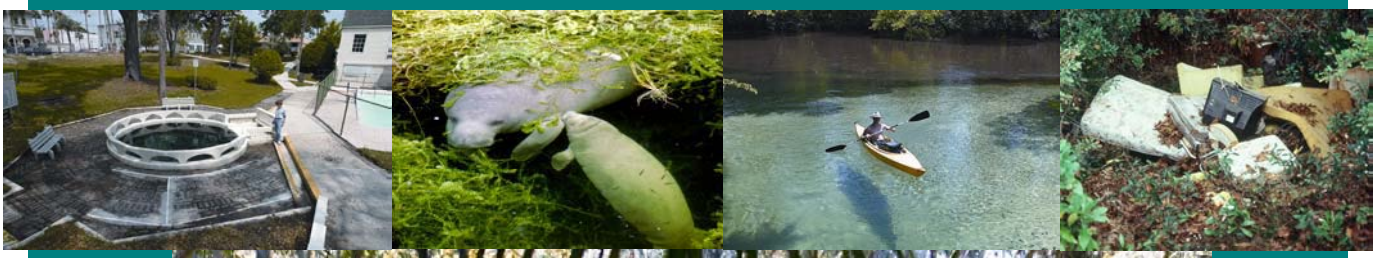

Florida's Springs

Strategies for Protection and Restoration

May 2006

The Florida Springs Task Force

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Green Cove Springs, Clay County. Photo by Tom Scott, FGS
Manatee nursing her calf in the Wakulla River, Wakulla County. Photo by Tom Scott, FGS
Kayaking at Gainer Springs, Bay County. Photo by Tom Scott, FGS
Trash in a sinkhole near Ichetucknee Springs, Columbia County. Photo by Jim Stevenson
Fern Hammock Springs, Marion County. Photo by Tom Scott, FGS

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Strategies for Protection & Restoration

May 2006

Prepared for

Florida Department of Environmental Protection
Office of Ecosystem Projects
3900 Commonwealth Blvd. MS45
Tallahassee, FL 32399-3000

The Florida Springs Task Force

May 1, 2006

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Over 30 Task Force members and advisors provided input and expertise to the strategies for springs protection and restoration in this report. In addition, several members and advisors deserve special mention for their significant contributions to other portions of this report. Specifically, for the update and writing of the background section, thanks to Mike Bascom, Dana Bryan, Bruce Day, Dave DeWitt, Jon Martin, Harley Means, Tom Pratt, Kent Smith, Jim Stevenson, Sam Upchurch, and Tom Mirti. For providing a substantial amount of technical information, thanks to Gary Maddox, Harley Means, Laura Morse, and Tom Scott. Finally, we are thankful to Mike Bascom and his staff from the Department of Environmental Protection's Florida Springs Initiative for their support and responsiveness.

Florida Springs Task Force at Salt Springs in 2003. Photo by Tom Scott, FGS

Acronyms and Abbreviations

AWTP – advanced wastewater treatment plant

BMP – best management practice

cfs – cubic feet per second

CUP – consumptive use permit

DACS –Florida Department of Agriculture and Consumer Services

DCA – Florida Department of Community Affairs

DEP – Florida Department of Environmental Protection

DOH – Florida Department of Health

DOT – Florida Department of Transportation

DRI – Development of Regional Impact

EPA – U.S. Environmental Protection Agency

ERP – Environmental Resource Permit

FAC – Florida Administrative Code

FGS – Florida Geological Survey

FS – Florida Statutes

FSTF – Florida Springs Task Force

GIS – Geographic Information System

gpd – gallons per day

IFAS – Institute of Food and Agricultural Sciences (University of Florida)

IPMP – Integrated Pest Management Plan

MFL – Minimum Flows and Levels

mg/L – milligrams per liter

mgd – million gallons per day

NWFWMD – Northwest Florida Water Management District

OFW – Outstanding Florida Water

OSTDS – Onsite Sewage Treatment and Disposal System (includes: septic system; aerobic treatment unit; performance-based treatment system)

RPC – Regional Planning Council

SJRWMD – St. Johns River Water Management District

SPRTF – Springs Protection and Restoration Trust Fund (a proposed method for funding the strategies in this report)

SRPP – Strategic Regional Policy Plans

SRWMD – Suwannee River Water Management District

SWFWMD – Southwest Florida Water Management District

USGS – United States Geological Survey

WMD – Water Management District

WUP – water use permit

WWTP – Wastewater Treatment Plant

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I. Executive Summary

The number and concentration of Florida's freshwater springs is unequalled anywhere on the planet. Florida's more than 700 springs are a world-class resource providing natural, recreational, and economic values for Floridians and tourists.[1] Florida's springs are a critical component of Florida's ecosystems and provide important habitat for many plant and wildlife species. The economic impact from springs is critical to our local, regional, and state economies. Florida's fifteen state parks named for springs attracted over two million visitors in 2005 and collect about $8.6M in revenue annually. Ichetucknee Springs State Park alone generates an estimated $22M to the local economy each year.[2,3,4]

Rock Springs, Orange County. Photo by Tom Scott, FGS

The major issues impacting springs include population growth, urban sprawl, growing demand for ground water, and introduction of fertilizers, pesticides, and other pollutants in **springsheds**.

Florida's population has increased from 2.7 million to 15.9 million between 1950 and 2000, which is a nearly six-fold increase.[5] Population growth brought an increase in water use as well as extensive land use changes that can have adverse impacts on spring flow, water quality, and spring ecosystems. Once-popular springs, such as Kissengen Spring in Polk County, have stopped flowing altogether, and discharge measurements indicate flow reductions in other springs. Since the 1970s, scientists have also documented a decline in water quality in most Florida springs, particularly with regard to an increase in nutrients.[6]

In 1999 David Struhs, then Secretary of the Florida Department of Environmental Protection, directed Jim Stevenson of DEP to form the Florida Springs Task Force to determine the status of Florida's springs and develop strategies for their protection. The multi-agency Task Force developed recommendations presented in the original springs report, *Florida's Springs: Strategies for Protection & Restoration, November 2000*.

The 2000 Springs Report became the foundation of the Florida Springs Initiative formed later that year after it was presented to Governor Jeb Bush and the Florida Legislature. The Florida Springs Initiative (FSI) is a comprehensive springs protection effort coordinated by the Department of Environmental Protection (DEP) with the participation of federal and state agencies, water management districts, regional planning councils, local governments, universities, non-government organizations, the business community, and private citizens. FSI is supported by Governor Jeb Bush and the Florida Legislature who have appropriated about $2.5M annually to fund springs protection and restoration strategies.

In 2003, Mike Bascom succeeded Jim Stevenson as the FSI Coordinator and Chairman of the Task Force. In 2004, Colleen Castille succeeded David Struhs as the Secretary of DEP and she continues the support of the FSI program.

FSI has implemented over 100 projects based on the recommendations from the 2000 Springs Report. Many of the actions in the 2000 Springs Report have been completed or are underway, but new and ongoing actions remain critical to protecting Florida's springs. This new report updates the 2000 Springs Report, documents the progress-to-date and reaffirms or redefines future strategies and action steps.

The *Florida's Springs: Strategies for Protection and Restoration, May 2006* report represents the current consensus from experts and key stakeholders regarding what needs to be done to protect Florida's springs. Recommendations are presented as action steps in five categories: Education & Outreach, Research & Monitoring, Land Use Planning & Management, Regulation, and Funding.

Education & Outreach Strategies

The successful resolution of many threats to springs is dependent on the actions of an educated public, including local government officials, homeowners, farmers, golf course managers, public works officials, and visitors to public springs. Education can nurture citizens' appreciation of Florida's springs and bring about cooperation and voluntary compliance.

Manatee nursing her calf, Wakulla River, Wakulla County. Photo by Tom Scott, FGS

FSI has spent approximately $400,000 per year on Education & Outreach Strategies, funding 28 projects. The FSI has made significant progress in the area of education; however, many of the education programs remain critical in the ongoing effort to reach a broad and continually growing audience with important springs messages. The estimated funding needed to accomplish education and outreach actions during the next 5 years is $900,000 per year.

Research & Monitoring Strategies

Research and monitoring are important in order to understand both the existing and changing conditions in Florida spring systems. The information gained from such work allows scientists to predict potential impacts to spring systems from activities within springsheds, and provides for the development of effective springs protection strategies.

FSI has spent approximately $1.6M per year on Research & Monitoring Strategies. During that time 44 research and monitoring projects were funded and 57 sampling locations were established at first magnitude and other selected springs. Although these projects have provided

new insights, many important questions remain unanswered. The estimated funding needed to accomplish research and monitoring actions during the next 5 years is $5M to $15M per year. The high end of this range includes increasing the program based on the number of first and second magnitude springs in Florida.

Land Use Planning & Management Strategies

Both the quality and quantity of spring flows have declined notably in many of Florida's springs. Without effective remedial action, further declines can be expected. Urbanization and intensive agricultural practices on the land surface can and do have adverse impacts upon the quality and quantity of ground water, thereby affecting spring flow, water quality, and spring ecosystems. Effective land use planning and management strategies can reduce impacts to springs and protect them for future generations.

FSI has spent approximately $500,000 per year on Land Use Planning & Management Strategies. Since 2000, 33 projects have been accomplished or are underway, including restoration (10), recreation management and erosion control (9), wastewater improvements (8), and best management practices (6). The primary goal of Land Use Planning & Management Strategies is to create tools for local governments to implement springs protection. Some land use planning actions are underway at the state, regional, and local government levels, but more are needed as Florida's population continues to grow. The estimated funding needed to accomplish land use planning and management actions during the next 5 years is $600,000 per year.

Florida Springs Task Force at a farm enrolled with the Suwannee River Partnership. Photo by: Harley Means, FGS

Regulation Strategies

Regulations provide an important legal framework for protecting springs and our water supply by setting specific standards to which stakeholders must abide. Current regulatory programs that are designed to protect water quality and quantity for public health and safety can also apply to spring water quality, spring flow, and springs-related species and their habitat. However, by themselves existing regulations do not adequately protect springs. This can be due to limited implementation, programs designed to address non-spring water resources, or when land use intensity increases beyond what the regulatory mechanism was originally designed to manage. Regulations must in some cases be amended, strengthened, and enforced to protect springs. While the majority of the regulation actions can be accomplished in-house without additional funding, an evaluation of existing regulations will require estimated funding of $50,000.

Funding Strategies

Springs protection is a statewide issue and should address critical water supply issues in addition to recreation uses, spring aesthetics, and springs ecology. The future success of the FSI program is dependent upon continued funding support by the Florida Legislature and a permanent dedicated funding source. Current funding is provided from general revenue. The FSTF recommends that a permanent, dedicated funding source be created in the form of a Springs Protection and Restoration Trust Fund. While the Trust Fund is growing, it will supplement general revenue funding, which should continue until the Trust Fund reaches levels to adequately fund the FSI. It is important to note that FSI funding is often leveraged through projects that provide multiple benefits, funds spent by other agencies on springs and springs-related projects, cooperative funding, and matching funds.

Over the first five years, the Florida legislature has funded the FSI with about $2.5M per year of the initial $4.5M requested in the 2000 Springs Report. This annual funding has allowed the FSI to meet many of the recommendations in the 2000 Springs Report. However, to fully meet all the recommendations, funding of approximately $6.5M to $16.5M per year is required. The high end of this range includes expanding the research and monitoring program based on the number of first and second magnitude springs in Florida. In addition, the allocation of state agency staff needs to be addressed to fully implement the strategies as they are funded.

