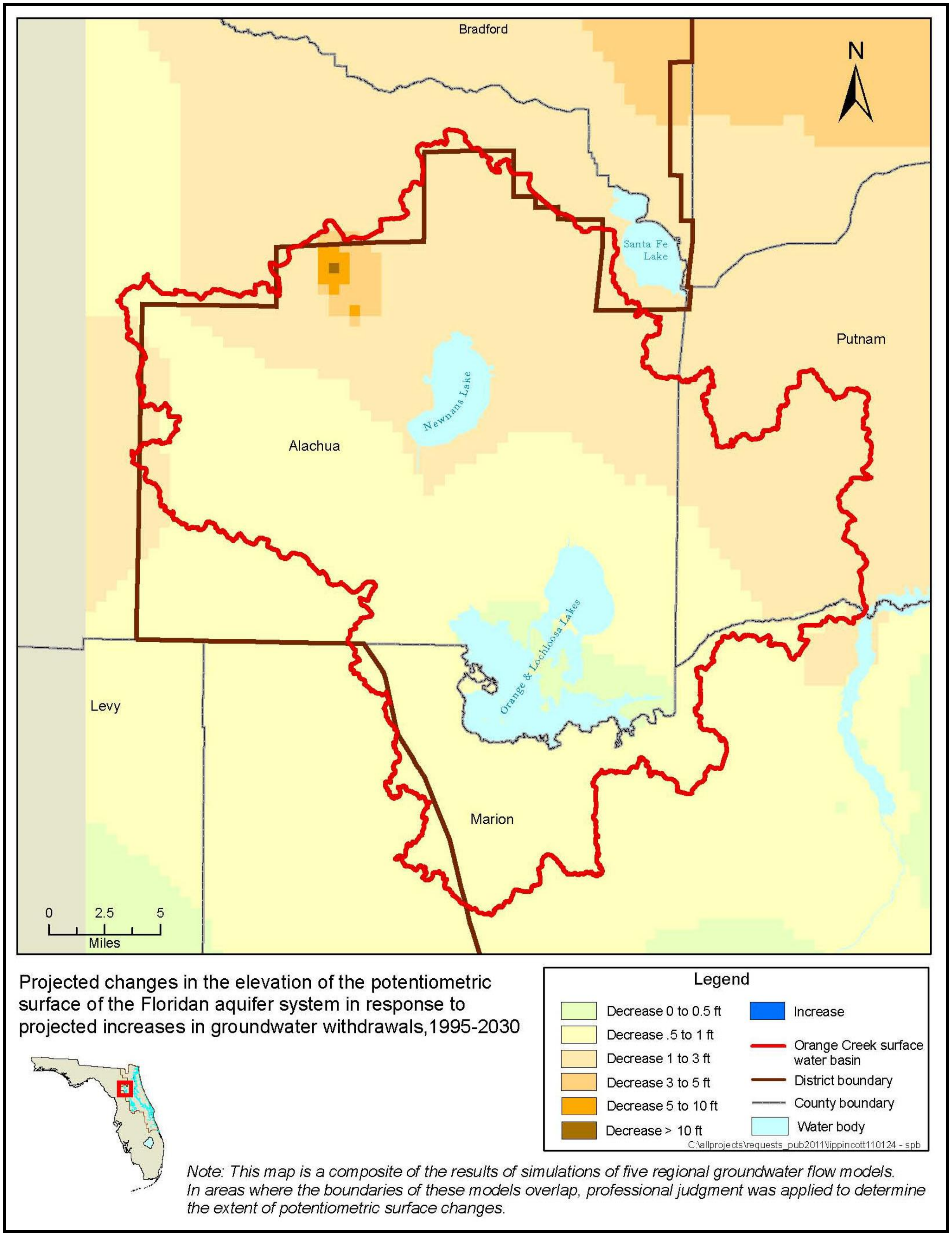

Figure 20. Draft - Projected changes in the elevation of the potentiometric surface of the Floridan aquifer system in the Orange Creek Basin from 1995 to 2030 in response to projected increases in groundwater withdrawals.

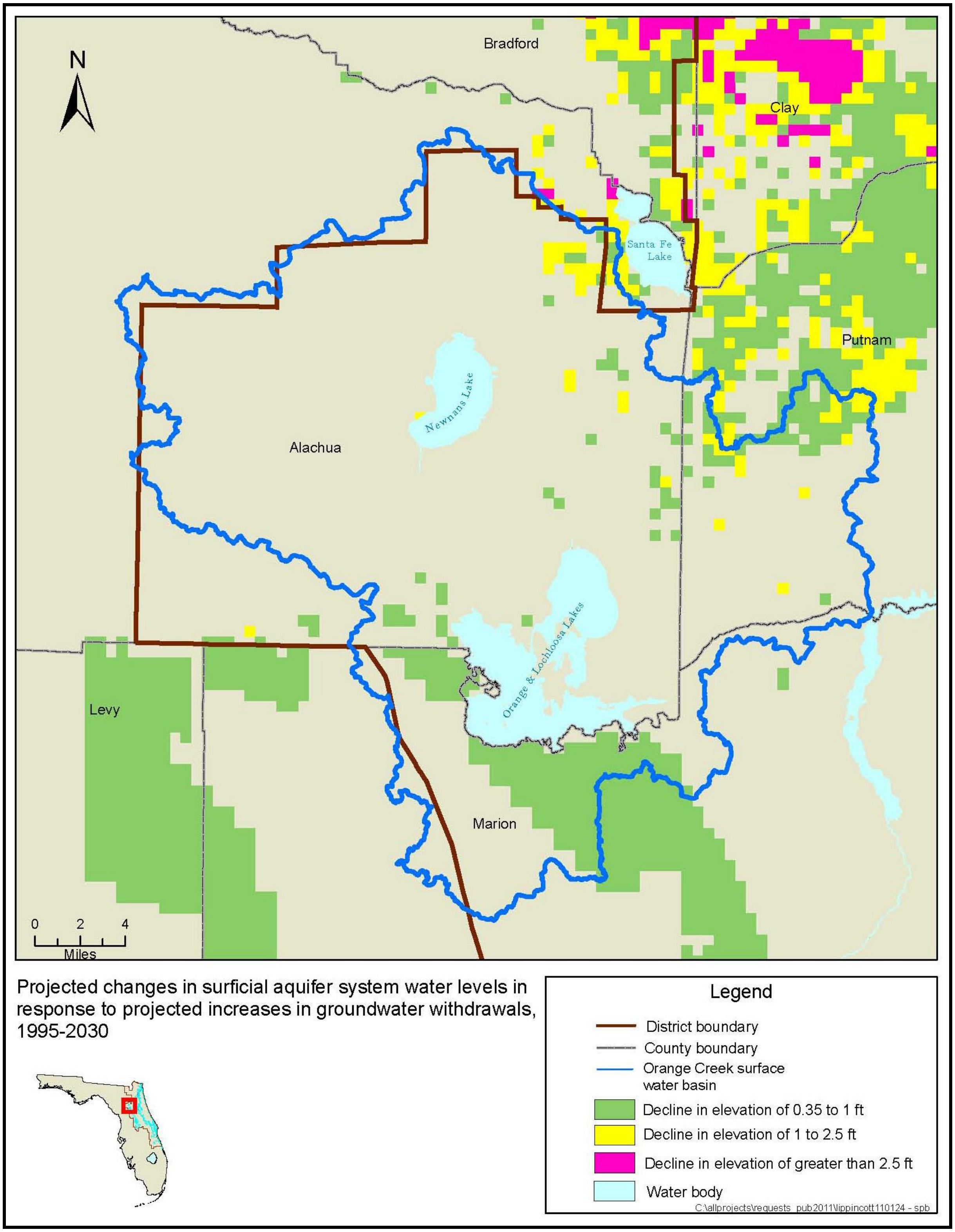

Figure 21. Draft - Projected changes in surficial aquifer system water levels from 1995 to 2030 in the Orange Creek Basin in response to projected increases in groundwater withdrawals.

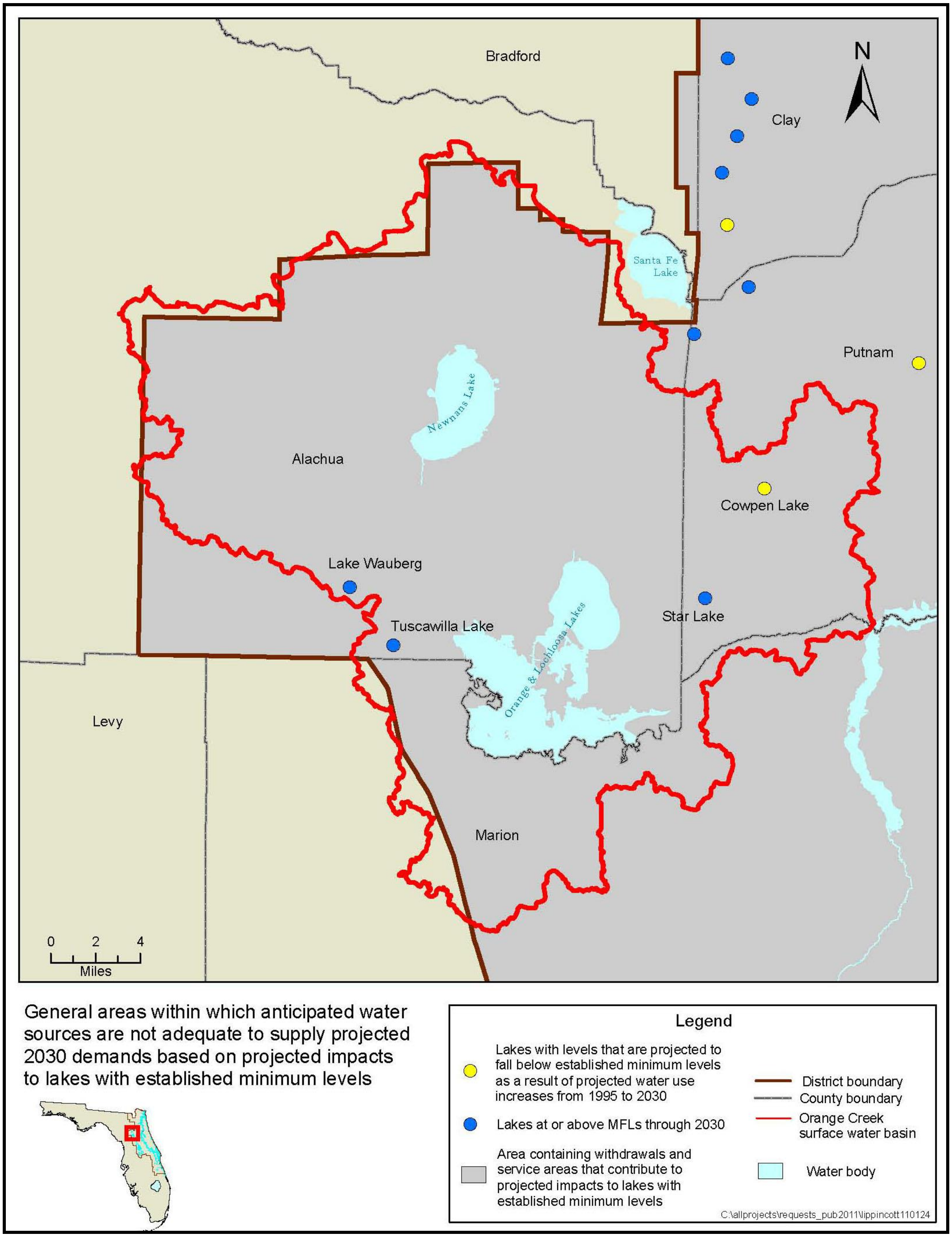

Figure 22. Draft - General areas in the Orange Creek Basin within which anticipated water sources are not adequate to supply projected 2030 demands based on projected impacts to lakes with established minimum levels.

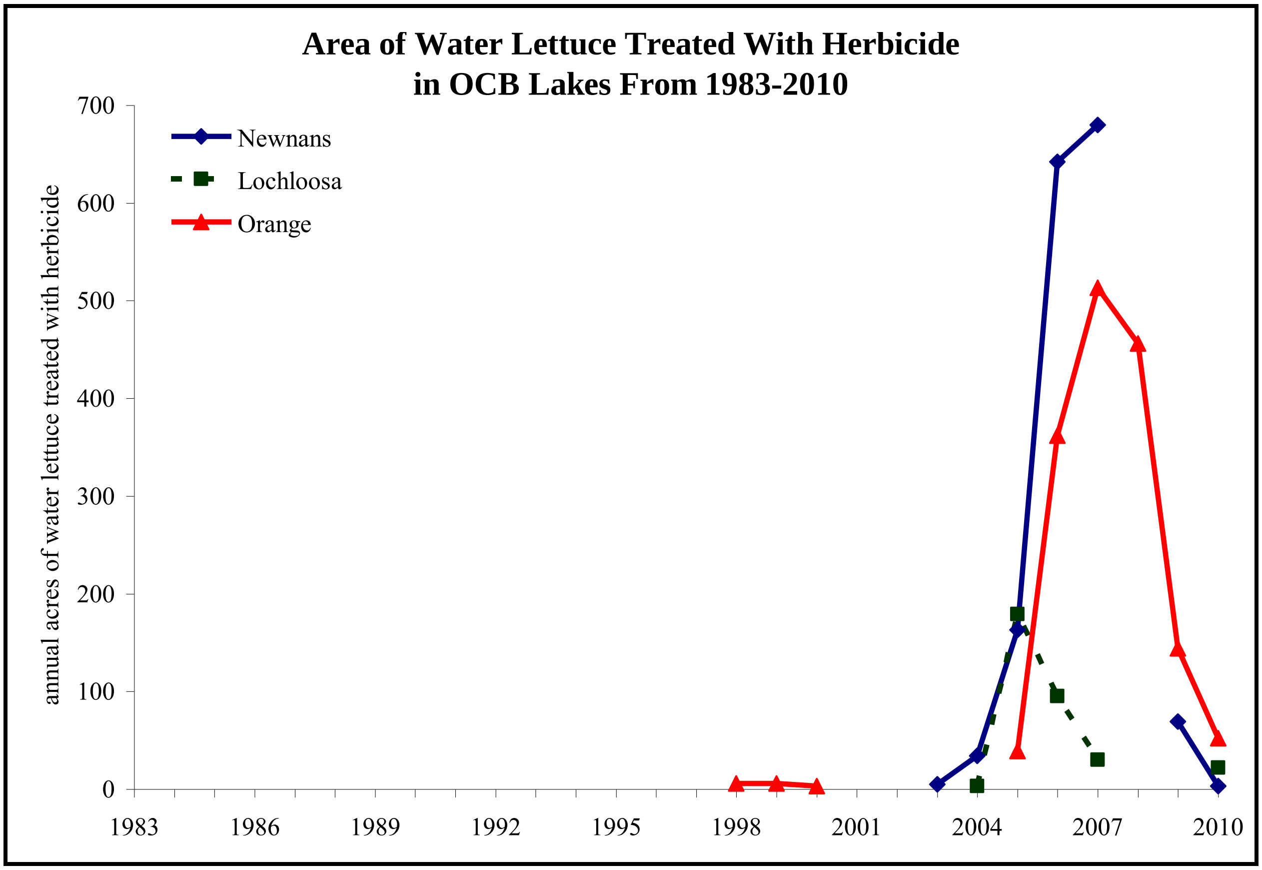

Figure 23. Annual area of water lettuce treated with herbicide in Newnans, Lochloosa, and Orange lakes from 1983 through 2010. Data source: FWC Invasive Plant Management.