Horn Spring, Leon County. Photo by Harley Means, FGS

II. Introduction

The bank was dense with magnolia and loblolly bay, sweet gum, and gray-barked ash. He went down to the spring in the cool darkness of their shadows. A sharp pleasure came over him. This was a secret and a lovely place. – Marjory Kinnan Rawlings, *The Yearling*, 1938

The number and concentration of Florida's freshwater springs is unequalled anywhere on the planet. The mere mention of springs evokes in most people something magical, mysterious, pure, and visceral. As the noted Florida author Al Burt describes, "Springs have a way of getting into your mind and staying there." Springs are a closely held part of Florida's heritage, history, and culture. We are proud of them and value them as one of the things that make Florida…Florida. Mr. Burt also shows his keen insight by reminding us that springs are "Watering holes for the spirit."

Florida's more than 700 springs are a world-class resource providing natural, recreational, and economic values for Floridians and tourists.[1] Florida's springs are a critical component of Florida's ecosystems. They are important habitat for several protected plant and wildlife species as well as rare, endemic, and managed species.

Kayaking at Gainer Springs, Bay County.
Photo by Tom Scott, FGS

Archaeological evidence indicates that humans have been attracted to Florida's life-giving springs for 12,000 years.[1,7,8] Florida springs continue to draw awed and grateful visitors today – our fifteen state parks named for springs attracted over two million visitors in 2005.[2] Florida's springs have provided a major contribution to the state's economy for over a century and hopefully will continue to do so over the next hundred years. Health resorts at several Florida springs attracted thousands of tourists to the state around 1900. Springs were Florida's first major tourist attractions, and Silver Springs and Weeki Wachee Spring continue in that role today.

The economic impact from springs is critical to our local, regional, and state economies. The fifteen state parks named for springs collect about $8.6M in revenue annually.[3] The St. Johns River Water Management District documented that in one year visitors from outside Marion County spent over $61.4M connected with Silver Springs, which generated over 1,060 jobs and $12.6M in wages.[9] Ichetucknee Springs State Park generates an estimated $22M to the local economy each year.[4] Ginnie Springs, a privately owned spring, is the most popular freshwater diving location in the world and many other private springs are also key destinations for many visitors. Available information indicates that private springs also contribute millions of dollars to Florida's economy per year, making them important contributors to Florida's tourist economy.

The major issues impacting springs include population growth, urban sprawl, growing demand for ground water, and introduction of fertilizers, pesticides, and other pollutants in **springsheds**.

Florida's population has increased from 2.7 million to 15.9 million between 1950 and 2000, which is a nearly six-fold increase.[5] Population growth brought an increase in water use as well as extensive land use changes that can have adverse impacts on spring flow, water quality, and spring ecosystems. Once-popular springs, such as Kissengen Spring in Polk County, have stopped flowing altogether, and discharge measurements indicate flow reductions in other springs. Since the 1970s, scientists have also documented a decline in water quality in most Florida springs, particularly with regard to an increase in nutrients.[6]

In 1999 David Struhs, then Secretary of the Florida Department of Environmental Protection, took a bold step toward protecting Florida's springs. He directed Jim Stevenson of DEP to form the Florida Springs Task Force to determine the status of Florida's springs and develop strategies for their protection. The multi-agency Task Force included one federal and three state agencies, four water management districts, a state university, a regional planning council, the business community, and private citizens. The Task Force met monthly from 1999 to 2000 to develop the recommendations presented in the report, *Florida's Springs: Strategies for Protection & Restoration, November 2000*.

Cypress Spring, Holmes Creek, Washington County. Photo by Tom Scott, FGS

The 2000 Springs Report was presented to Governor Jeb Bush and the Florida Legislature and became the foundation of the Florida Springs Initiative formed later that year with $2.5M in funding from the 2001 Florida Legislature.

The Florida Springs Initiative (FSI) is a comprehensive springs protection effort coordinated by the Florida Department of Environmental Protection (DEP) with the participation of federal and state agencies, water management districts, regional planning councils, local governments, universities, non-government organizations, the business community, and private citizens. FSI is supported by Governor Jeb Bush and the Florida Legislature who have continued to appropriate about $2.5M annually to fund springs protection and restoration strategies.

In 2003, Mike Bascom succeeded Jim Stevenson as the FSI Coordinator and Chairman of the Task Force. In 2004, Colleen Castille succeeded David Struhs as the Secretary of DEP and she continues the support of the FSI program.

FSI has implemented over 100 projects based on the recommendations from the 2000 Springs Report. DEP has distributed the annual funding to implement these projects, including education and outreach, research and monitoring, restoration projects, land use planning and best management practices programs, recreation management and erosion control, and wastewater improvements at state parks with springs (Appendix A). Many of the actions in the 2000 Springs Report have been completed or are underway, but several new and ongoing actions remain critical to protecting Florida's springs.

This new report updates the 2000 Springs Report, documents the progress-to-date, and reaffirms or redefines future strategies and action steps. To accomplish this update, the Florida Springs Task Force met monthly from October 2005 through April 2006 to provide an assessment of progress and needs, and make a sound set of recommendations that will continue to guide the Florida Springs Initiative over the next 5 years. This report presents their current findings and recommendations.

The *Florida Springs Initiative: Strategies for Protecting and Restoration, May 2006* report represents the current consensus from experts and key stakeholders regarding what needs to be done to protect Florida's springs.

It is every Floridian's responsibility to protect Florida's springs. Marjorie Stoneman Douglas said, "Springs are bowls of liquid light." The implementation of the recommendations in this report will help ensure that Florida's "bowls of liquid light" will sparkle for the grandchildren of the children who play in Florida's springs today.

Juniper Springs, Marion County. Photo by Harley Means, FGS

III. Accomplishments

The Florida Springs Initiative (FSI) has implemented over 100 springs projects (see Appendix A) with the goal to sponsor efforts that increase understanding, support, and protection of one of Florida's most unique resources. These accomplishments were made possible through funding from the Florida Legislature, coordination from DEP, and contributions from the many participating agencies, non-government organizations, businesses, and citizens. In addition, 28 Springs Champions have been recognized since 2000 by the Florida Springs Task Force with awards for springs protection and education (Appendix B).

The following is a summary of FSI projects implemented to date.

Mike Bascom (FSI Coordinator and FSTF Chairman) presents a Springs Protection Award to David Hornsby in 2005 (then with the Suwannee River Water Management District).

Research & Monitoring (44 projects): Spring water monitoring (6), springs assessment (7), nutrient, pesticide, and other pollutant analysis (11), origins of spring water (7), biological studies of plants and animals (7), mapping and bathymetry studies (2), stream-to-sink feature study (1), location of cave systems (1), water dating (1), economic impacts of springs (1).

Education & Outreach (28 projects): Publications (6), website (2), education programs (2), videos (2), public workshops and conferences (3), exhibits and signage (3), education curriculum (1), public service announcements (1), springs working groups (6), spring ambassadors (2).

Land Use Planning & Management (33 projects): *Best Management Practices*: Created best management practices for land use, nutrient reduction, springs, and golf courses (3), designed land management tool (1), landowner assistance (2). *Wastewater Improvements*: Drainfield improvements (2), sewer and septic improvements (6). *Restoration*: Spring restoration (8), sediment removal (1), construction of a monitoring well (1). *Recreation Management and Erosion Control*: Recreation access and boardwalks (5), education center restoration (1), carrying capacity research (1), trail management (1), erosion control (1).

Total Projects: 105

IV. Background

A Short History of Florida's Springs

Springs add a melody to the land. – Al Burt

Archaeologists tell us that people have been drawn to Florida's springs for thousands of years. Twelve-thousand-year-old bones, tools, and weapons have been recovered from Wakulla Springs in Wakulla County and from Little Salt Spring in Sarasota County. Numerous prehistoric spear points have been recovered from the beds of the Wacissa, the Ichetucknee, and other spring-fed rivers in north and central Florida.[7,8]

In 1513, a Spanish explorer, Juan Ponce de Leon, invaded Florida in search of land and riches. Legend holds that he was searching for a spring known as the "fountain of youth."[10] Later, Florida's springs served as locations for Spanish missions, steamboat landings, gristmills, and post offices. They were used for baptisms by local churches, as sources of drinking water for homesteads, and as reservoirs for irrigating crops.

In the middle to late 1800s many of Florida's springs served as magnets for development, attracting settlers, tourists, and even railroads. A few springs gave birth to towns, including Silver Springs in Marion County, Green Cove Springs in Clay County, and De Leon Spring in Volusia County.

Source: Florida Photographic Collection, Florida State Archives, Florida Department of State

Some of Florida's springs have been valued for their perceived therapeutic qualities. People once flocked to White Spring (Hamilton County) seeking the benefits of its healing waters. Panacea Mineral Springs (Wakulla County) was the site of the 125-guest Panacea Hotel in the early 1900s. Worthington Spring (Union County), now completely dry, once drew visitors seeking to drink from and bathe in its healing waters. Warm Mineral Spring (Sarasota County) still attracts visitors to its year-round 87-degree waters.[1,11,12]

Many Florida springs have provided recreational opportunities for swimmers, boaters, wildlife watchers, and cave divers. Some, such as Kissengen Spring and White Spring, that were once popular swimming holes have diminished to a trickle or have stopped flowing completely. Sulphur Spring in Tampa has been closed to public use due to poor water quality. However, other springs and spring runs that were once damaged by overuse have been restored through good

stewardship. Among these are Madison Blue Spring (Madison County), Ichetucknee Springs (Columbia County) and Volusia Blue Spring (Volusia County).

Springs have supplied drinking water to Floridians for thousands of years. The ground water that flows from most of Florida's springs originates from the Floridan Aquifer System, the same aquifer system that is tapped for most municipal supplies and private wells in the state. Boulware Spring (Alachua County) once provided water to the city of Gainesville. Today it is a city park and a National Historic Landmark.

Today, Florida's springs serve more often as windows to the mysteries of the Floridan Aquifer System than as drinking water supplies. At the same time, many of Florida's diverse wildlife communities depend on our careful stewardship of Florida springs over the coming decades. The challenge lies in preserving the value of Florida's springs while balancing the pressing and seemingly conflicting needs of the state's many water users.

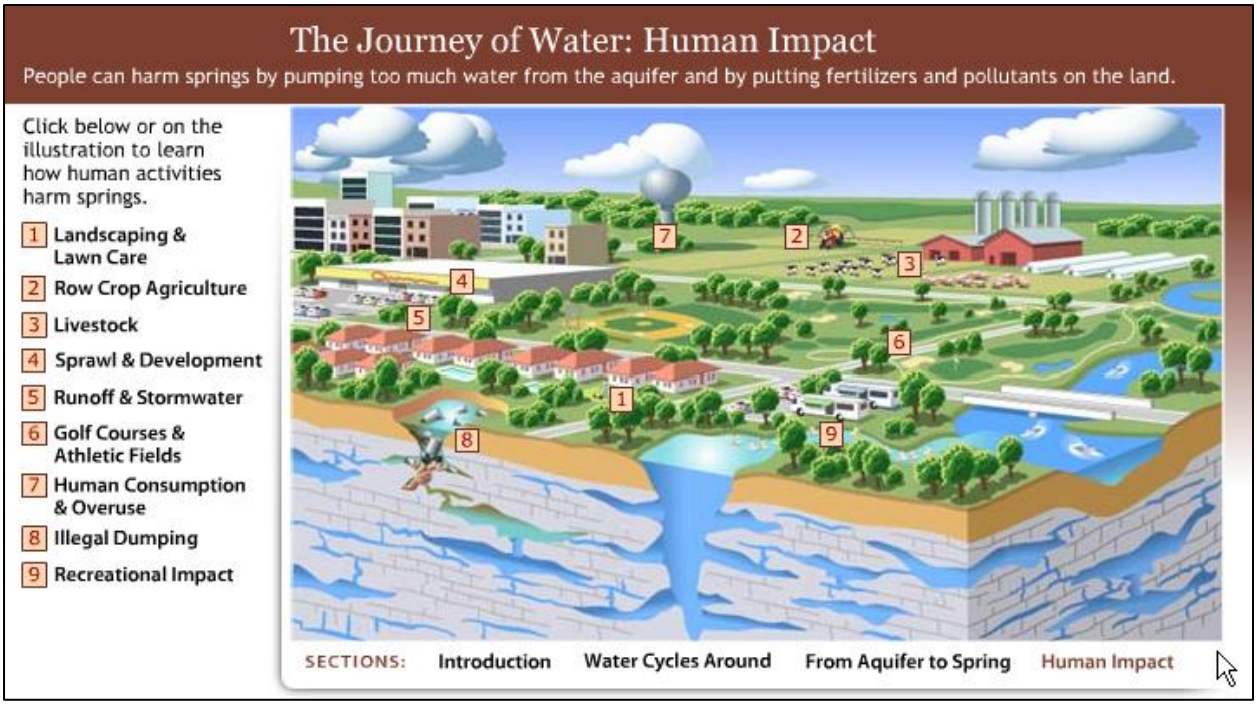
Green Cove Springs in the 1880s, Clay County. Photo from Florida State Archives

Understanding Florida's Springs

As scientists have studied Florida's **springs** over the years, they have come to realize that a spring is the "outlet" from a large and complex land area that captures rainwater, which **percolates** down through soil and rocks into the Floridan Aquifer System. This contributing area is known as a "**springshed**" or "**spring recharge basin**."