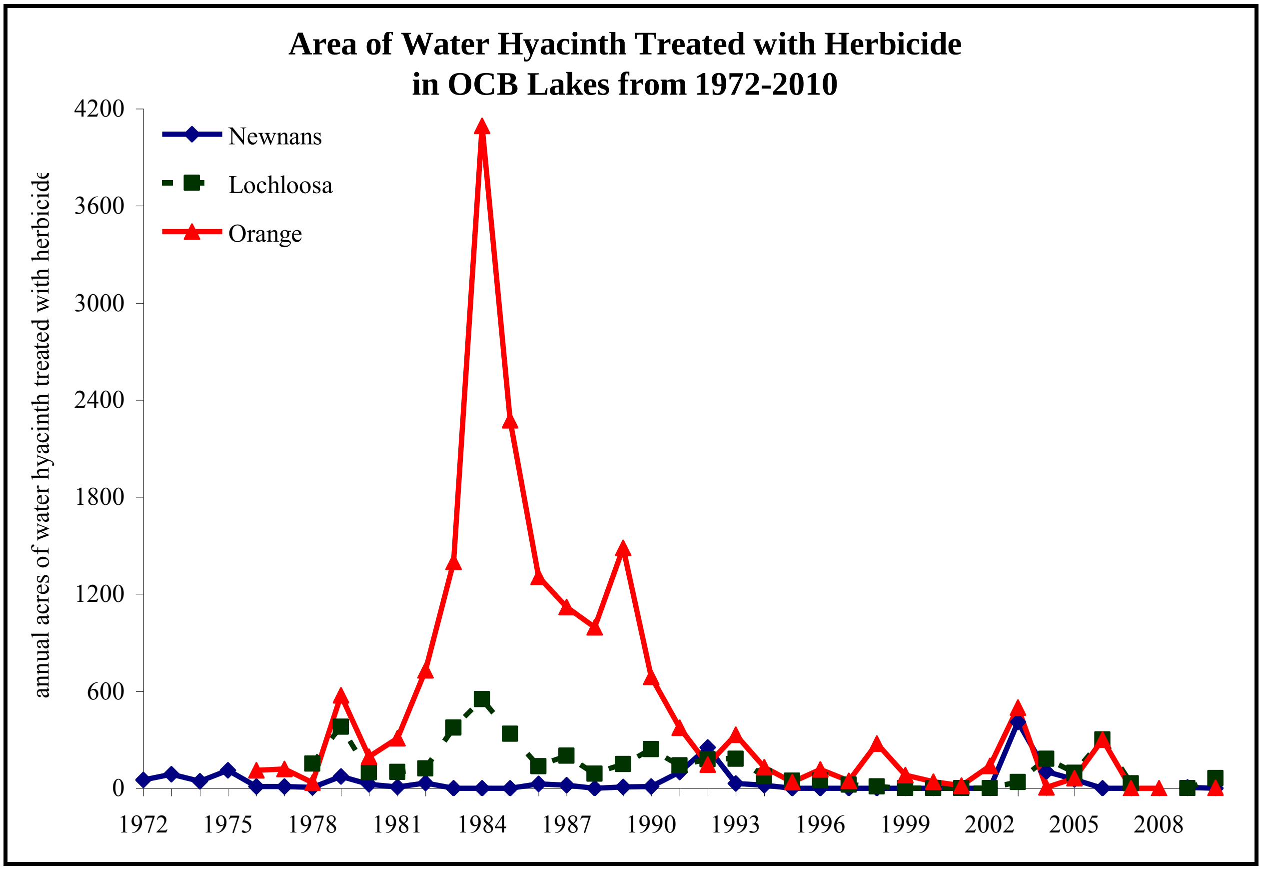

Figure 24. Annual area of water hyacinth treated with herbicide in Newnans, Lochloosa, and Orange lakes from 1972 through 2010. Data source: FWC Invasive Plant Management.

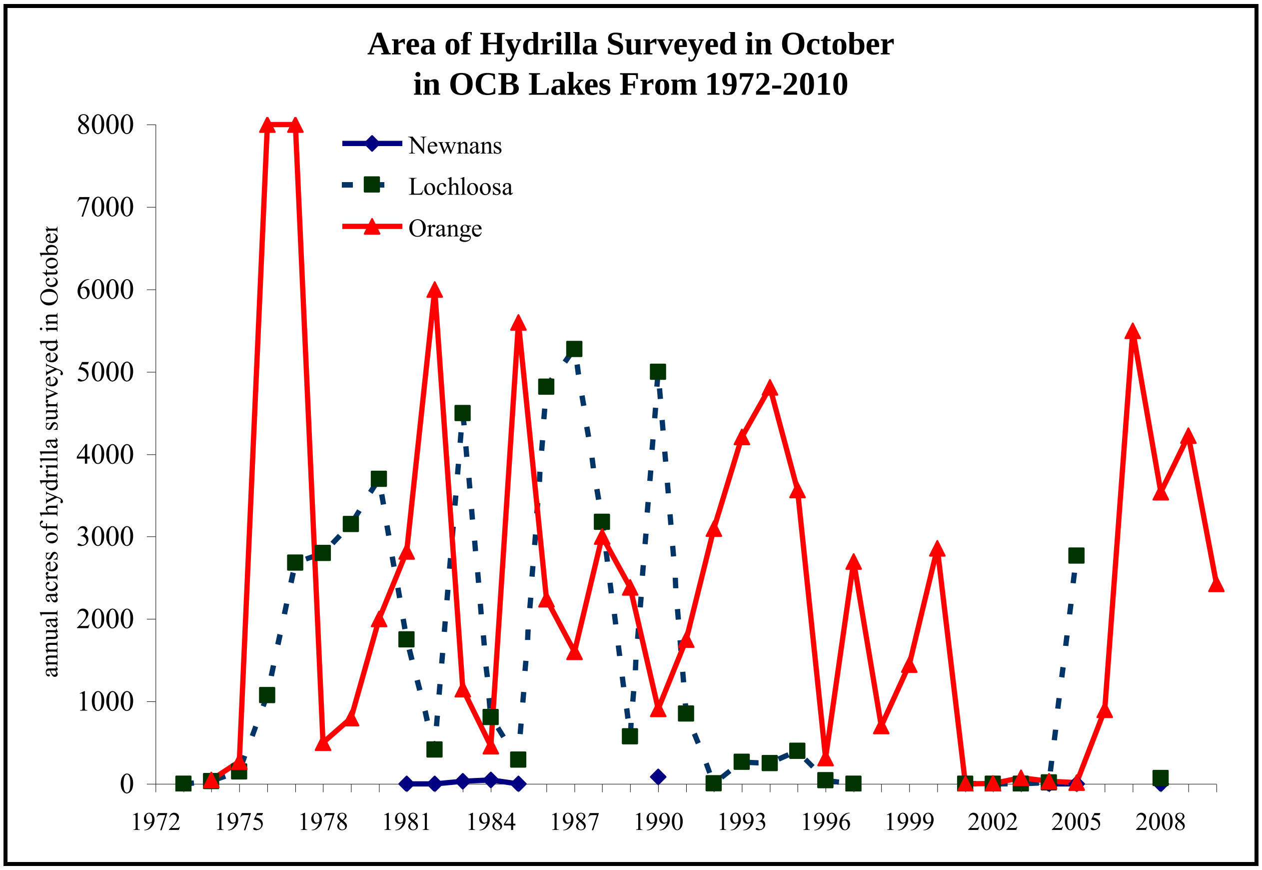

Figure 25. Annual area of hydrilla observed during 1-2 day surveys in October in Newnans, Lochloosa, and Orange lakes from 1972 through 2010. Data source: FWC Invasive Plant Management.

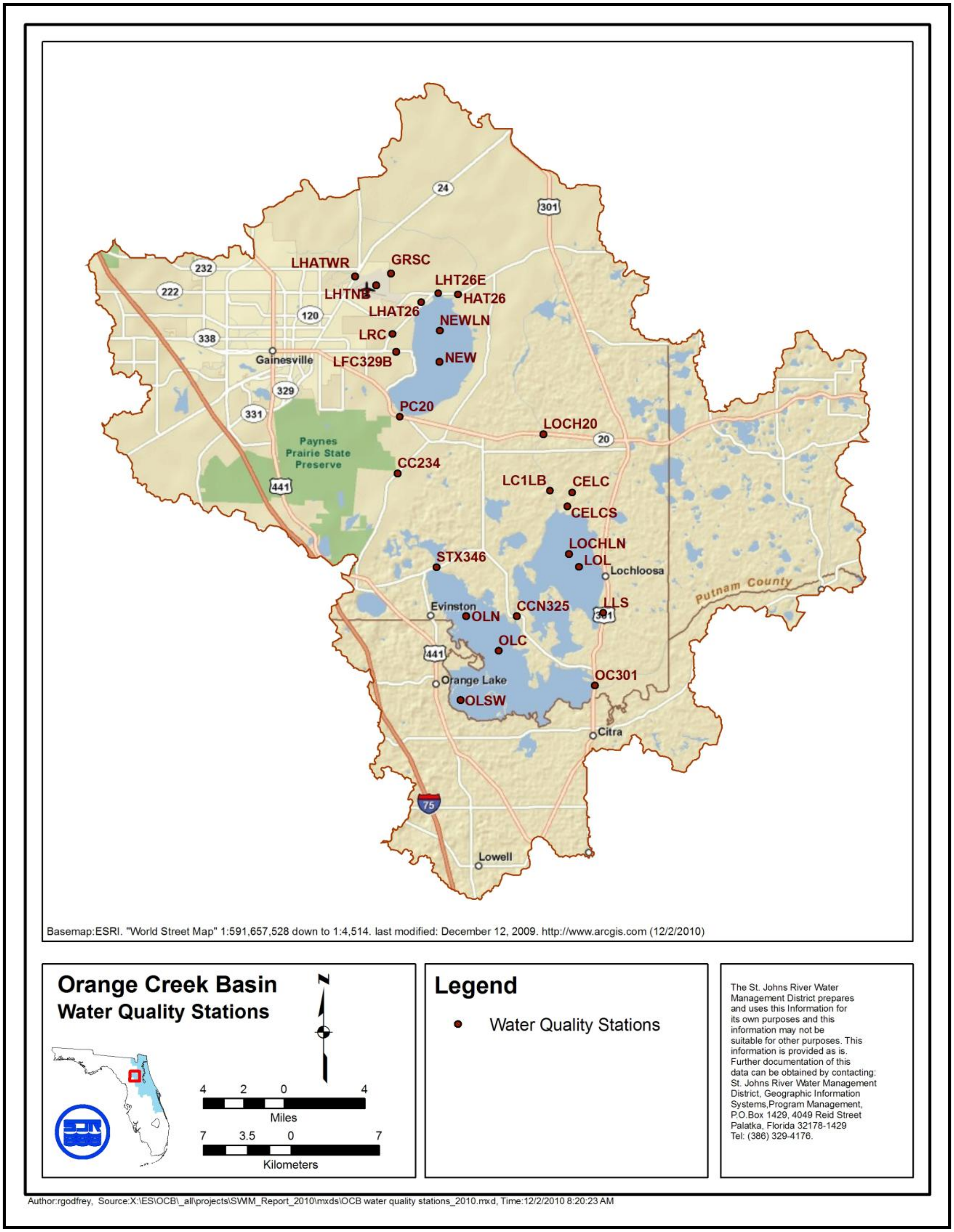

Figure 26. Orange Creek Basin stations where water quality and plankton samples are collected monthly by the District.

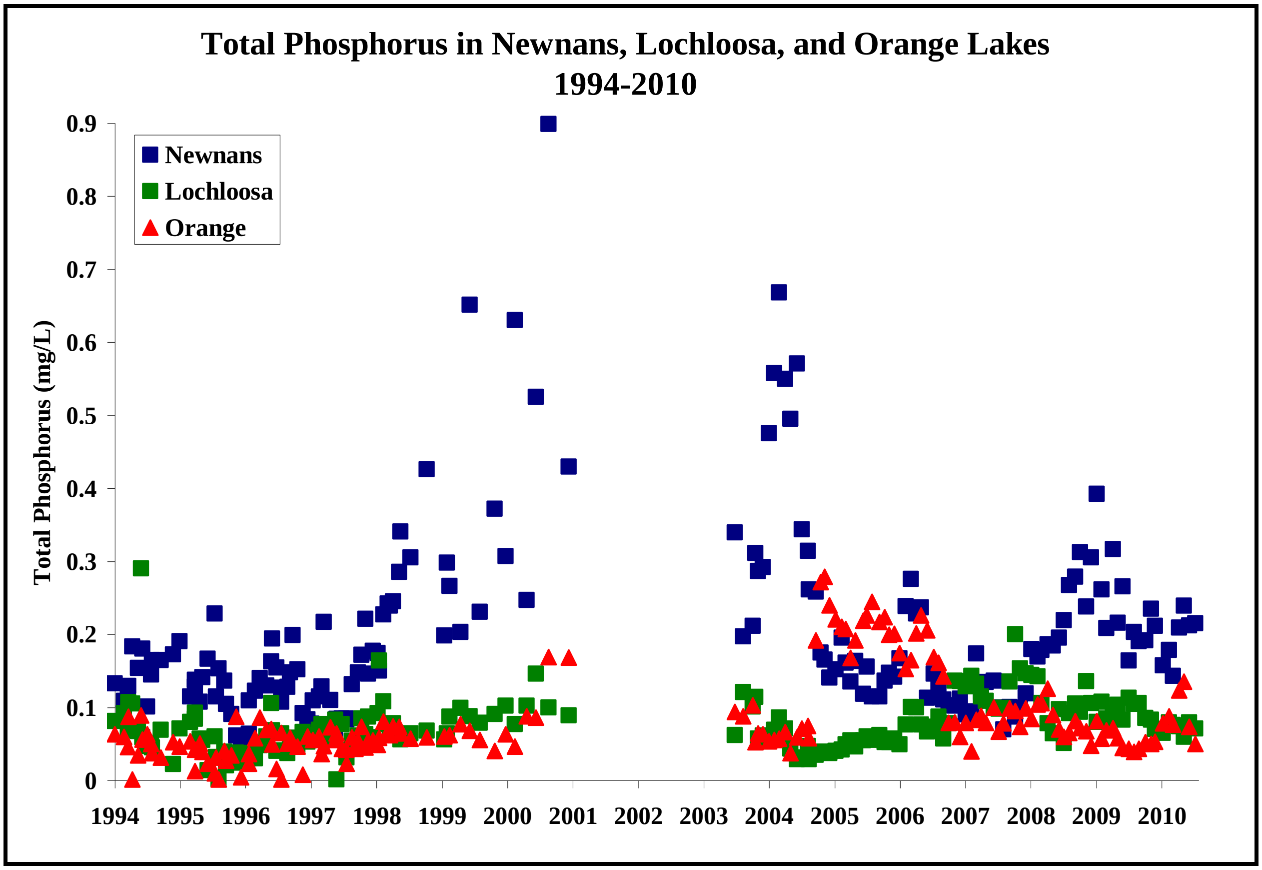

Figure 27. Total phosphorus concentration in Newnans, Lochloosa and Orange lakes from 1994-2010.

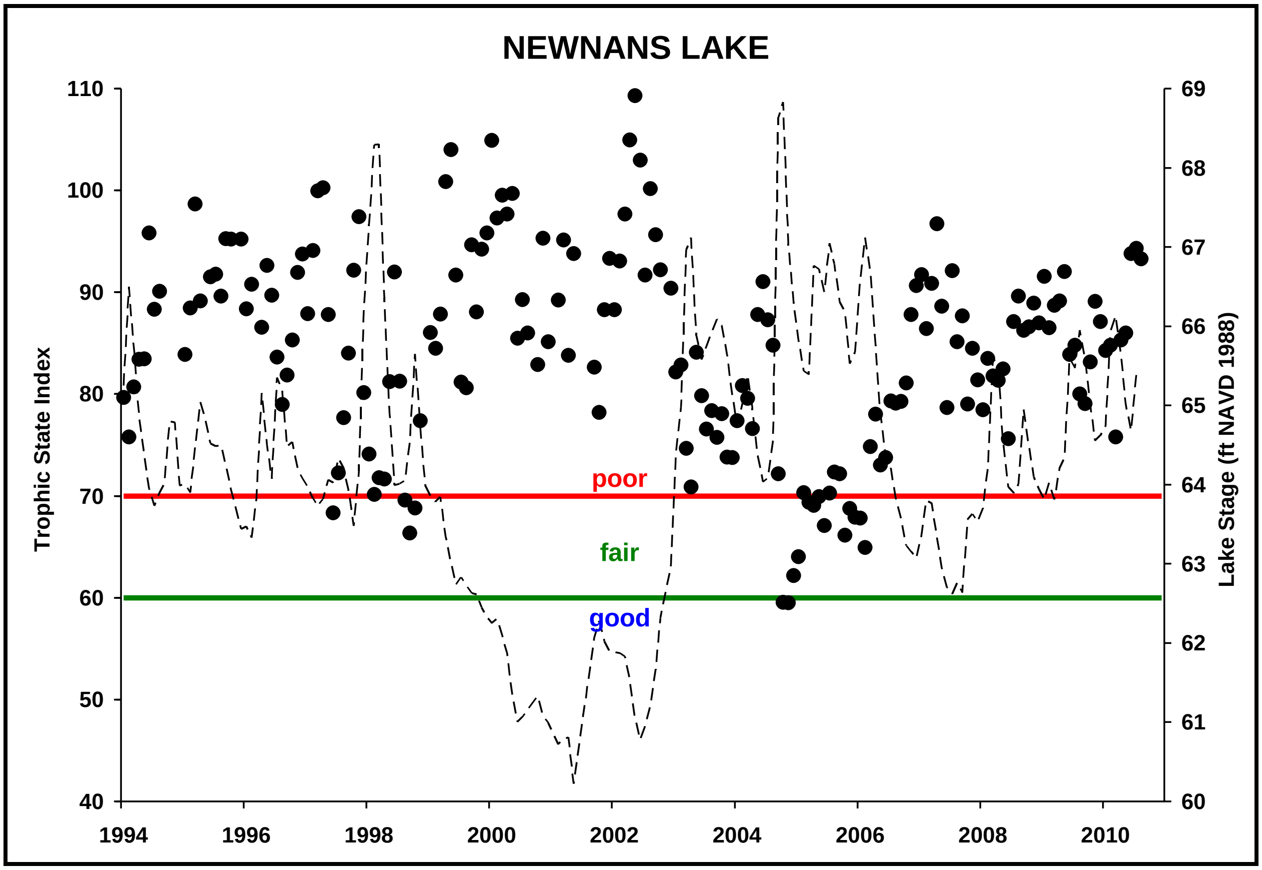

Figure 28. Trophic State Index and lake level in Newnans Lake from January 1994 through August 2010.

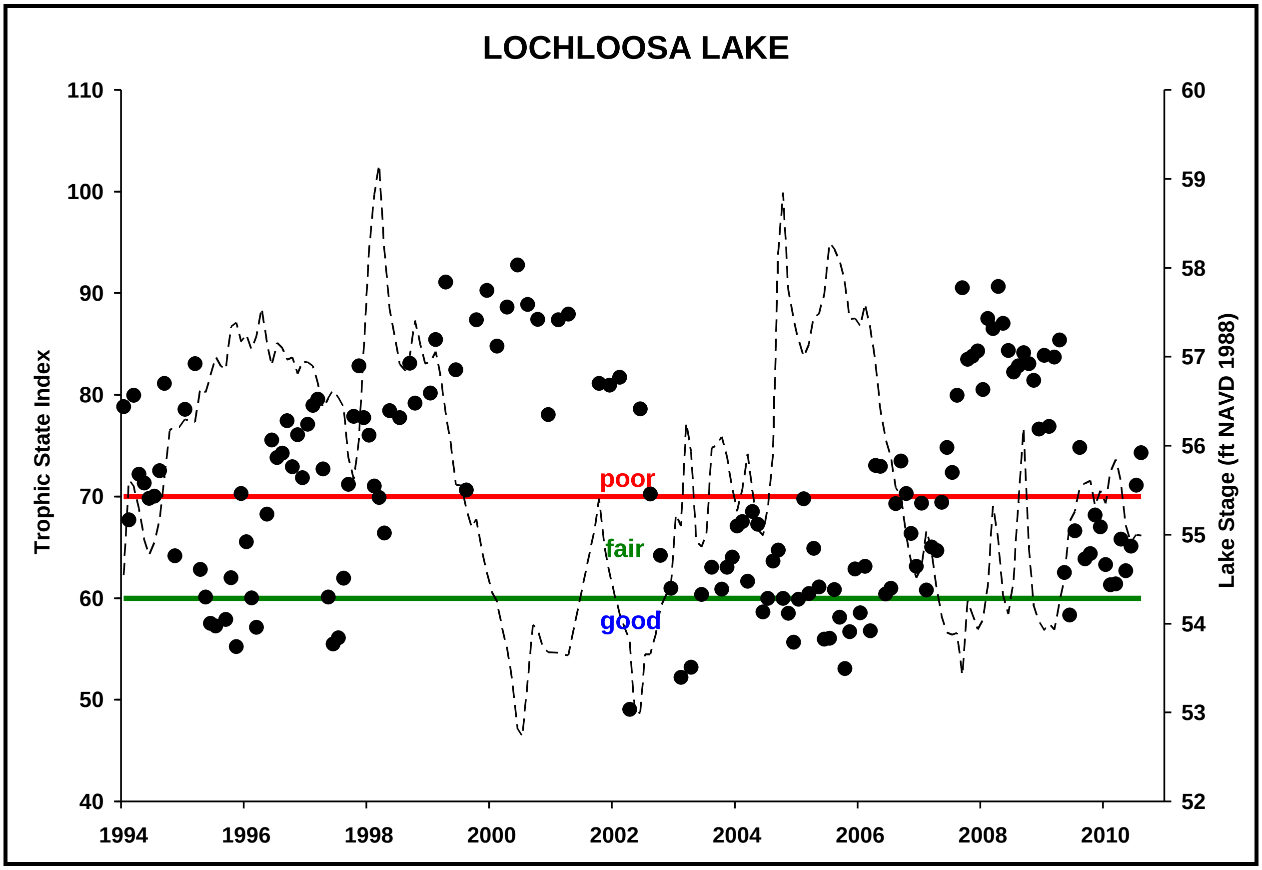

Figure 29. Trophic State Index and lake level in Lochloosa Lake from January 1994 through August 2010.

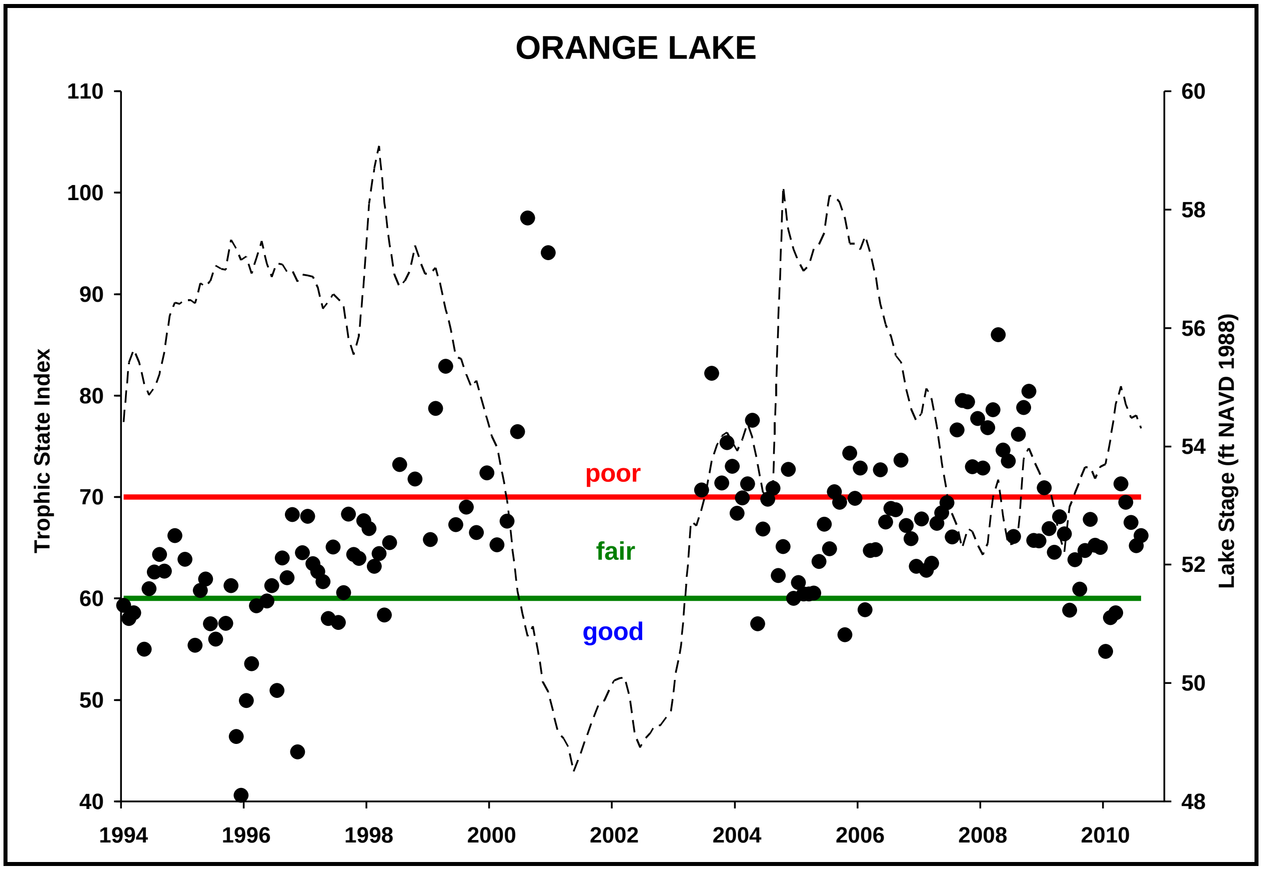

Figure 30. Trophic State Index and lake level in Orange Lake from January 1994 through August 2010.