To understand Florida's springs, we have to look beneath the land surface as well as upstream into the aquifer, and explore the springshed. Many of the problems affecting the springs are from sources several miles upstream in the springshed. The major issues impacting springs include population growth, urban sprawl, growing demand for ground water, and introduction of fertilizers, pesticides, and other pollutants to springsheds.

Threats to the quality and quantity of water in the Floridan Aquifer System and thus the springs can be classified into three different categories: inputs (the contaminants we put in a springshed); outputs (the amount of water we take out of the aquifer); and impacts (the physical damage we cause in and around the spring and **spring run**). The Protection and Restoration Strategies presented in this report are focused on reducing and eliminating these threats.



Interactive tour of springs anatomy. Learn about the water cycle, how water moves through the Floridan Aquifer System, and how human activities impact the quality and quantity of water in the aquifer and ultimately in the springs. Source: DEP Florida's Springs website, http://www.floridasprings.org/anatomy/jow

Effectively protecting our springs depends on continued efforts by state and local agencies, and private citizens who care. In this section you'll learn about Florida's springs, from how they formed and wildlife that depend on them, to factors affecting spring waters and how you can participate in springs protection decision making.

Hydrogeology

Florida is young, freshly washed from the ocean in a recurring series of Ice Age fluctuations that has reconfigured its soft coastline as sea-born escarpments. – Bill Belleville, from an essay in *The Wild Heart of Florida*, 1999

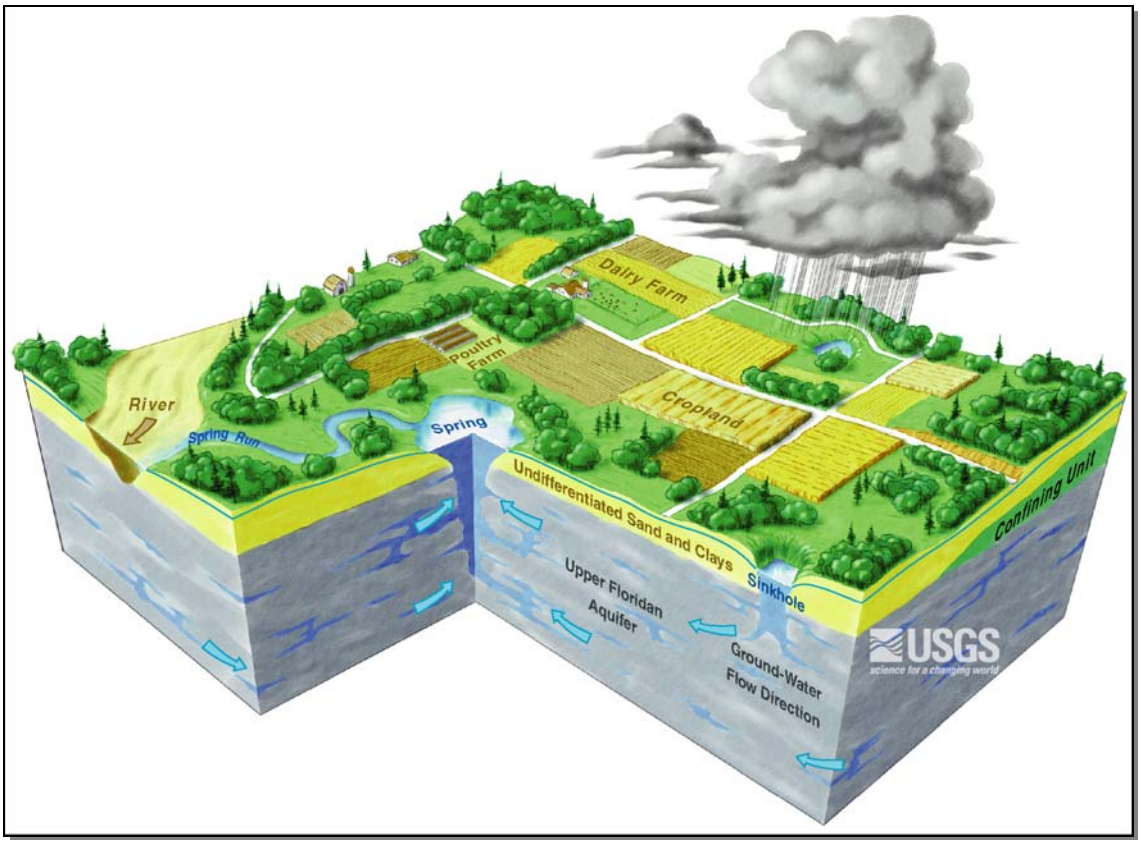
As Belleville so eloquently states, Florida's springs and hydrogeology can be best understood in terms of Florida's geologic history and the rocks that make up its aquifers. To gain that understanding, this narrative explains how modern Florida formed from ancient marine sediments, which were subsequently modified through erosion to produce the world-class natural resource we know as Florida's springs.

All of Florida is underlain with **limestone**, which formed from the shells of marine organisms over 24 million years ago. During this period Florida was separated from mainland North America by the Gulf Trough, a deep-water trough similar to the modern Straits of Florida that separates Florida from the Bahamas. About 24 million years ago sediments, which eroded from the Appalachian Mountains, filled the trough and covered Florida with sand and clay, sealing the underlying limestone from infiltration by rainwater. Subsequent fluctuations in sea level, brought about by the formation and retreat of glaciers, have removed this material from parts of north-central Florida and exposed it to rainwater, particularly inland of the Big Bend region.

The limestone underlying Florida, commonly referred to as the Floridan Aquifer System, is not solid rock. As much as 20% of its volume is small interconnected pore spaces left over from when the shells were deposited. Most of this space is filled with water – only very shallow depths contain air. As rainwater (made acidic from carbon dioxide in the atmosphere and from decaying plant materials in the soil) flows slowly through the Floridan Aquifer System (requiring years to decades), it dissolves the rock, forming **conduits** (or channels) and **caves** that vary in size from pin-sized to human-sized. These large openings increase the rate of water flow through the rocks, allowing it to move rapidly underground and back up to the surface, sometimes in only a few days or weeks. This rapid flow of ground water up to the land surface is the source of the hundreds of spectacular springs for which Florida is so widely known.

Cave diver in a human-sized conduit inside the aquifer. Notice how rapidly the water is moving. Photo by Wes Skiles

Springs represent only one step in the journey water takes, or what scientists refer to as the hydrologic cycle, from the atmosphere to the earth and back to the atmosphere again. The cycle originates with rainfall, which in Florida averages 53 inches per year, or 150 billion gallons over the entire state per day. As the raindrops fall onto Florida's **karst** topography, the water percolates downward through the soil and rocks and replenishes (or recharges) the Floridan Aquifer System. Some of the rainfall is also captured by trees, soils, lakes, and rivers, which use part of it and then release water into the air through evaporation and transpiration. In some places, flow returns to the surface of the land in the form of a spring. The spring's water can then flow into rivers, lakes, and eventually to estuaries and the ocean. Evaporation from these water bodies acts like a giant still, recycling water back into the atmosphere and completing the cycle.



Some of the rain that falls on Florida soaks into the ground to replenish the Floridan Aquifer System, which supplies most of Florida's drinking water and is the source for most of Florida's springs. The karst topography that is common in many parts of Florida leaves the aquifer vulnerable to contamination from activities on the land surface. Source: USGS

Springs are classified by the amount of water they **discharge**, known as **spring magnitude** (Table 1), with first magnitude springs (Appendix C) producing the greatest amount of water. The state of Florida is home to 33 first magnitude springs, and hundreds of second and lower magnitude springs. The numerous springs concentrated in north-central Florida represent the highest density of large springs in the world, and a natural resource in desperate need of protection.

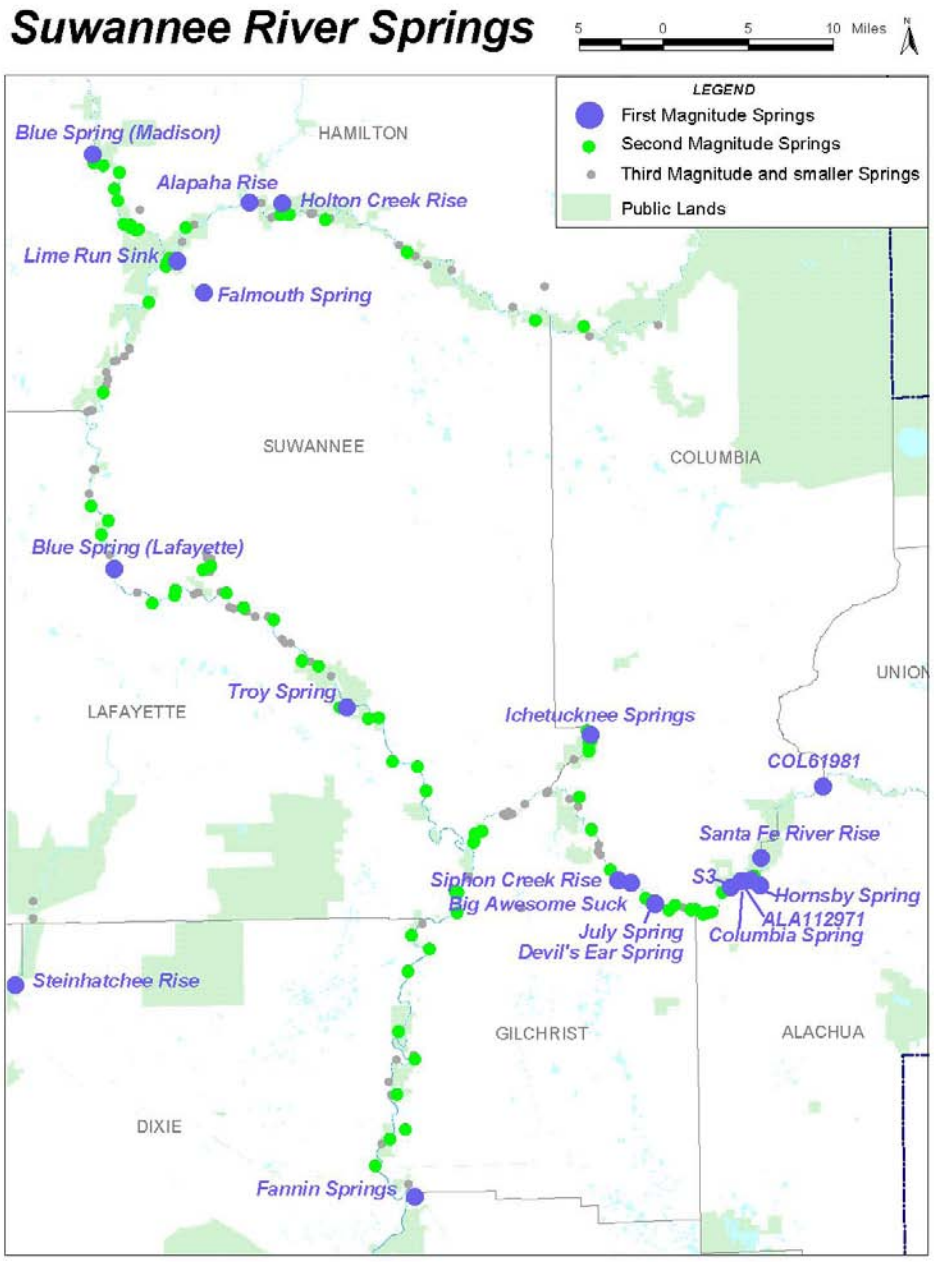
Table 1. Classifications of Spring Magnitude