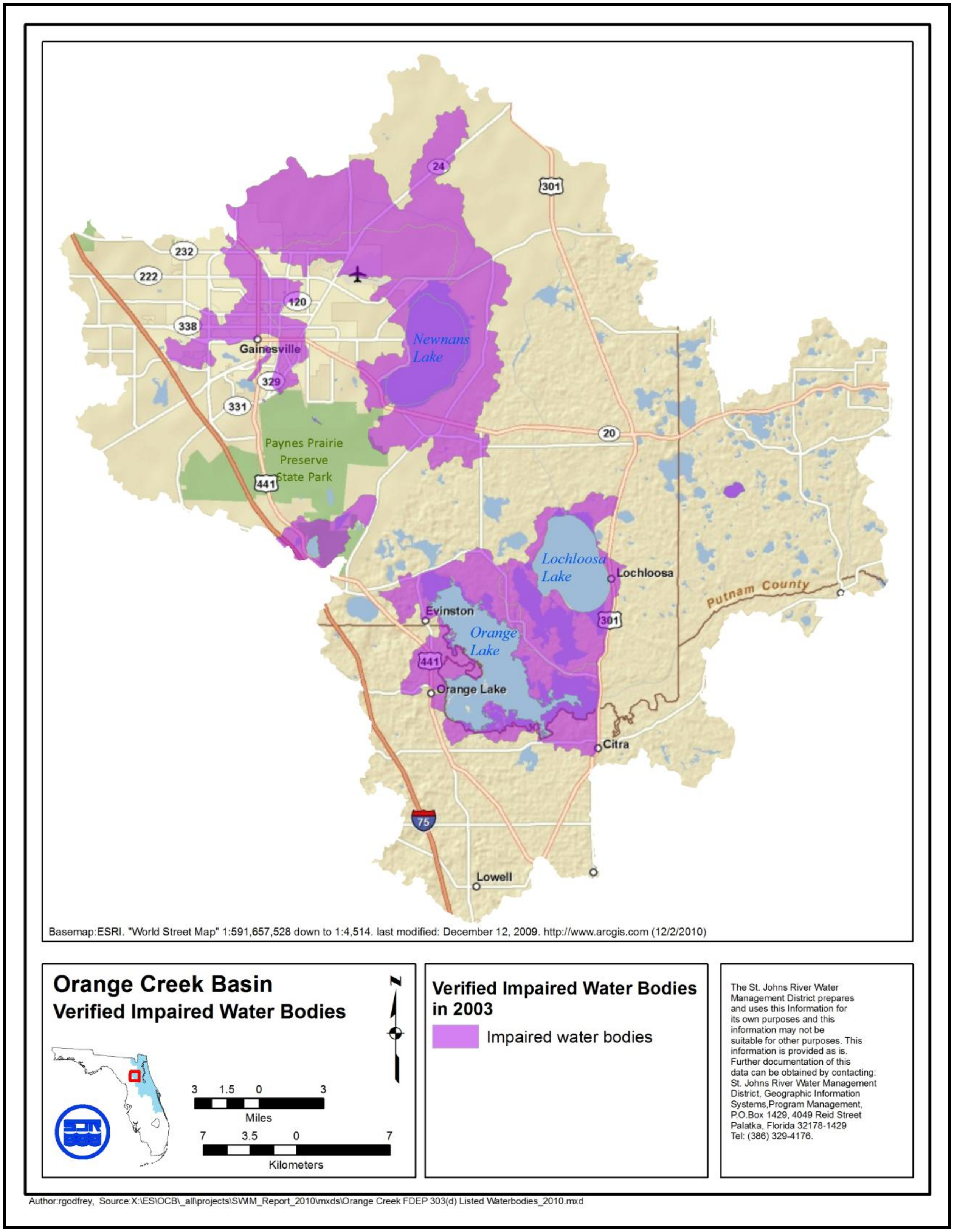

Figure 31. Verified impaired water bodies in the Orange Creek Basin listed by FDEP in 2003.

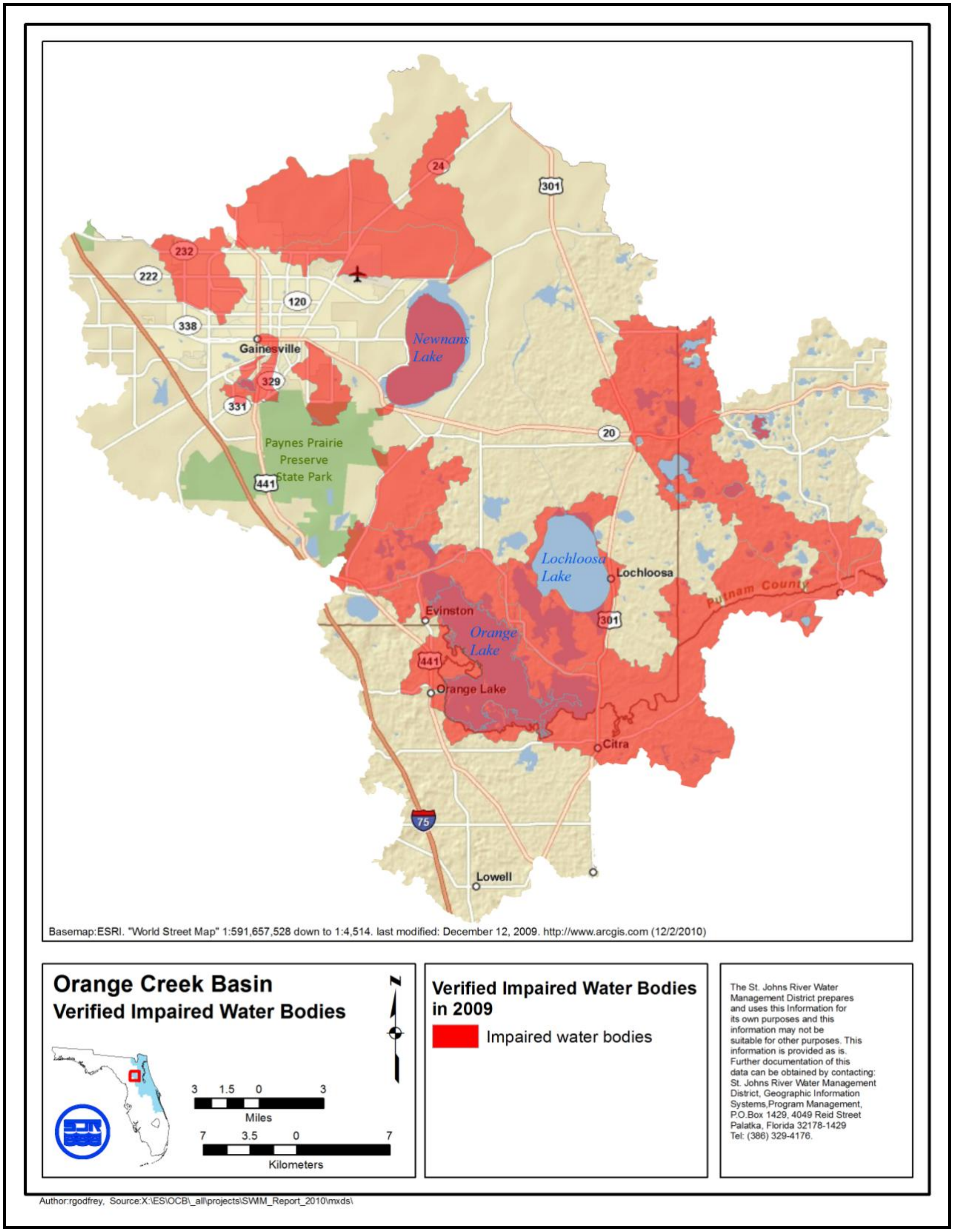

Figure 32. Verified impaired water bodies in the Orange Creek Basin listed by FDEP in 2009.

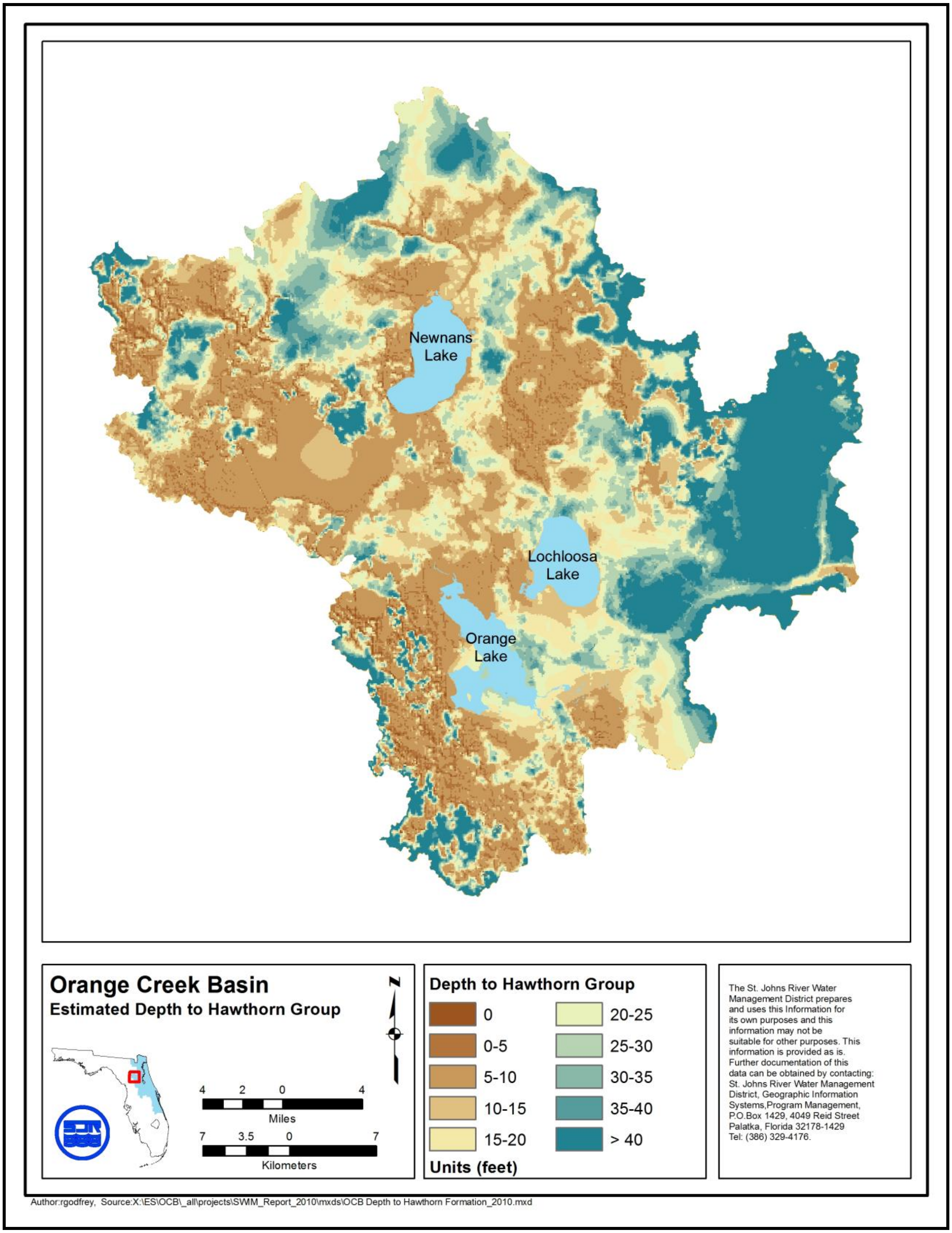

Figure 33. Map of estimated depth from the land surface to the top of the Hawthorn Group in the Orange Creek Basin.

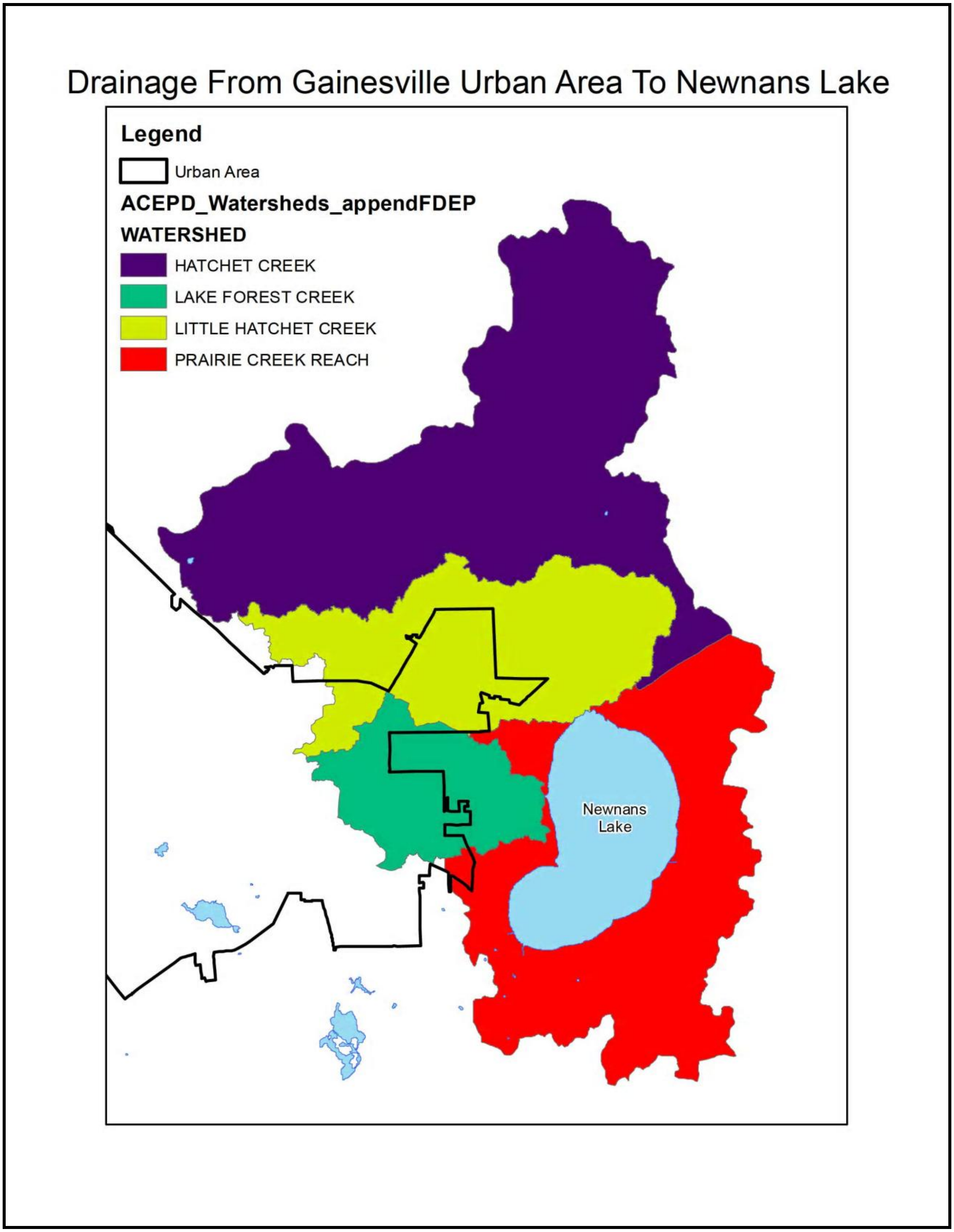

Figure 34. Drainage from Gainesville MS4 urban area to Newnans Lake. Urban Area Boundary based on 2000 census. Source: City of Gainesville, Clean Water Partnership.

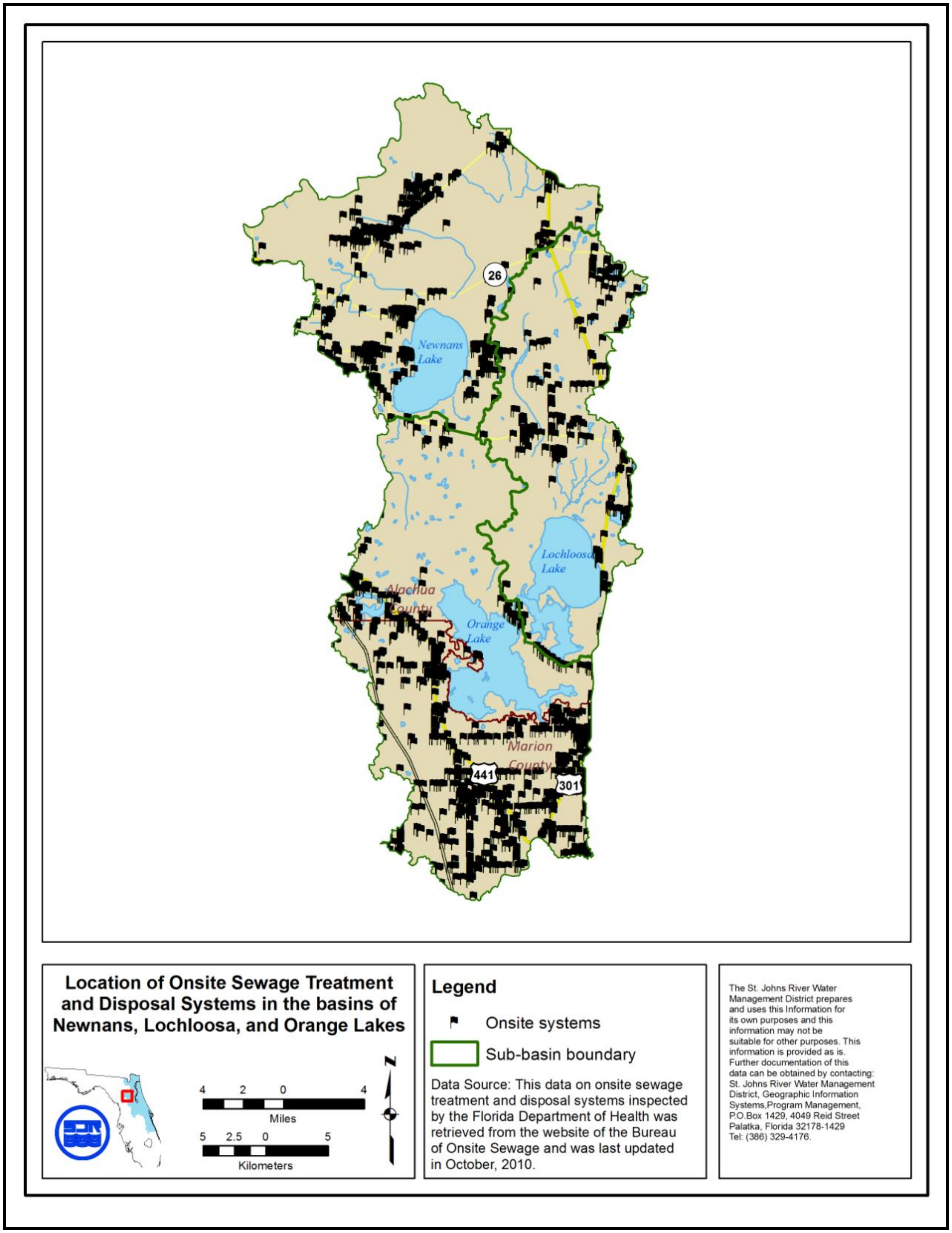

Figure 35. Onsite sewage treatment and disposal systems (= septic systems) in the basins for Newnans, Lochloosa and Orange lake that have been inspected by the Florida Department of Health.

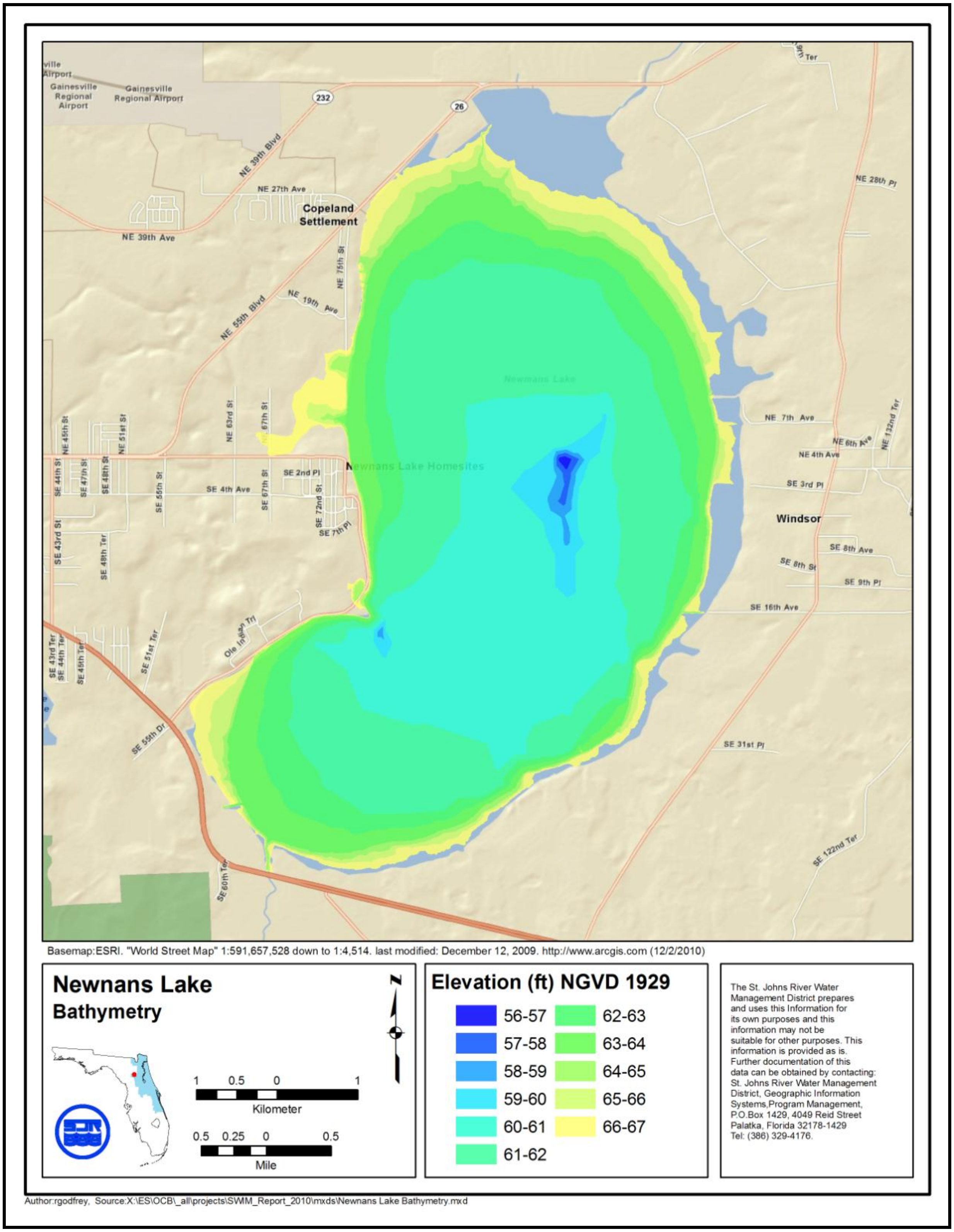

Figure 36. Bathymetry of Newnans Lake. These data are in the older NGVD 1929 datum. If converted to the newer NAVD 1988 datum, the elevations would be approximately 0.89 feet lower.

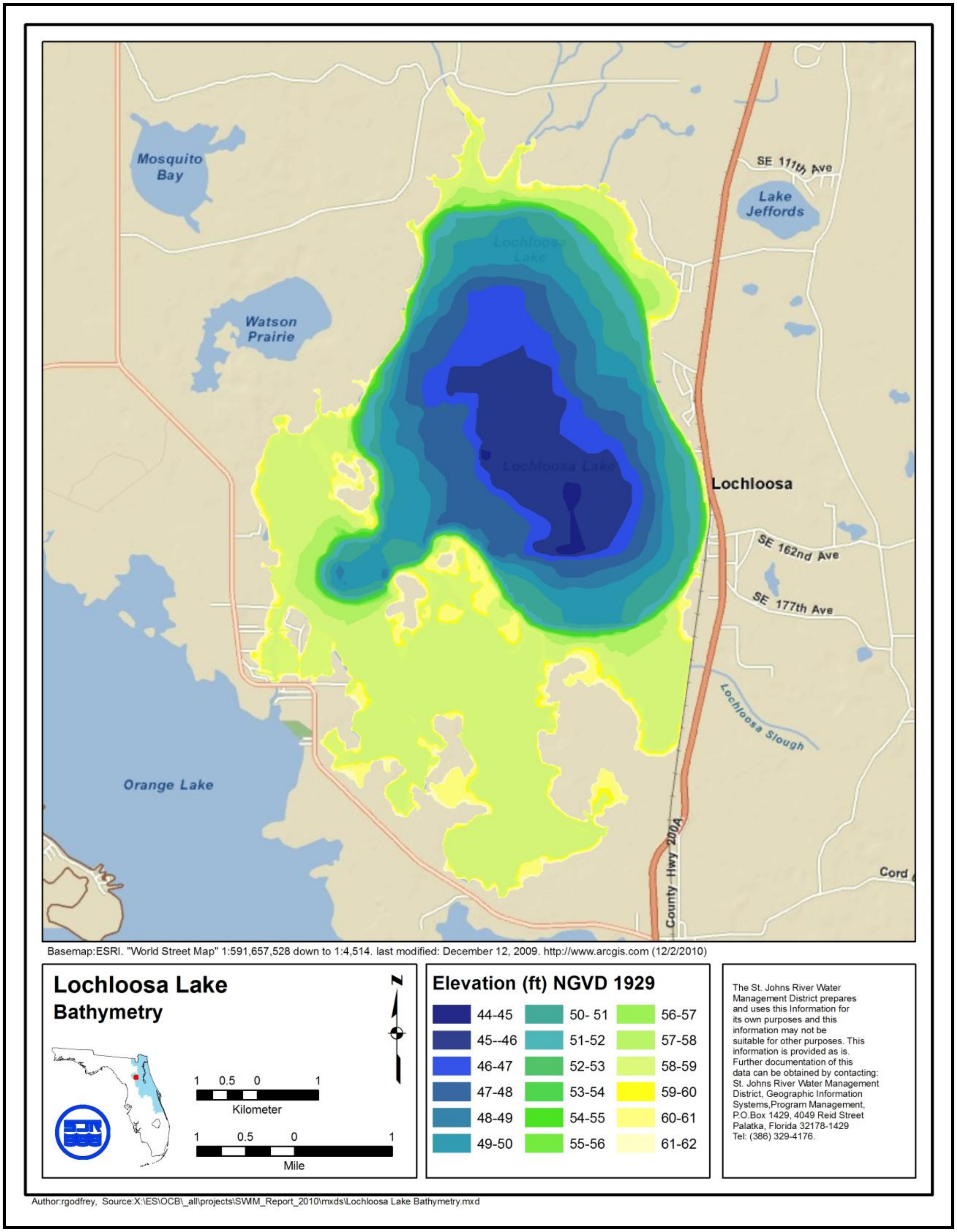

Figure 37. Bathymetry of Lochloosa Lake. These data are in the older NGVD 1929 datum. If converted to the newer NAVD 1988 datum, the elevations would be approximately 0.90 feet lower.

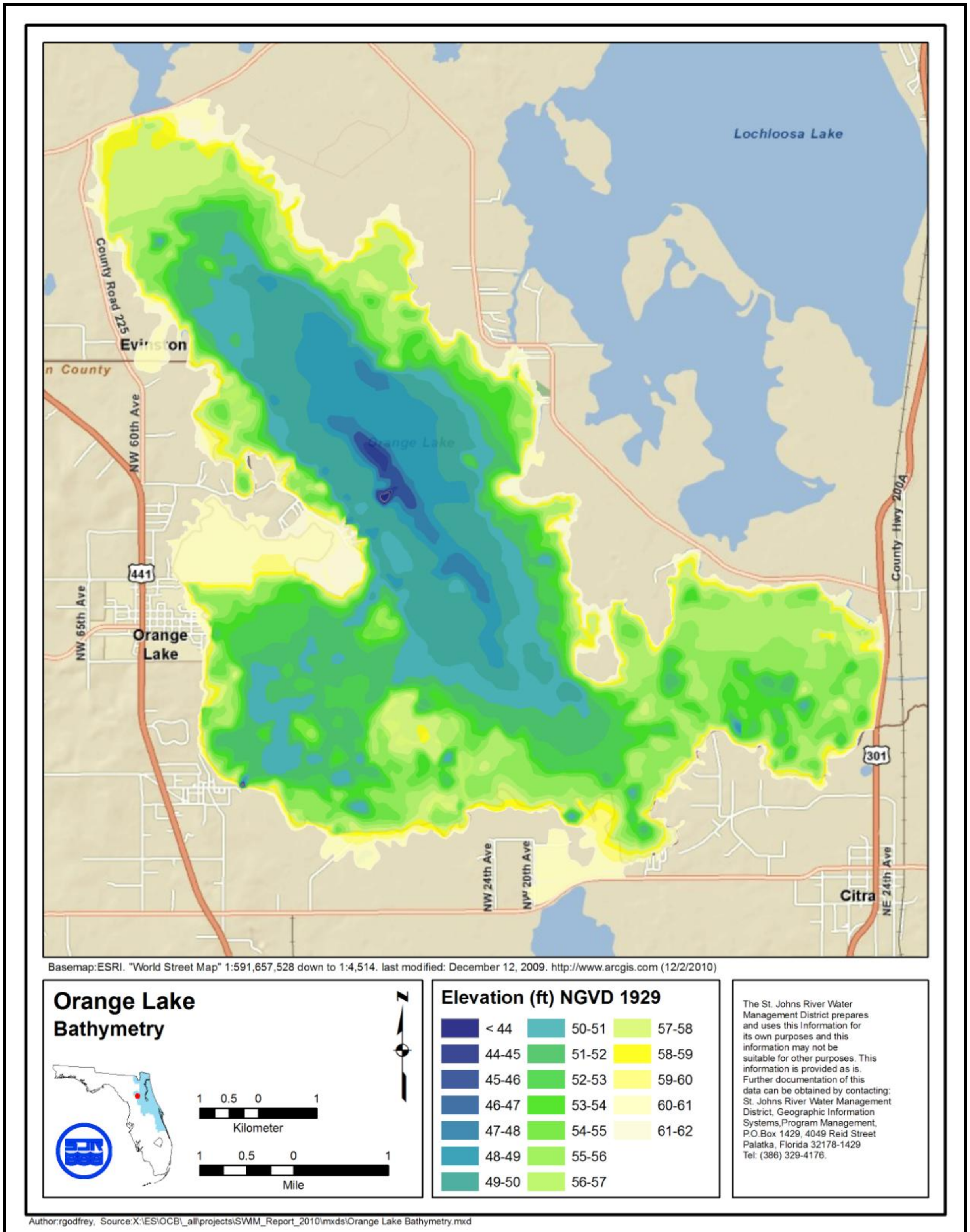

Figure 38. Bathymetry of Orange Lake. These data are in the older NGVD 1929 datum. If converted to the newer NAVD 1988 datum, the elevations would be approximately 0.87 feet lower.