Magnitude	Average Flow (Discharge)
1	64.6 mgd or more
2	6.46 to 64.6 mgd
3	0.646 to 6.46 mgd
4	100 gpm to448 gpm
5	10 to 100 gpm
6	1 to 10 gpm
7	1 pint to 1 gpm
8	Less than 1 pint/min

Notes: mgd = million gallons per day; gpm = gallons per minute; pint/min = pints per minute; see the glossary for conversions and metric units
Source: Modified from *Springs of Florida, Florida Geological Survey, Bulletin No. 66,* 2004

Not all of the rainwater that falls on Florida percolates slowly down into the aquifer. Rain that falls onto solid surfaces like concrete and pavement flows quickly across the hardened surfaces, commonly picking up road-grime pollutants such as oil and gas. The rainwater picks up other pollutants from the land, including fertilizers, pesticides, and human and animal waste. Although it is commonly known that water and its pollutants can flow directly to lakes and rivers, what is less commonly recognized is that water also flows directly through **sinkholes** into the Floridan Aquifer System, which supplies as much as 60% of the water supply for Florida. Water flowing from Florida's springs is a window to this critical water resource, demonstrating why the quality and quantity of spring water is so critical to Florida: Florida's water supply is only as good as Florida's spring water.

Springs generally discharge water directly onto the land surface forming a spring run. Most of Florida's largest springs behave in this fashion. Some springs, however, discharge into existing bodies of water like rivers, lakes, and the ocean. Many springs along the Suwannee River discharge below the river surface and contribute significant flow to the system. Apopka Spring discharges from the bottom of Lake Apopka sometimes causing a "boil" to form on the surface of the lake. Other springs are known to discharge in the near shore marine environment like the Spring Creek Group in Wakulla County.

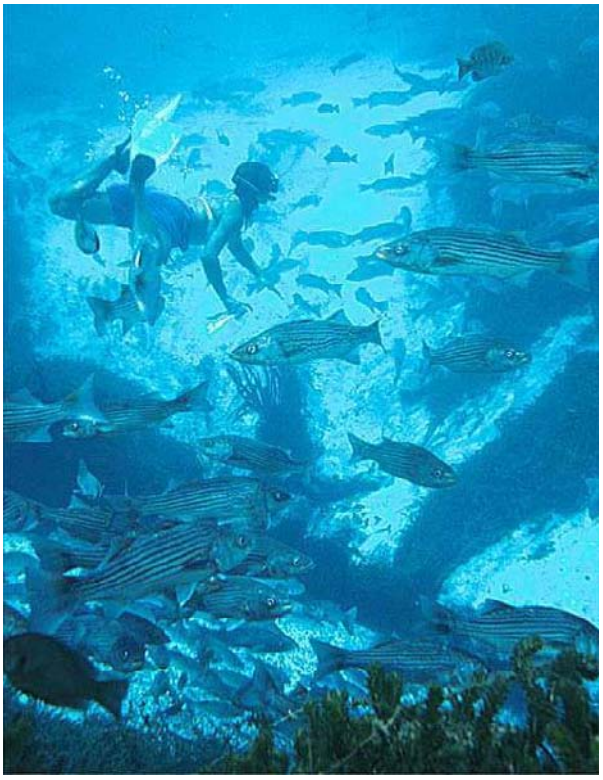


Springs along the Suwannee River. Source: DEP, FGS

Springs Ecology

Each spring is different from all the others; but in the intensity of its grace and color each is a little ecologic jewel in which geology and biology have created a masterwork of natural art. – Archie Carr, *A Celebration of Eden*, 1994

While visiting springs in Florida, you may encounter all kinds of wildlife attracted to the cool clear water just as we are. Fish such as gar and bluegill may swim by as you snorkel, and an alligator or snapping turtle may rest on the bottom. Along the water's edge you may see raccoons, otters, and great blue herons, while bald eagles and osprey fly over. You may also see butterflies, quail, turkey, deer, fox, and gopher tortoises as you walk through their habitats, which are part of the natural system that also brings us a valuable resource – water.



Beneath the surface at Silver Glen Springs in the Ocala National Forest. Photo from SJRWMD

The numbers and diversity of the plants and animals that live in a spring-fed stream paint a picture of a spring's condition. Spring-fed streams are distinguished from other Florida streams by the following characteristics: more constant flow, higher pH, abundant submerged aquatic vegetation, naturally low dissolved oxygen and nutrients, high calcium levels, constant temperatures, and remarkable clarity. Some plants and animals that make up spring biological communities are specially adapted to these conditions, and are found nowhere else in the world.[13,14] Because of these characteristics, the animal and plant communities supported by springs are highly vulnerable to the effects of pollution, human disturbance, and over-consumption of ground water.

Spring communities are comprised of numerous species of aquatic plants, benthic macroinvertebrates, amphibians, native fish, reptiles, birds and mammals. Plant communities flourish in clear sun-lit waters, they form the base of the foodweb and support macroinvertebrates – a critical link in the food web. Many macroinvertebrates are juvenile forms of insects such as dragonflies and mayflies. Other benthic macroinvertebrates include crayfish, small shrimp, snails and freshwater mussels. Springs in Florida also harbor many animals unique to specific spring systems, such as the Volusia Blue Spring hydrobiid snail.

Amphibians (including frogs, sirens, and salamanders) are found in both the spring waters and adjacent wetlands, and are highly sensitive to degraded water quality. Fish are both residents of and visitors to spring systems. Some fish (such as blue catfish, brown bullheads, and American eels) inhabit spring **caverns** in large numbers. Striped bass populations use springs as cold water

refuges to survive warm water temperatures in river and lake during the summer months. Turtles (such as snapping, mud, and musk turtles) also live in these systems, as do river otters and rare mammals like the Florida mink. Wading birds, birds of prey, and migrating ducks all use springs as foraging, roosting, or nesting habitat at various times of the year. Limpkins, whose haunting call can be heard around many spring systems in Florida, feed on apple snail populations in healthy springs. The federally endangered West Indian Manatee depends on Florida springs as life-sustaining warm-water refuges in the wintertime. Currently, over 600 manatees regularly winter in the spring systems in Citrus County (primarily Kings Bay and Homosassa springs) and Volusia County (Volusia Blue Spring). This represents about seventeen percent of the total Florida manatee population. The continued flow of spring systems throughout Florida is critical for the recovery of this protected species.[15]

Cave Crayfish. Photo by Karst Productions

With such diversity, it's not surprising that springs also provide habitat for unique cave animals. Florida's spring caves harbor one of the richest varieties of underground aquatic animals in North America. Many of Florida's spring and cave creatures are extremely rare. In fact, twenty-two Florida cave-dependent species are found nowhere else in the world. The Florida Committee on Rare and Endangered Plants and Animals has recognized that most Florida spring- and cave-dependent species merit state or federal protection, although currently only three species are legally protected.[15] Much about the life cycles of submerged cave life has yet to be learned. The known range of many of these species is limited to a few or only one spring system. Thus, entire species are highly vulnerable because their survival is totally dependent on a continuing supply of clean water.

Factors Affecting Springs

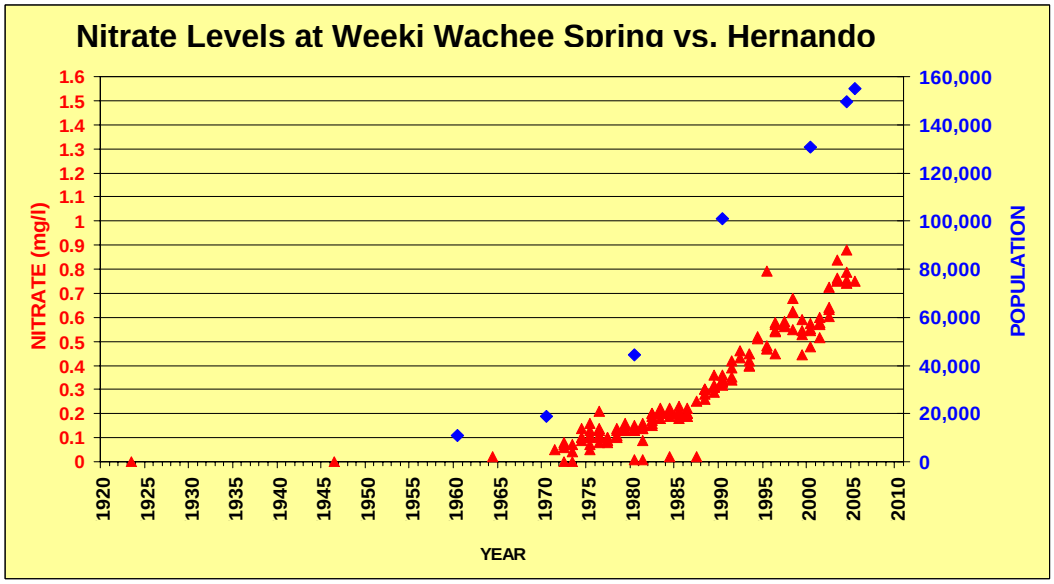
If you are standing on solid ground, yet water is moving under the ground beneath your feet, in, then you know you are in Florida standing on top of one of the world's most productive aquifers. The condition of this underground system of water-filled caves and **conduits** is integral to keeping springs healthy, providing us with recreational opportunities and clean drinking water. A spring is only as healthy as its springshed. The ground water flowing from springs is recharged when rainfall seeps through the soil or flows directly into the aquifer of rainfall through sinkholes and sinking streams. Because of this recharge process, the condition of spring systems is directly influenced by human activities and land uses within the springshed. [13,14]

Factors Affecting Water Quality

The water quality of Florida's springs is important for several reasons. Many springs are managed as parks and conservation areas for the long-term use and enjoyment of the public, so we want them to be clean and healthy for generations to come. We can address spring water quality problems and prevent future problems by addressing land use practices on the surface. After all, in Florida many of us live on top of our drinking water.

As mentioned earlier, the area of land contributing water to a spring is known as the springshed. The land uses in a springshed can affect spring water quality. In some places, there is little sand or clay covering the karstic limestone underneath. This makes it easier for pollutants (such as excess nutrients, heavy metals, oil, petroleum by-products, and bacteria) to seep down into the aquifer.

Pollutants can also enter the aquifer from other sources, in particular septic systems (OSTDS), untreated stormwater, and excess fertilizer and pesticides spread on the ground. Advanced wastewater treatment plants and nitrogen reducing septic systems treat wastewater to reduce pollutants and then discharge the water into the ground where it will eventually reach the aquifer. However, accidents or leaks in sewer pipes, and old or improperly maintained septic systems release poorly treated wastewater to the aquifer. In addition, what you pour down the sink (or into a storm drain), such as household chemicals and pesticides, can end up in the ground water. Untreated stormwater runoff (water that is not absorbed by soil or plants) also carries pollutants to rivers, lakes, and sinkholes. Required measures to reduce stormwater pollution have only been in place since the 1980s, and some are considered less effective in karst areas.