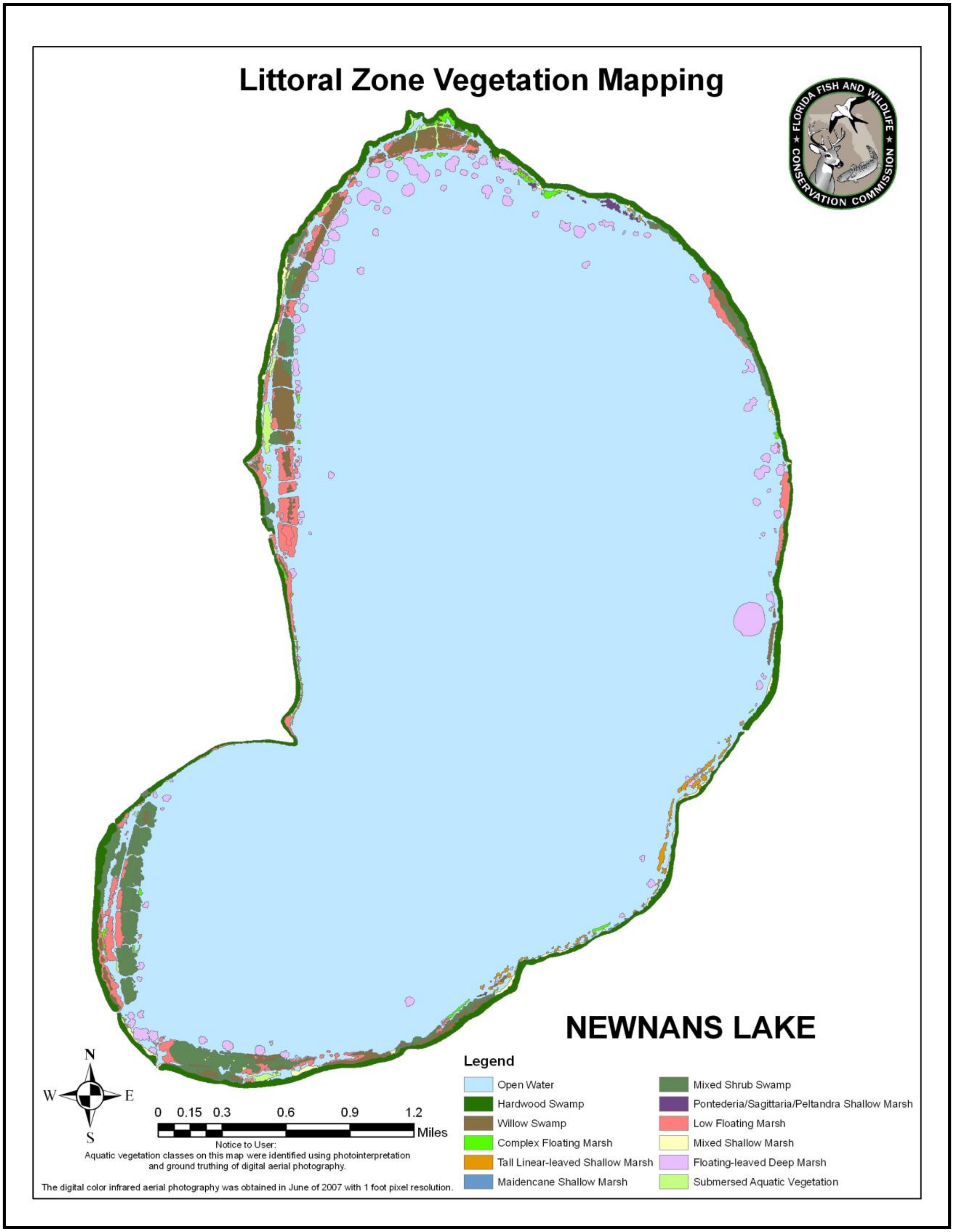

Figure 39. Littoral zone vegetation in Newnans Lake based on 2007 aerial photographs.

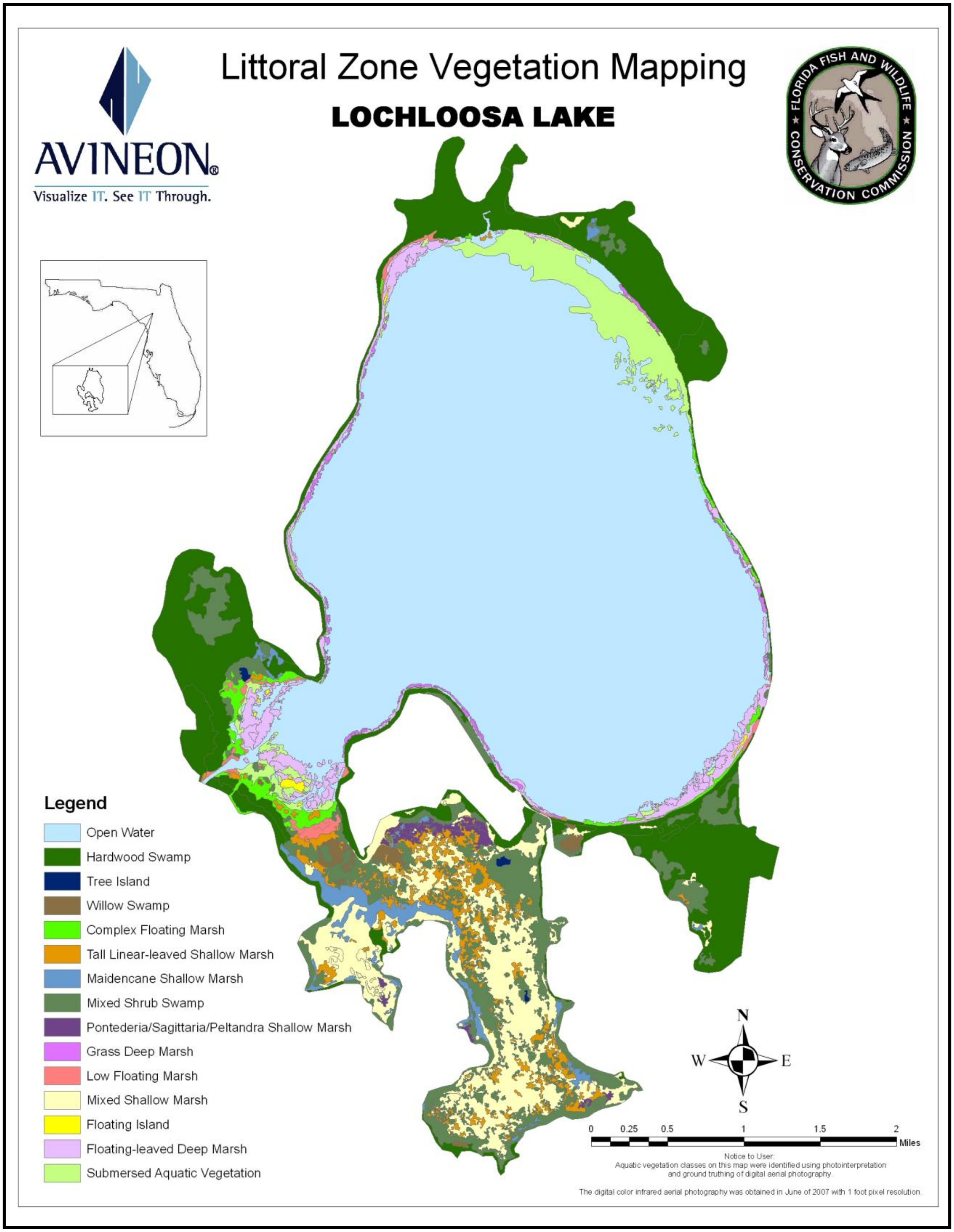

Figure 40. Littoral zone vegetation in Lochloosa Lake based on 2007 aerial photographs.

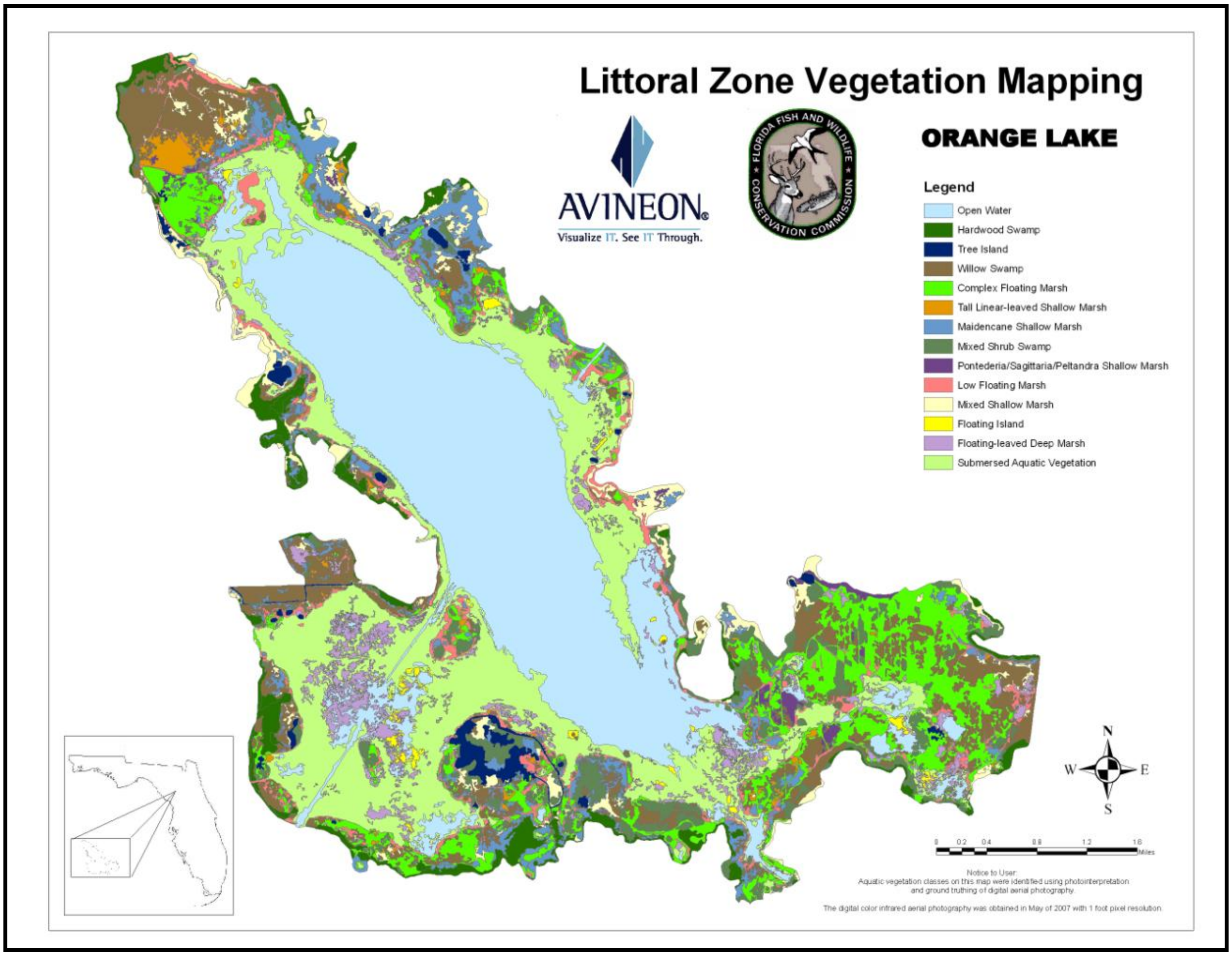

Figure 41. Littoral zone vegetation in Orange Lake based on 2007 aerial photographs.