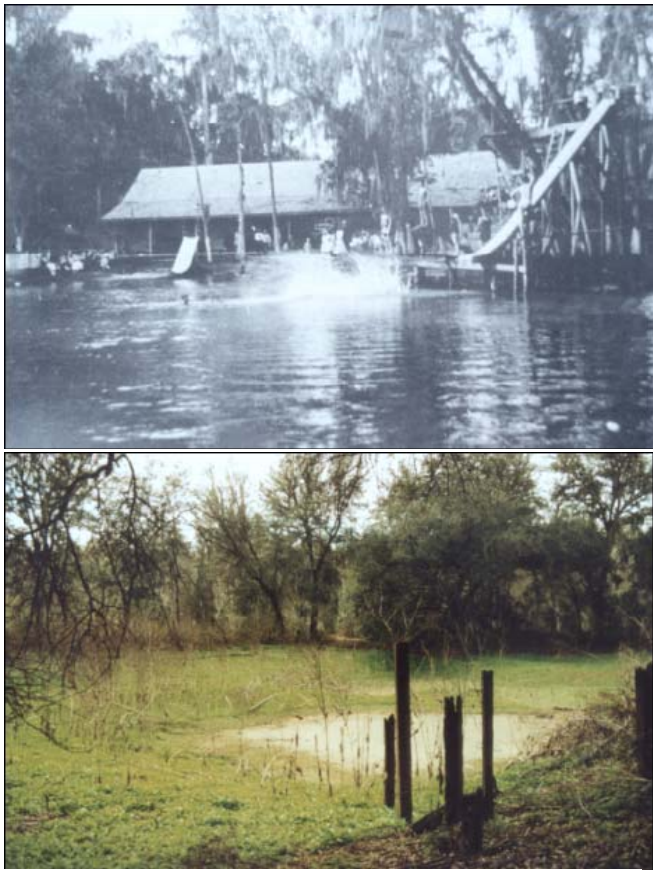
Nitrate-nitrogen concentration at Weeki Wachee Spring compared with population growth in Hernando County. Source: SWFWMD

Excess nutrients come from fertilizers spread on row crops and pastures, golf courses, athletic fields, and lawns. In high amounts, these nutrients can cause an imbalance in the ecosystem leading to increased algal and invasive exotic plant growth in springs and rivers, and can even make our drinking water unsafe. Elevated nutrient levels are an increasing problem in Florida's springs. A steady rise in nutrients in the form of nitrate-nitrogen has been observed over the past 30 years in most Florida springs. Nitrogen, an essential plant nutrient, was once only a minor constituent of spring water. Typical nitrate-nitrogen concentrations in pristine springs range from 0.05 mg/L to 0.2 mg/L. Today many springs discharge water with nitrate-nitrogen levels in excess of 1.0 mg/L – levels at which research has shown a link with ecological impairment. These levels are far lower than the current drinking water (ground water) standard of 10 mg/L for nitrate-nitrogen (Ch.62-550 and 62-520 FAC), but too high for Florida's Springs.

Factors Affecting Spring Flow

Florida is blessed with an abundance of beautiful lakes, rivers, and springs, not to mention thousands of miles of ocean shoreline. With so much water around us and billions of gallons of rainfall, why are we short on water and how can we protect it?

Of the average 53 inches of rain that Florida receives each year, less than 25% replenishes the Floridan Aquifer System by percolating down through upland soils or flowing directly into sinkholes and sinking streams. This renewal of water to the Floridan Aquifer System can be affected when recharge lands are paved. Water levels in the aquifer are also affected by the amount of ground water that people use (withdraw from the aquifer). According to USGS data, Floridians used over 5 billion gallons of ground water per day in 2000, more than any other state east of the Mississippi River.[16] This is an increase of nearly 730 million gallons per day in 5 years. The largest users of ground water in 2000 were public supply (43 percent) and agriculture (39 percent); followed by commercial-industrial (8 percent) and recreational uses (5 percent).[17] About 60 percent of this ground water is withdrawn from the Floridan Aquifer System, which is the source for most of our springs.



Top: Kissengen Spring in 1921. Photo from Florida State Archives. Bottom: Kissingen Spring in 2000. The spring stopped flowing in 1950 because ground water was withdrawn for phosphate mining within the springshed. Photo by Charles Cook.

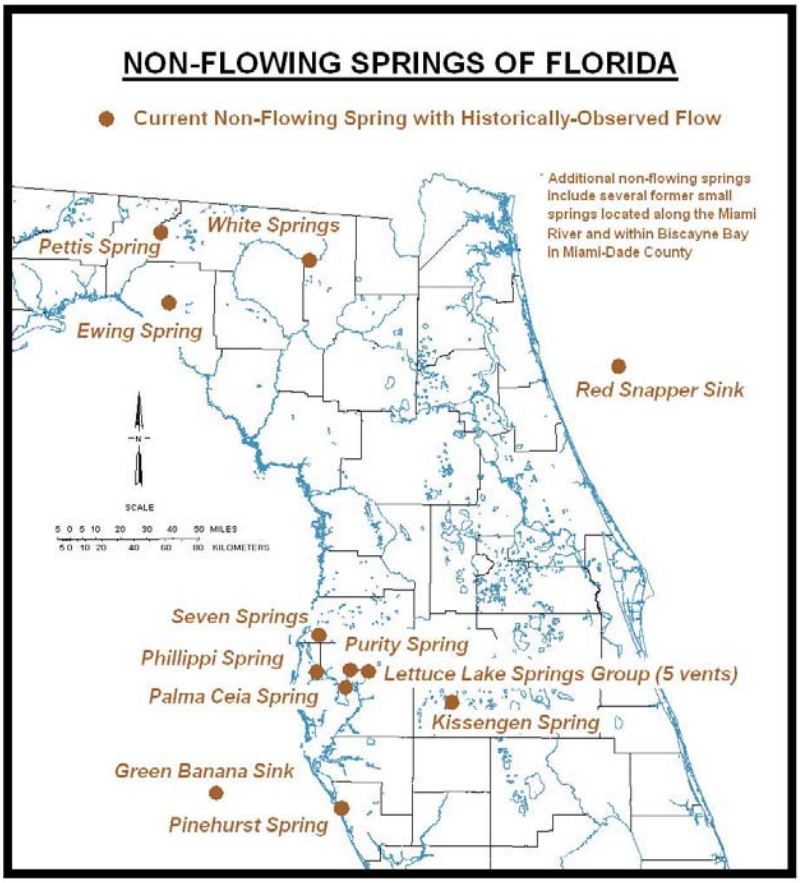
The Floridan Aquifer System ranges in thickness from about 500 feet to over 2200 feet thick. While this is a large reservoir, if the top 20 to 40 feet of that water is lost to over-consumption of ground water, particularly during times of drought, then Florida's springs will largely dry up. Think of the aquifer and springs in terms of a bucket of rocks and water with a spout near the top, where the spout represents the spring. As long as you are pouring water into the bucket (recharging the aquifer), it flows from the spout; but once the level falls below the spout, the water flow stops. Florida's climate is extremely variable, so low rainfall amounts combined with over-consumption frequently occur at the same time.

As with water quality, the quantity of **spring flow** is vulnerable to the effects of activities that occur within springsheds. The nature and magnitude of the threats varies according to land use practices and geology within each springshed. Drought, major development, mining within a springshed, or excessive ground water withdrawals from supply wells can reduce or even stop a spring's flow.[1] Consumptive use also adds more pressure to spring flow during times of drought,

when lower rainfall amounts reduce aquifer recharge. Some land uses also affect recharge by increasing the amount of impervious surface, which prevents rainwater from soaking into the ground. The resulting stormwater collects pollutants and carries them directly into sinkholes and streams.

The impacts of reduced spring flow are most noticeable on smaller springs and those that are the uppermost springs along their respective water bodies. For example, White Springs on the Suwannee River and Worthington Springs on the Santa Fe River are generally dry now. Flows from a number of springs have been significantly reduced or have ceased altogether because of human activities. Kissengen Springs in Polk County, once a second magnitude spring and a popular recreational area, stopped flowing in the early 1950s in response to aquifer pumping and changes in the local hydrogeology from phosphate mining. Flow from Blue Spring in Volusia County, an important winter refuge for manatees, has already declined from increases in ground water use due to population increases in the springshed. Several Wekiva River springs in Orange County are projected to fall below minimum levels set for them unless alternative water supplies are developed.

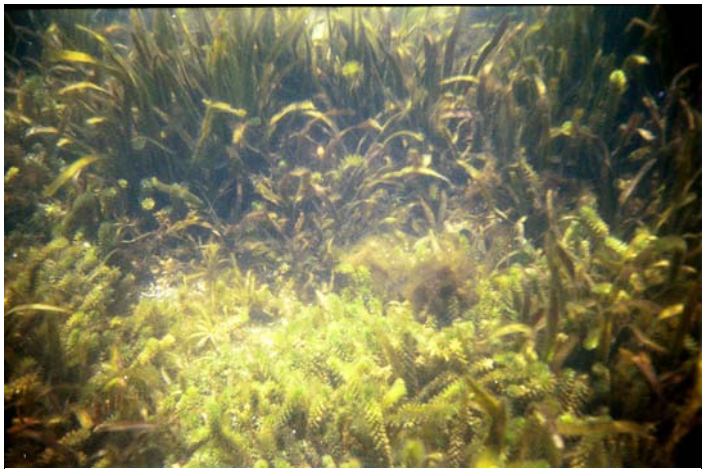
A key challenge for the future is the protection of spring flow of all springs. This is dependent on the conservative use of water by residential, agricultural, and commercial users in Florida. The protection of spring flow requires the implementation of management and conservation practices that reduce ground water withdrawals to the lowest level possible. If ground water levels are maintained, then spring flows will also be maintained.



Source: DEP

Factors Affecting Springs Ecology

The members of a biological system respond cumulatively to a wide variety of natural and human factors. When human actions adversely affect a system, biological populations change, leading to a degraded or imbalanced biological community. Pollution-sensitive species disappear, food webs are disrupted, diversity of species decreases, and undesirable nuisance species can dominate the community.



Invasive exotic *hydrilla* (at bottom) and native eelgrass. Photo by Christine Denny

Changes in a spring's plant community are an early indicator of elevated nitrate-nitrogen. Land uses within the springs' recharge area can result in altered spring water quality, leading to a change in the type of plants growing at the springs. This can affect species like Manatees that depend on aquatic plants for food.[15]

Nuisance algal mats and exotic species of rooted aquatic plants such as *Hydrilla* have become increasingly common in Florida springs and may be related to high nitrate-nitrogen levels that have become widespread in spring-fed streams.[14] Thriving on excess nutrients, invasive exotic plants grow out of control, replacing the native aquatic vegetation relied upon by fish and other creatures.

Benthic macroinvertebrates, such as crayfish and snails, are affected by plant overgrowth, decreased dissolved oxygen, and changes in food quality (often caused by excess nitrate-nitrogen). These combine to reduce the numbers and diversity of benthic macroinvertebrates, which are also directly affected by pesticide contamination.

Rare cave species are particularly vulnerable to changes in water quantity and quality, as well as to natural and manmade earth moving activities. For instance, human-caused erosion will soon seal the entrance to the cave where the only known population of the Putnam County Cave Crayfish (*Procambarus morrisi*) is found, and may extinguish the species. The entire ranges of the Orlando Cave Crayfish (*P. acherontis*) and the Miami Cave Crayfish (*P. milleri*) lie within heavily urbanized areas that are at risk for ground water pollution, and in Miami's case, salt water intrusion.[18] The effects of chemical contamination on submerged cave life is not well known and much about the life cycles of these animals has yet to be learned.