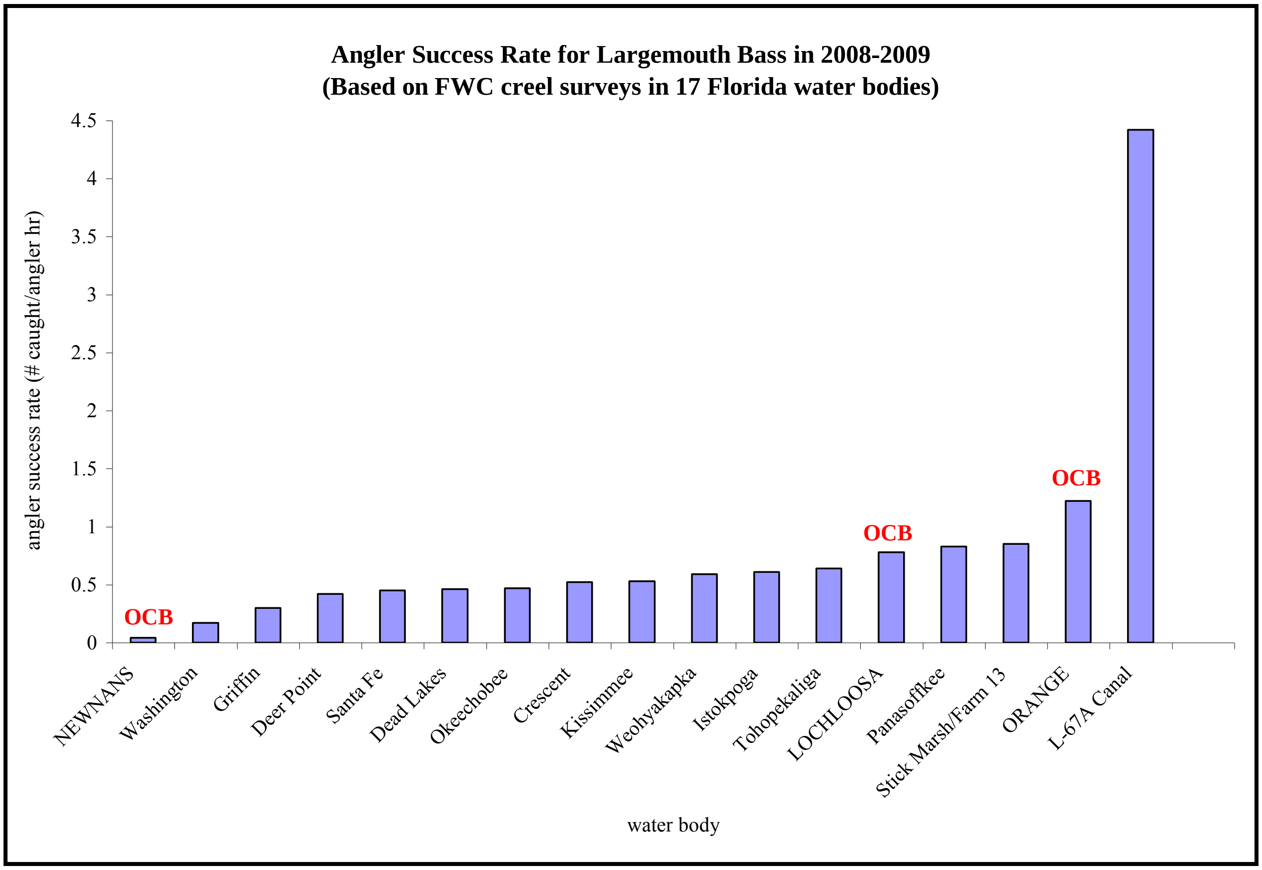

Figure 42. Angler success rate for largemouth bass in Florida lakes, based on FWC creel surveys in 2009.

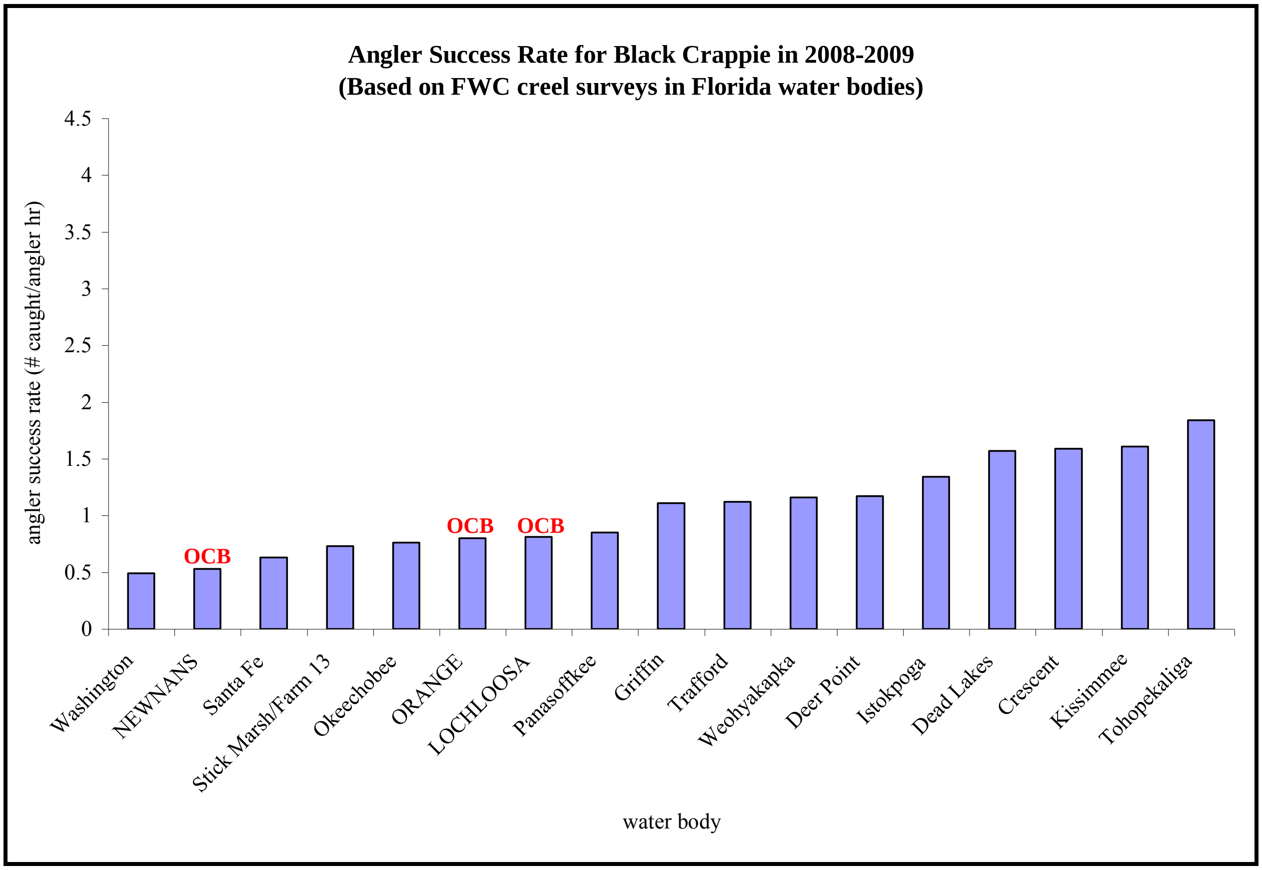

Figure 43. Angler success rate for black crappie in Florida lakes, based on FWC creel surveys in 2009.

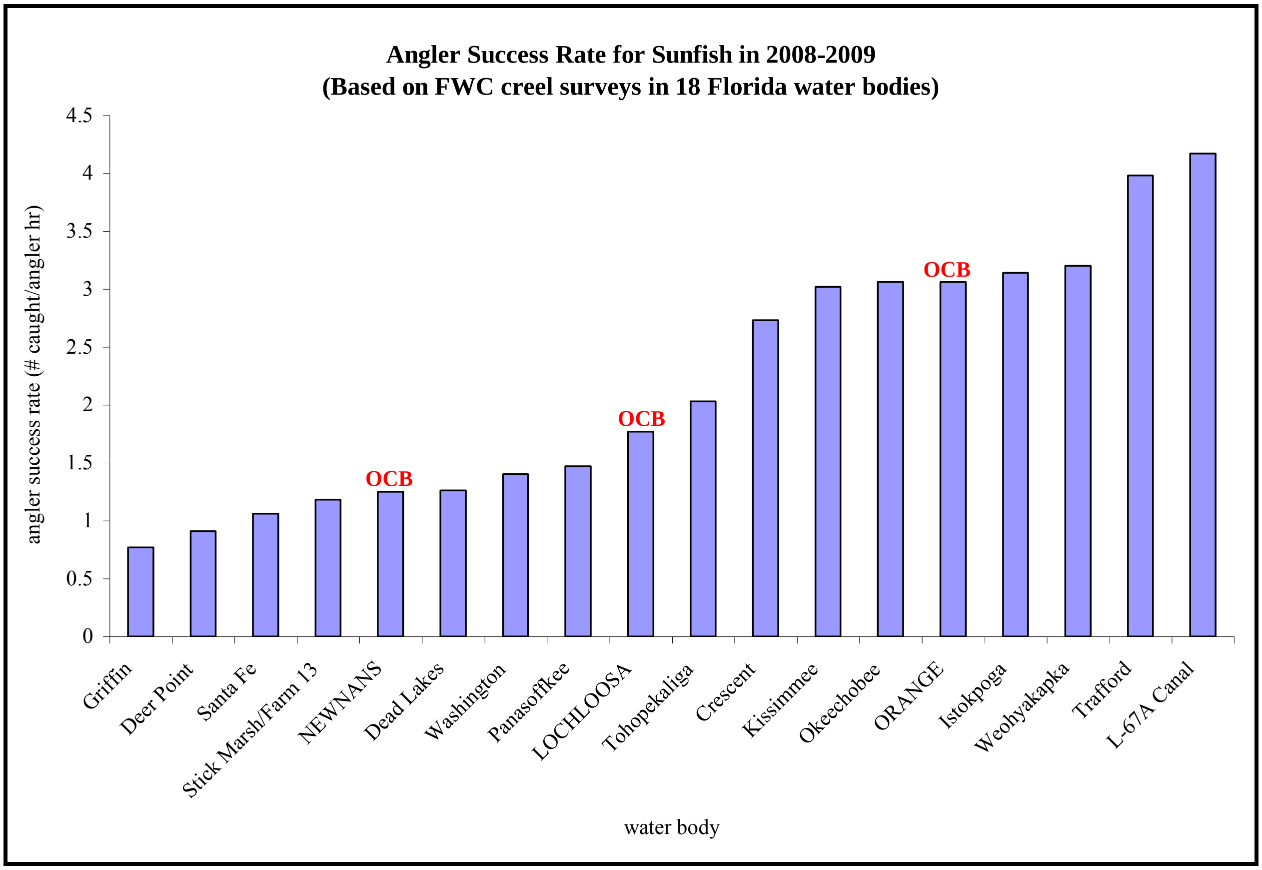

Figure 44. Angler success rate for sunfish in Florida lakes, based on FWC creel surveys in 2009.

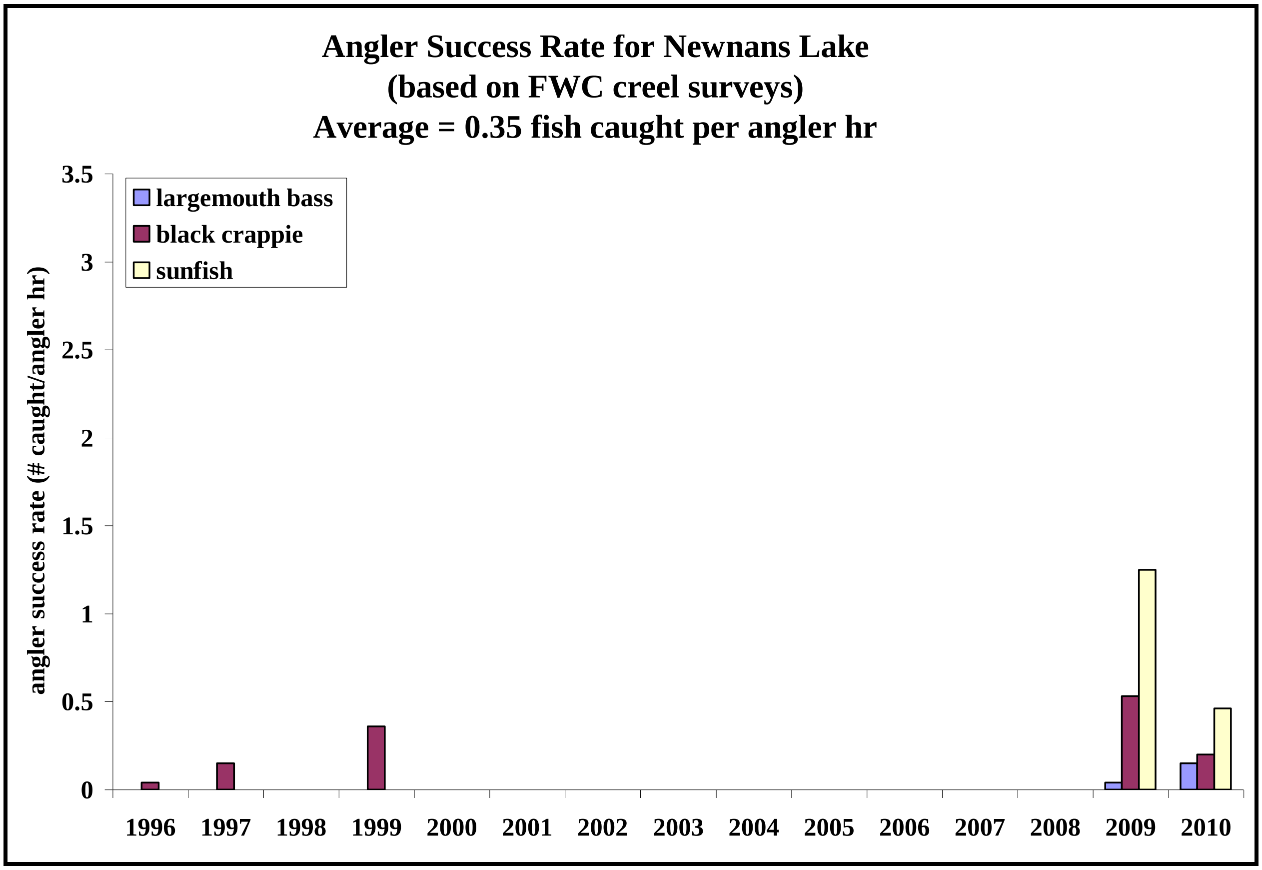

Figure 45. Angler success rate for largemouth bass, black crappie, and sunfish in Newnans Lake, based on FWC creel surveys.