The ground water flowing from the springs that many of these animals depend upon is also increasingly in demand for water supplies. Aquifer withdrawals for domestic or public water supplies can lead to reductions in spring discharge, threatening some of these essential thermal refuges for species like the manatee and striped bass.

Citizen Participation & Decision Making for Springs Protection

Citizens can make a difference by participating in many of the strategies included in this report. In particular, citizens can get involved in decision-making processes that protect Florida's springs.

In Florida, "water is a public resource benefiting the entire state" (Ch. 373.016 FS). The permission to utilize these resources is granted through a permitting process administered by the State's five regional Water Management Districts. Policy and permitting decisions are acted upon the Governing Board of each District. The Governing Board members are appointed by the Governor and confirmed by the Florida Senate. The public can attend WMD Governing Board meetings to provide comment on related activities, including permitting, land acquisition, and management activities. Under Chapter 120, the public may object to decisions made by the Board and can challenge those decisions in the legal process.

At the county or local level, citizen participation can start with the comprehensive planning process and land development regulations. The public can attend Planning and Zoning Board meetings and Board of County Commissioner (BOCC) meetings, which often include public hearings on zoning issues that may affect water use. Many counties and local governments also have citizen boards that advise the BOCC and elected officials on environmental matters. The public can also participate in comprehensive plan compliance through the Florida Department of Community Affairs (DCA).

Citizens review a map of land uses in the springshed of Silver Springs. Photo from the Silver Springs Basin Working Group

An easy way to get started is to visit the website for your WMD, county, local government, or the DCA (Appendix D). You can also call staff directly with questions or concerns. Below is more information to get you started, including information about ongoing land use planning programs and activities in Florida and a brief description of the roles of local, regional, and state government in land use and water management planning.

Land Use Planning Programs in Florida

Comprehensive Plans

In general, when land uses are assigned to a particular location on a Future Land Use Map by local governments, they must demonstrate the suitability of those uses for that site by considering soils, topography, natural resources, and other relevant factors under the provisions of Chapter 163 FS and Rule 9J-5.006 FAC.

A *General Sanitary Sewer, Solid Waste, Drainage, Potable Water, and Natural Ground water Aquifer Recharge Element* is required in all comprehensive plans (Ch. 163.3177 FS). It includes waste management, drainage, and aquifer recharge provisions. Local governments are required to depict any areas adopted or identified by Water Management Districts as prime or high ground water recharge areas for the Floridan and Biscayne aquifers and to give these areas special consideration when designating land uses (Ch. 163.3177 FS). Rule 9J-5.011 FAC requires comprehensive plans to "address protecting the functions of natural ground water recharge areas," and regulate land use and development to protect the functions of aquifer recharge areas.

A *Conservation Element* is a required part of comprehensive plans and must include policies to protect water sources and to restrict activities and land uses known to affect adversely the quality and quantity of identified water sources, including natural ground water recharge areas, wellhead protection areas and surface waters used as a source of public water supply (Ch. 163.3177 FS and Rule 9J-5.013 FAC).

Cave divers in a large underground water-filled room. Cave divers participate in springs protection in several ways, including mapping cave systems, reporting observations, and coordinating with springs scientists. Photo by Wes Skiles

Strategic Regional Policy Plans

Strategic Regional Policy Plans (SRPPs) are a tool for coordinating protection of natural resources, such as springsheds, that extend across governmental jurisdictions. SRPPs are created by Regional Planning Councils (RPCs) and must provide goals and policies to address natural resources of regional significance (Ch.186.507 FS). These goals and policies must be used to develop a coordinated program of regional actions directed at resolving identified problems and needs. SRPPs provide the basis for RPC review of comprehensive plans and Developments of Regional Impact (DRI). SRPPs must identify natural resources of regional significance by specific geographic location and not by generic type. In their SRPPs, RPCs may recommend specific locations or activities in which a project, due to its character or location, should undergo DRI review.

Development of Regional Impact Review

All development projects that, due to size and character, are likely to create regional impacts are required to undergo review (Ch. 380 FS, Rule 9J-2 FAC). The purpose of the review is to determine the nature and extent of possible impacts. Impact mitigation may be required as part of development order conditions. Under Chapter 380 FS agriculture is excluded from consideration as development and is therefore not directly regulated under DRI or

comprehensive planning programs. It should be noted, however, that other programs do provide some measure of consideration for agricultural practices that relate to water quality. Chapter 403.0752 FS provides for Whole Farm Planning under the Department of Environmental Protection's Ecosystem Management efforts. In this program farming practices and agriculture best management practices are considered in a watershed context.

Voluntary Programs

A number of voluntary programs are sponsored by state and regional agencies and organizations. These focus on encouraging best management practices (BMPs) to protect ground water. Programs such as Florida Yards and Neighborhoods and the Audubon International standards for golf course design and maintenance help lessen development impacts to ground water quality. Another program, The Suwannee River Partnership, works with local land users in the Suwannee and Santa Fe river basins to minimize future nutrient loading through voluntary, incentive-based programs. While the Partnership's focus has mainly been on agricultural landowners, it is increasingly considering residential and commercial activities as the population in the Suwannee River Water Management District grows and urban uses become more common. In recent DRI reviews, the Department of Community Affairs has been promoting the use of these programs by encouraging local governments to incorporate these practices into DRI development orders as development conditions.

Government Agencies Involved in Springs Protection

Local Government

Local governments have the primary responsibility of determining land use activities within their jurisdictions (city or county). Under Florida Statutes, local governments also have the responsibility to provide for the conservation and enhancement of natural resources, including ground water (Ch. 163 and 180 FS). Local government comprehensive plans include goals, objectives, and policies that address land use, natural resource protection, and other development considerations. All development undertaken or approved by a local government must be consistent with its comprehensive plan. A strong local government comprehensive plan that is effectively implemented can be a major force for protection and restoration of springs.

People enjoying Cherokee Sink at Wakulla Springs State Park. Photo from Florida Park Service

Although local governments can designate land for agricultural use, under the Right to Farm Act (Ch. 828 FS) they have virtually no ability to regulate agricultural activities. In addition, Chapters 380 and 163 FS exclude agriculture as development subject to land use regulation. Regulation of existing agriculture activities is instead carried out by the

Department of Agriculture and Consumer Services (DACS), and in some cases the Department of Environmental Protection (DEP) issues wastewater permits for feedlots and dairies.

Regional Government

Regional planning councils (RPCs) coordinate the review of land use and policy decisions of local governments. They exercise this responsibility through comprehensive plan review. Comprehensive plans must be consistent with RPC Strategic Regional Policy Plans (SRPPs). RPCs, Water Management Districts (WMDs), and other state and regional agencies provide technical assistance to local governments on comprehensive planning. RPCs also coordinate the review of DRIs.

WMDs are responsible for establishing Minimum Flows and Levels (MFLs) for the level of surface and ground water at which further withdrawals would be significantly harmful to the water resources or ecology of the area. MFLs are established using scientific information and data collection, which can take several years to complete. WMDs (except for the NWFWMD) also issue Consumptive Use Permits or Water Use Permits to regulate ground water withdrawals, and exercise regulatory authority for individual projects through their review of stormwater management permits and environmental resource permits. However, WMDs do not have local land use authority.

Florida State Agencies

The Department of Community Affairs (DCA) has land use planning oversight responsibility as well as authority for the determination of local comprehensive plan compliance with state law. DCA also has review responsibility for large-scale developments and appeal authority (DRIs, Florida Quality Developments). DEP, WMDs, DACS, and Department of Transportation provide review and comment to the DCA on plans and plan amendments. The Department of State and Florida Fish and Wildlife Conservation Commission also review and provide comments. DEP also has regulatory authority for activities affecting submerged state lands, resource extraction, and water quality.

DEP and the WMDs issue wastewater and environmental resource permits (Ch. 403 and 373 FS) to ensure that permitted or regulated activities do not violate water quality standards. DEP also implements the Total Maximum Daily Load (TMDL) program to identify and restore water bodies that do not meet water quality standards. However, to date only a few springs have been included on the impaired waters list and thus subject to TMDLs.[19]

The Florida Department of Health (DOH) regulates the drinking water for approximately 70% of Florida's residents and has permitting authority over septic systems (OSTDS) for domestic flows <10,000 gpd and commercial flows <5,000 gpd (Ch. 381 and 386 FS). DOH also regulates freshwater bathing places, which includes many of Florida's springs (Ch. 514 FS).

Case Histories: Local Values of Florida Springs, Issues That Threaten Them, and Strategies Implemented to Protect and Restore Them

More than 700 springs are known to exist in Florida. Each is a special place to someone, and each has a story. The following pages present seven springs whose stories illustrate the range of values and issues that define Florida's springs, as well as strategies being implemented to protect and restore them. Five of these springs face threats from land uses within their springshed. The sixth spring is located in the Ocala National Forest where the springshed is protected from land uses that could otherwise affect water quality and quantity, but it is still threatened by unrestricted recreation access. The seventh spring presented here is historical in that no other spring has been studied so thoroughly or for as long, making it the flagship for spring protection through local government action. Some protection strategies have been implemented for these seven springs, but more strategies are needed. Activities presented in these stories can show the way to a future where the downward environmental spirals being experienced by most of our springs can be reduced or halted. The fate of these springs is dependent on the continued efforts by state and local agencies, and private citizens who care.

Volusia Blue Spring

A manatee refuge that is losing flow and gaining nitrate-nitrogen.

Left: Volusia Blue Spring, Volusia County, in 1973 when purchased by the State. Right: Volusia Blue Spring after the Florida Park Service restricted foot traffic and reestablished native plants on its banks. The spring provides essential habitat to the endangered Florida manatee. Photos by Jim Stevenson

This first magnitude spring, the focal point of Blue Spring State Park in Volusia County, is the source of a quarter-mile-long spring run that flows to the St. Johns River. The spring and its run provide essential habitat for the endangered Florida manatee population of the St. Johns River and for two species of aquatic snails found nowhere else in the world. In 1766 naturalist John Bartram visited Blue Spring and described it in his journal:

> "What a surprising fountain must it be, to furnish such a stream, and what a great space of ground must be taken up in the pinelands, ponds, savannahs, and swamps, to support and maintain so constant a fountain, continually boiling right up from under the deep rocks, which undoubtedly continue under most part of the country at uncertain depths?"

Volusia Blue Spring was the site of a steamboat landing and post office at the turn of the twentieth century. Currently, the spring provides recreational, scenic, wildlife, and historic values that attracted over 359,000 visitors in 2005.

Threats

The springshed of Volusia Blue Spring is being rapidly transformed into an urban/suburban landscape, with an associated increase in ground water pollution and in water withdrawals for human use. Water quality is steadily declining, with recent nitrate-nitrogen measurements as high as 1.1 mg/L (2004). Spring discharge measurements show that the spring's flow rate has dropped below the historic natural level. Flow will be further reduced, at least temporarily, as more ground water is withdrawn for domestic water supplies and agriculture. Long-term diminished spring flow represents a significant threat to the recovery of the Florida manatee population in the St. Johns River. Volusia Blue Spring's other values will also be impacted by further flow reductions.

Strategies

Regulatory. The St Johns River Water Management District (SJRWMD) is planning to adopt a Minimum Flows and Levels (MFLs) rule for the discharge from Volusia Blue Spring based on the habitat requirements of the manatee population that gather in the spring run each winter. SJRWMD also issues consumptive use permits that ensure that withdrawals of ground water are not harmful to the water resources of the area. The Florida Park Service regulates public recreation in the spring and spring run while protecting manatees and the scenic, recreational, and biological values of Blue Spring State Park.

Research. The SJRWMD published the results of a research project in 1999, *Water Quality and Isotope Concentrations from Selected Springs in the St. Johns River Water Management District* (Technical Publication SJ99-2). Volusia Blue Spring was among those included in the study. The study results indicate that the spring flows from the Floridan Aquifer System, that the source waters originate from a variety of depths, and that the ground water flowing to the spring is increasingly degraded by nitrate-nitrogen pollution.