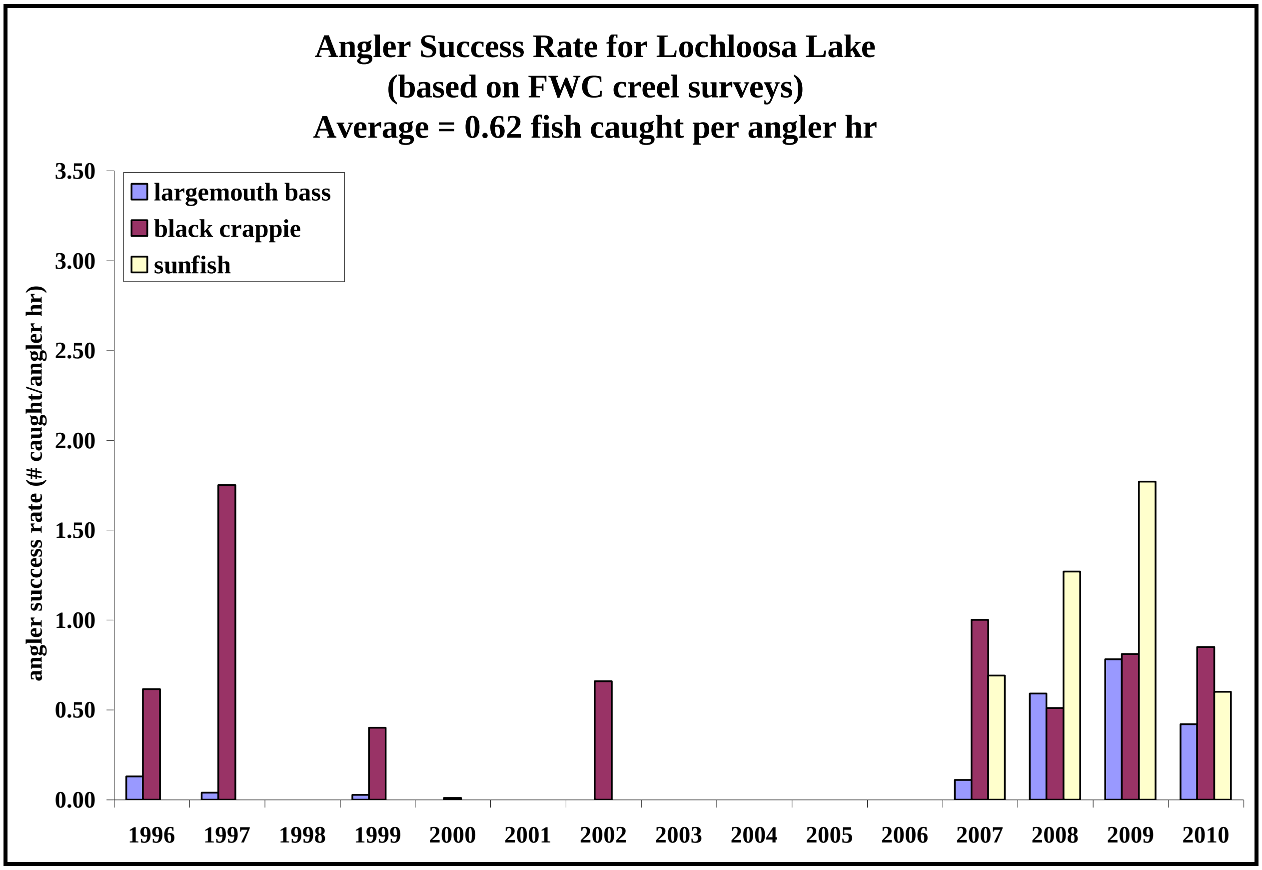

Figure 46. Angler success rate for largemouth bass, black crappie, and sunfish in Lochloosa Lake, based on FWC creel surveys.

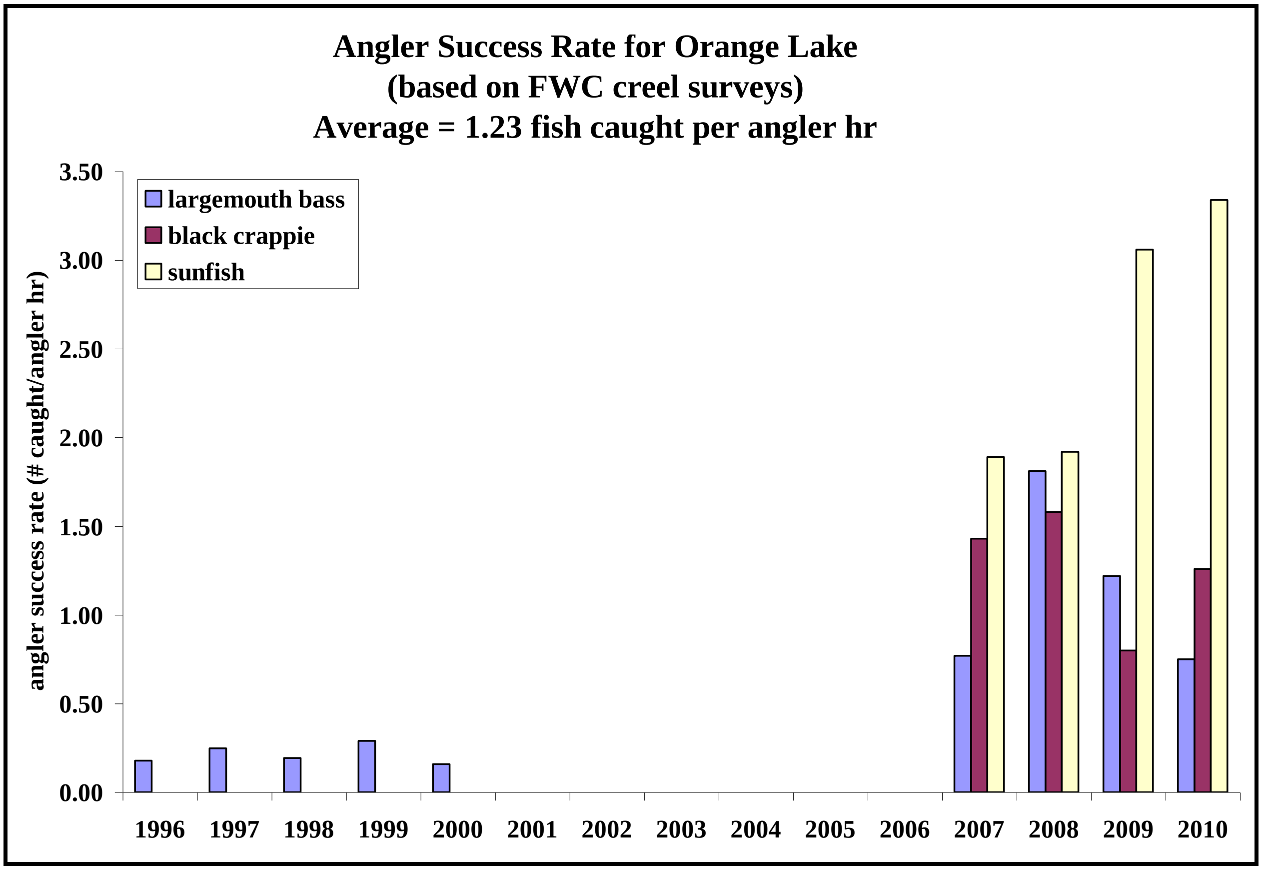

Figure 47. Angler success rate for largemouth bass, black crappie, and sunfish in Orange Lake, based on FWC creel surveys.

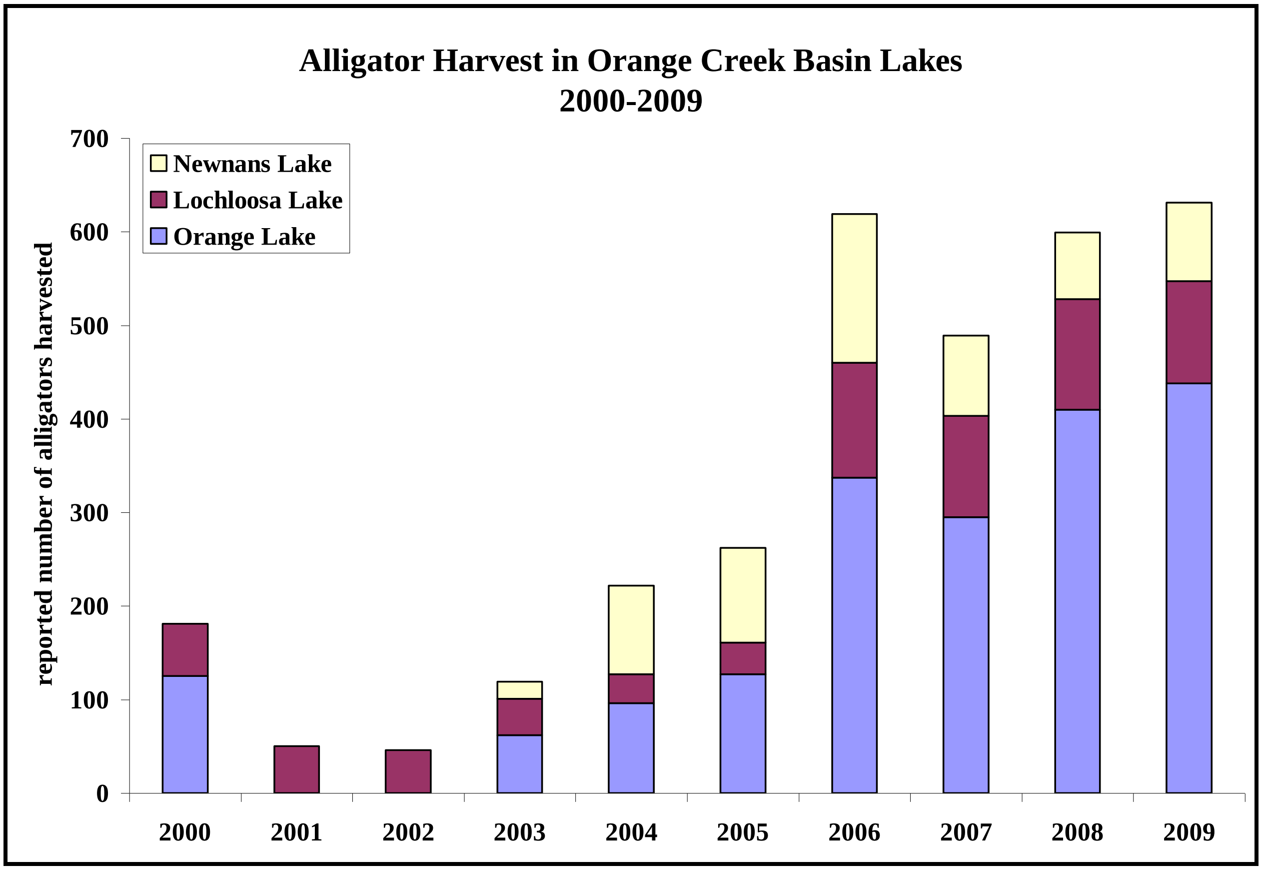

Figure 48. Reported number of alligators harvested in Newnans, Lochloosa, and Orange lakes from 2000-2009. Source: Florida Fish and Wildlife Conservation Commission.

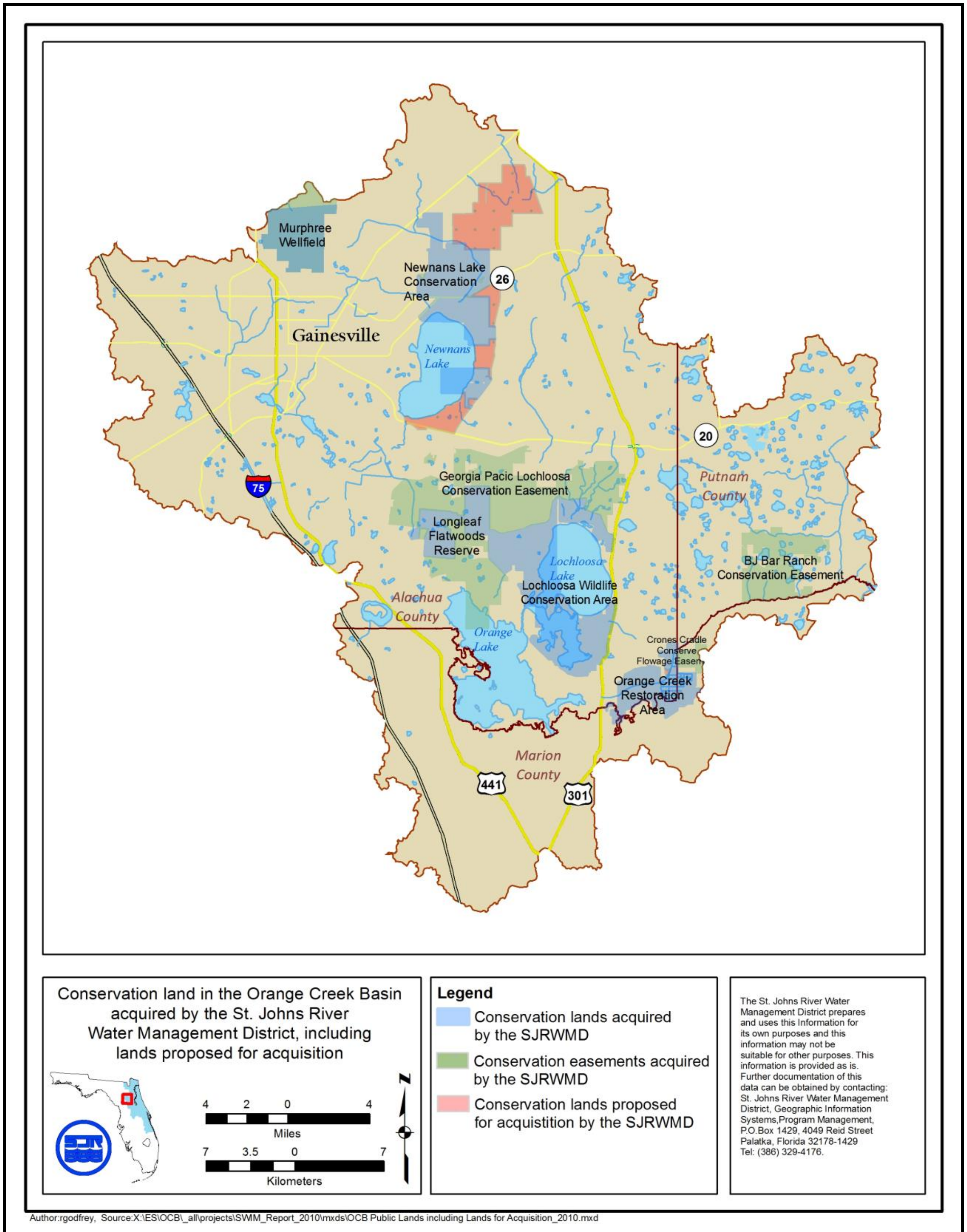

Figure 49. Conservation land in the Orange Creek Basin acquired by the St. Johns River Management District, including lands proposed for acquisition.