Monitoring. The USGS has monitored water levels at Volusia Blue Spring since 1932. SJRWMD has monitored water quality since 1983. Volusia County and the Florida Geological Survey also monitor water quality. The Florida Museum of Natural History is monitoring the endemic Blue Spring silt snail population. The Florida Park Service closely monitors the manatee population, identifying individuals, their positioning in the spring run, and the distance of cold water intrusions up the spring run.

Stewardship. State park personnel have slowed erosion and restored the spring shorelines by building boardwalks to restrict foot traffic and re-establishing native plant communities.

Ginnie Spring

World-famous diving site and bottled water source now – but what about 10 years from now?

Ginnie Spring, Gilchrist County. Photo by Wes Skiles

Ginnie Spring, so named for the woman (Virginia) who once washed laundry in its unsoiled waters, is located in Gilchrist County, a sparsely populated county in North Central Florida. Ginnie Spring is one in a series of eleven springs in the immediate area with a combined total discharge of 260 million gallons per day.

This series of springs drains two different physiographic regions. The northern basin, known as the Columbia Karst Plain, drains into four of the springs, including Devil's Ear and Devil's Eye. The southern basin, which comprises part of the High Springs Gap, drains into the other seven springs, including Ginnie and Dogwood. The western edge of the recharge area is the Wacassassa Flats, a unique perched wetland system that overflows into a series of lakes and sinkholes that are connected to the springs and Santa Fe River. On average, these eleven springs contribute up to 25 percent of the total average flow of the Santa Fe River, which in turn flows into the Suwannee River.

Ginnie Spring is privately owned and managed by Ginnie Springs Outdoors, LLC, as a recreation area. It is located seven miles west of the town of High Springs, and is the most popular freshwater and cave-diving site in the world. The spring is also the source for water bottled near the site by CCDA Waters, LLC (CCDA).

Threats

The spring's water quality is affected by increasing nitrate-nitrogen levels, which have recently been measured at between 1.29 mg/L and 1.58 mg/L. Agricultural operations and increasing residential and urban development within the springshed have probably contributed to this trend.

These types of land uses can have a serious impact on spring water quality. The growing popularity of the area's springs is leading to increased population growth and as a result agricultural lands are being converted to low-density residential communities. Septic systems within the springshed are the only type of wastewater treatment available.

Strategies

Working Group. The Santa Fe Springs Working Group was formed in 1998 to protect waters flowing to the Santa Fe River and its springs, including Ginnie Springs. Coordination of the working group is currently funded by the Florida Springs Initiative. Recent accomplishments by the Working Group include hosting workshops for local government elected and appointed officials and staff, which include a tour of features throughout the springshed; collaborating to produce a draft map of the area that affects Poe, Ginnie, and Gilchrist Blue Springs to guide future activities; and collaborating with the University of Florida's Institute of Food and Agricultural Science's Florida Yards and Neighborhoods program to hold a workshop on springs protection and Florida-friendly landscaping at a subdivision located within a mile of Ginnie Springs.

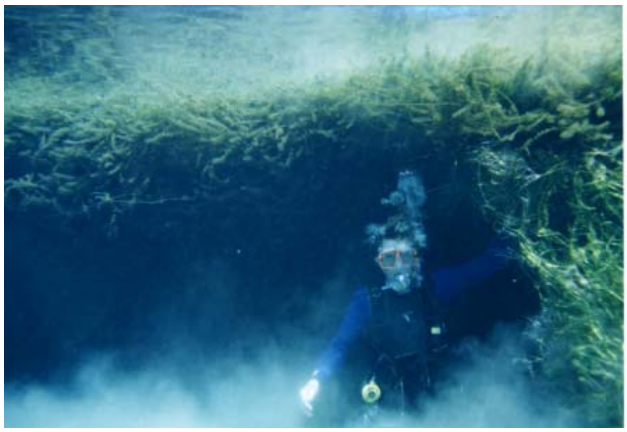
Land Acquisition. Ginnie Springs Outdoors, LLC directly controls approximately 200 acres at its world famous resort, which comprise the recreation lands that encompass the springs and along the Santa Fe River. Over 800 additional adjacent and nearby acres within the springshed are owned by family members linked to the Ginnie Springs operation. CCDA has purchased a 9 acre site at the southeast corner of the Spring Ridge subdivision in the springshed to buffer and protect a natural sinkhole that is open to the aquifer. These private land protection efforts afford some protection to water quality and quantity of Ginnie Springs, but as large agricultural tracts of private property in the springshed gradually become converted to smaller, residential lots with private septic systems and wells, public acquisition of land will become a higher priority for protection of Ginnie Springs and other springs along this section of the lower Santa Fe River.

Monitoring. CCDA has established a comprehensive monitoring program within the expected springshed utilizing wells on residential, commercial, and public properties to assess the quality and quantity of ground water moving toward the Ginnie Springs Group, and to help define the extent of the springshed. These efforts include the establishment of a water quality well network that is routinely sampled, ongoing spring discharge measurements, water level measurements at both the Ginnie Spring local well network (since 1999) and the High Springs Gap Water Level Monitoring Network (established in 2003), and a rainfall measurement station (installed in 2005). Additionally, the CCDA in-house laboratory routinely monitors the springs and nearby production wells (spring taps).

Education. The Santa Fe Springs Working Group is responding to the continuing need for information by residents of the Ginnie Springs capture basin on how their activities affect ground water, particularly landscaping practices, septic system maintenance, and the need to protect sinkholes and abandoned phosphate pits from stormwater discharge and illegal solid waste disposal. The group also provides information to local elected officials who must make land use decisions in areas that may affect Ginnie Springs.

Wakulla Spring

A wildlife paradise choking on Hydrilla.



Left: A diver is removing the *Hydrilla* that threatens to obscure visitors' view of the spring. Photo by Tom Kennedy, Park Volunteer. Right: One of the glass bottom boats that give Wakulla Springs State Park visitors a glimpse of the features of the spring bowl.

In 1837 John Lee Williams wrote, "Wakulla Spring is one of the finest springs in Florida or perhaps the world." Owned by the state of Florida and managed as a state park, Wakulla Spring is one of the world's largest first magnitude springs, with a discharge of 252 million gallons per day. The spring is the source of the Wakulla River. Cave divers have determined that Wakulla Spring flows from one of the longest underwater cave systems in the United States, and the **spring pool** is one of the deepest in Florida. The spring has recreational, scenic, wildlife and historic values, and Wakulla Springs State Park is the third largest employer in Wakulla County. One of the foremost wildlife observation areas in Florida, it attracts nearly 200,000 visitors a year. The 600 square mile springshed encompasses a portion of Apalachicola National Forest, as well as about 300 square miles of Leon County including the City of Tallahassee.

Threats

Water quality of Wakulla Spring has been significantly degraded during the past 30 years. In the mid-1970s nitrate-nitrogen concentrations were about 0.3 mg/L. By 1990, nitrate-nitrogen concentrations had risen to 1.0 mg/L. This represented a tripling in the nitrate-nitrogen load discharged from the spring, from about 176,000 pounds per year to about 600,000 pounds per year. Nitrate-nitrogen concentrations have since declined slightly, to between 0.6 mg/L and 0.8 mg/L presently. In the late 1990s, the invasive exotic plant *Hydrilla* was detected at the spring vent. It remains a major problem for Wakulla Springs State Park. The uncontrolled growth of *Hydrilla* and algae has seriously degraded habitat quality in the spring and its run. This growth has presumably been aggravated by elevated nutrient concentrations in water flowing from the spring. Additionally, the frequency of clear-water days is diminishing, which limits the use of glass-bottom boats by visitors. This problem appears unrelated to the elevated nitrate-nitrogen.

The principal threat to Wakulla Spring is the urbanization and sub-urbanization of its springshed. The spring is located in Wakulla County, one of the fastest growing counties in the State. The City of Tallahassee and Leon County lie only a few miles upstream of the spring. A recent study

by the Northwest Florida Water Management District (NWFWMD) indicates that wastewater treatment and septic system practices are the principal source for the increase in nitrate-nitrogen concentrations in spring water observed over the past 30 years.[21] Stormwater runoff, agricultural practices and atmospheric deposition appear to play a smaller role.

Strategies

Working Group. The Wakulla Spring Basin Working Group was formed in 1992 to protect the waters flowing to Wakulla Springs. Coordination of the working group is funded by the Florida Springs Initiative.

Education. Field trips and slide presentations have been provided to elected officials and the public. In 1998, the working group conducted a Scientific Symposium and a Public Awareness Day. That same year, WFSU-TV produced the documentary *Below the Surface* about threats to the spring. A "Walk for Wakulla Spring" was conducted to raise awareness of the hydrologic connection between Tallahassee and the springs. The evening event "Exploring the Secrets of Wakulla Springs" was held in Wakulla County and in Tallahassee to inform the public about the spring system. Several springshed field trips, a talk radio program and two TV appearances have been conducted. A brochure is distributed to homeowners in the springshed and a web site "Wakulla Spring: A Giant Among Us" is online. A two-day workshop "Solving Water Pollution Problems in the Wakulla Springshed of North Florida" was held in May 2005. Sponsored by 1000 Friends of Florida, the workshop was intended to recap the current state of knowledge regarding the water quality problems of Wakulla Spring. Based on meeting presentations and follow-up inquiry, a peer review committee prepared a summary report entitled, *Degradation of Water Quality at Wakulla Springs, Florida: Assessment and Recommendations* (December 2005). DOT has installed 12 "Wakulla Spring Basin" signs on roads crossing the springshed.

Research. A 2002 NWFWMD study entitled, *Nitrate Loading as an Indicator of Nonpoint Source Pollution in the Lower St Marks-Wakulla Rivers Watershed*, concluded that human waste disposal practices in Leon and Wakulla counties were likely a significant contributor to the observed increase in nitrate-nitrogen concentration from 0.3 mg/L to 1 mg/L over the past 25 years. Prompted in part by the conclusions of the NWFWMD study and the questions it posed, further studies were undertaken, some of which are concluded.

From 2002 through 2004, Florida Geological Survey (FGS) and Florida State University (FSU) researchers conducted a series of dye-tracing studies that demonstrate hydrologic connections between the previously-mapped Leon Sinks conduit system and Wakulla Spring. As of yet, the furthest-distant feature connected to Wakulla Spring lies about 6 miles northwest of the spring and provides a refined understanding of the position of the western edge of the Wakulla Spring capture basin. The studies also demonstrate high fluid velocities within the conduit system, with ground water traveling as much as a mile per day. In 2004, dye studies at Ames Sink (downstream terminus of the Lake Munson stormwater drainage system) demonstrated a connection between this feature and Wakulla Spring. Dye traveled about 5.8 miles to Wakulla Spring in about 20 days (0.3 miles per day).

In 2004 the City of Tallahassee and the USGS began an investigation of ground water impacts near and down gradient of the southeast sprayfield, including installation of 10 monitoring wells.

Water sampling at these wells and at springs features includes an extensive list of pharmaceuticals, wastewater treatment byproducts, and other compounds. In addition, dye studies initiated in 2006 by FGS and FSU researchers will test and possibly confirm the connection between the sprayfield and either St. Marks Rise, Wakulla Spring, or both.

Monitoring. Wakulla Springs State Park monitors water clarity on a daily basis. The USGS is developing a record of daily flows on the Wakulla River at County Road 365, 2.75 miles downstream from the headspring. This effort includes periodic discharge measurements at the recorder location. FGS and FSU continuously record velocity, temperature, and conductance with meters located in the main vent and at four other locations within the conduit system. FGS samples the main vent and conduits quarterly and makes quarterly discharge measurements at CR 365. The NWFWMD maintains a continuous velocity meter in the main conduit and a continuous stage recorder at a site below the main pool and performs periodic discharge measurements at both the main pool and at CR 365. The NWFWMD also collects monthly field parameters and quarterly water quality samples from the main vent.

Regulation. In 1994, the Wakulla County Commission adopted a land use ordinance: Wakulla Springs Water Quality Protection (94-28). The ordinance established protective measures for a one-mile wide zone above the cave system, extending north to the county line. This step was taken in an effort to protect a highly vulnerable portion of the springshed.

Land Acquisition. The State has acquired 7,367 acres in the Wakulla County portion of the springshed to protect the water flowing to the spring. This acquisition has enabled the establishment of the 4,200 acre Wakulla State Forest immediately north of the state park. DEP is pursuing the acquisition of additional tracts that overlie the cave system. A developer voluntarily agreed to the State's use of eminent domain to stop his project and acquire a 25-acre tract near the spring.

Land Management. DEP's Division of Recreation and Parks spent $453,000 to relocate the park's wastewater treatment facility farther from the spring. State park restroom facilities have been connected to a county central sewage system to remove sewage from the park. In 1997, divers and other volunteers conducted a cleanup of sinkholes in the springshed. They continue to assist in periodic manual removal of *Hydrilla* from the spring. FSU has designed an electric motor for the river tour boats to replace the outboard motors thereby eliminating this source of pollution.

Best Management Practices. A major landowner has restricted vehicle access to sinkholes connected to the cave system. Specific sinkholes are being restored in the springshed. A dump has been removed from Tucker Sink. Cattle have been fenced out of Butler Sink and erosion has been controlled at Cherokee Sink. The Wakulla Spring Ambassador is educating landowners about sinkhole protection and identifying privately owned sinkholes in need of restoration. DOT has agreed to discontinue the application of 218 tons of fertilizer to the shoulders on 195 miles of state roads that cross the springshed.

Land Use Planning. Wakulla County has agreed to be a model community and recipient of the Department of Community Affairs (DCA) technical assistance regarding the *Implementation*

Guide Book for Protecting Florida Springs: Model Land Development Code and Model Comprehensive Plan Objectives and Policies. DCA formed the Wakulla County Agency Work Group (composed of DCA, DEP, DOT, DOH, NWFWMD, and Wakulla County) which meets monthly to coordinate activities that will contribute to ground water protection in the county. DCA provided Wakulla County with a $10,000 technical assistance grant to review the Comprehensive Plan and Land Development Code for springs protection opportunities. Leon County, Wakulla County's northern neighbor, is retrofitting stormwater management systems within the springshed, and the City of Tallahassee has implemented stormwater management projects to reduce pollution flowing to Ames Sink and the spring.

Sulphur Spring

Too much pollution…too late to cure?

Left: Sulphur Spring in 1925 when it was still a popular Tampa recreation area. Right: Sulphur Spring today, closed to the public due to coliform bacteria contamination (Photo by Ryan Means, FGS). The spring also suffers from reduced flow and increased salinity. Hillsborough County, the City of Tampa, and SWFWMD are investigating ways to restore the spring.

Sulphur Spring is the largest of several springs that flow into the Hillsborough River within the City of Tampa. A second magnitude spring with a historic flow of 26 million gallons per day, Sulphur Spring is located in a heavily urbanized area of Tampa and most of the springshed is densely populated and developed. The spring and surrounding park have been a popular recreation area since the late 1800s. It was purchased in 1957 by the City of Tampa for public use and as a future water supply. Discharge from Sulphur Spring provides a significant source of freshwater flow into the lower Hillsborough River and a portion is used as a back up source to supplement Tampa's water supply reservoir, which is located on the Hillsborough River upstream from the spring. In the winter months manatees migrating up the Hillsborough River from Tampa Bay use the spring as a warm water refuge.

The geographic setting and past uses of Sulphur Spring have resulted in extensive physical and ecological changes to the spring. The entire springshed is covered with urban/residential land uses. Numerous sinkholes near the spring, which act as important points of ground water recharge, have been degraded by illegal dumping and stormwater inputs. The **spring vent** and pool are enclosed in a circular concrete pool, and discharge is manipulated through an adjustable weir structure. The banks of the 500-foot long spring run are mostly hardened with vertical concrete seawalls.

Threats

The present condition of Sulphur Spring is a prime example of the degradation that can occur without proper planning and protection efforts that emphasize understanding the hydrogeologic dynamics of spring systems. Some of the sinkholes have been plugged with debris and filled, which has contributed to reduced ground water flow to the spring. The flow at Sulphur Spring has declined over forty percent since the 1960s.

In addition to stormwater pollution problems, septic systems and wastewater treatment systems may also contribute contaminants to the ground water that flows from Sulphur Spring. Nitrate-nitrogen levels exceeding 1.2 mg/L have been reported, although there now appears to be a declining trend in nitrate-nitrogen concentrations at the spring. In 1986, contamination by coliform bacteria forced the permanent closure of the spring to swimming or other recreation. Also, the salinity of the spring water has been increasing, a symptom of reduced freshwater inflow due to plugged sinkholes and pumping of the aquifer for water supply.

The periodic use of Sulphur Spring as a source to augment water levels in the Hillsborough River reservoir has adversely affected spring flows and the spring run ecology, especially during times of drought. Since the lower Hillsborough River is tidally influenced, periods of low river flow and diversions of spring discharge have resulted in saline water from the river back-flowing into the spring run. Significant shifts in the types and numbers of macroinvertebrates have been documented, as well as changes in vegetation in the spring run and nearby river environment.

Although the spring system has been severely altered and will never be returned to its natural state, efforts are underway to regulate and maintain a healthy flow regime from Sulphur Spring and should result in noticeable improvements to the spring run and river.

Strategies

Watershed Planning. Hillsborough County has completed a stormwater plan for part of the springshed.

Regulation. The SWFWMD has proposed a minimum flow (MFL) of 18 cfs (cubic feet per second) for Sulphur Spring, with conditional MFLs of 10 cfs and 13 cfs allowable for certain circumstances with strict limitations. This proposed MFL is undergoing public comment, and the scientific methods for setting the flow rate will be subject to peer review before adoption as an established MFL for Sulphur Spring. Currently, a provisional MFL of 10 cfs, established in 2000, is in effect at the base of the Hillsborough River reservoir dam, which is approximately two miles upstream of the spring run. This flow is in part being facilitated through diversions of spring discharge, but improvements to the diversion system allows for dividing the diverted water and returning a portion of flow back to the spring pool and run. The established 10 cfs MFL at the dam spillway is under review in conjunction with setting an MFL for the entire stretch of the lower Hillsborough River, which includes discharge from Sulphur Spring needed to maintain an acceptable salinity regime in the lower river.

Monitoring. The USGS, in cooperation with the SWFWMD, is conducting stage/discharge monitoring using three continuous recording instruments. Also, a continuous water-quality monitoring device to measure water temperature and specific conductance has been in place since 1999. Monthly water sampling is conducted by the City of Tampa as a requirement of their WUP for Sulphur Springs. Detailed ecological monitoring has been conducted in the spring run and Hillsborough River for setting the proposed minimum flow at Sulphur Spring and the lower Hillsborough River. This monitoring will continue as MFLs are established and finalized, with an emphasis on maintaining low salinity levels in the spring run and adequate dissolved oxygen concentrations in the lower river.

Research. Sulphur Spring and the immediate springshed area is probably the most extensively studied second magnitude spring in Florida. Numerous dye trace studies have confirmed the connection of certain nearby sinkholes to the spring. Other studies have documented high coliform bacteria levels in the spring discharge several hours after major storm events. Recently completed work by consultants for the City documented the hydrodynamic response of ground water levels and water quality in the springshed to changes in spring flow. New information from cave diving expeditions has shed light on the sources of higher salinity water discharging from the spring during flow diversions for reservoir augmentation. Statistical analyses of discharge and water-quality trends have been completed for the proposed MFLs, which are detailed in a 2004 draft publication by the SWFWMD. Recent physical descriptions of the spring pool and run have been completed, including a bathymetric map of the spring run with an assessment of vegetation coverage. Comparative analyses of macroinvertebrate populations have also been conducted under varying conditions of spring flow and salinities. Thermal modeling of the lower Hillsborough River adjacent to the spring was also conducted to determine if MFL recommendations would maintain the thermal refuge requirements for manatees. Further research will be initiated to test the application of the proposed minimum flows as the MFL implementation proceeds.

Restoration. The City of Tampa and SWFWMD are evaluating results of studies for the restoration of sinkholes connected to the spring, along with improvements in stormwater treatment that may result in increased ground water flow to the spring and reduced salinity of spring discharge water. Also, results of the minimum flows analyses show promise for ecological restoration of the spring run to a fresh water system that is tolerant of periodic levels of higher salinities under a more natural condition of flows and variations in water quality. A Shoreline Restoration Masterplan has been completed that assesses sections of the Hillsborough River at Sulphur Springs Park and River Tower Park immediately downstream of Sulphur Spring. The Sulphur Springs Park assessment indicates that restoration activities will be dependent on participation of public and private stakeholder groups to initiate a restoration project.

Ichetucknee Springs

A scenic and recreational gem.

Ichetucknee Springs, Columbia County. Photo from DEP Florida Park Service

In his book *A Naturalist in Florida* Archie Carr wrote "The Ichetucknee and its run, the most beautiful landscape in the world." The eight named springs and three miles of the river are protected in Ichetucknee Springs State Park, established in 1970. Protection efforts since then, such as controlling bank erosion in 1970 and implementing a carrying capacity for recreation access in 1980, have resulted in significant improvements along the spring and its run. However in recent years, Ichetucknee Springs is facing new threats from increasing pollutants.

The springs discharge 233 million gallons per day, supplied by the 300 square mile springshed that encompasses 38% of Columbia County. In earlier times, the largest Timucuan village in Florida was located along the river. DeSoto visited the Ichetucknee in 1539 and the Spanish mission San Martin de Timucua was established at Mission Spring in 1610. Today, the Ichetucknee is the premier tubing river in the U.S. with up to 200,000 annual visitors enjoying the cool clear water.

Threats

The water flowing from the springs is becoming increasingly polluted, with nitrate-nitrogen approaching 1 mg/L. The nitrate-nitrogen is thought to be responsible for the rapidly expanding growth of algae that coats the eelgrass and forms floating mats that shade out the submerged aquatic vegetation. Lush eelgrass in Devils Eye and Millpond Springs has been replaced by algae. Rafts of water lettuce threaten to shade out the river bottom as well. The once abundant

populations of spring run crayfish and loggerhead musk turtles are almost gone. There are increasing reports of swimmers and tubers having allergic reactions to algae, including skin rashes and respiratory distress.

Strategies

Working Group. The Ichetucknee Springs Basin Working Group was formed in 1995 to protect the waters flowing to the springs. Attendance at quarterly meetings averages 50 members and often includes the County Manager, City Manager, State Representative, and the publisher of the Lake City Reporter. In 2000, the working group was awarded the Sustainable Florida Award for Leadership by the Governor's Council for a Sustainable Florida. Coordination is currently funded by the Florida Springs Initiative.

Education. Numerous educational activities and events are conducted to raise awareness and inform the citizens of Lake City and Columbia County. The Ichetucknee Springs Appreciation Day is an annual event for the citizens of the county that assembles all the experts of the springs and springshed to educate the public. Field trips of the springshed are conducted periodically throughout the year. One field trip has been filmed by Lake City Community College and the video was provided to all the schools in Columbia County. With Department of Transportation assistance, Ichetucknee Springs Basin Signs and "Creeks Drain to Ichetucknee Springs" signs have been placed on all state and county roads crossing the springshed.

Research. Three separate dye trace studies have confirmed the connection of sinkholes and swallets in the springshed with the springs. Numerous other studies have been conducted. In 2005, fourteen research and monitoring projects were underway in the springshed and others are planned. The DOH Aquatic Toxins Program and Columbia County Health Department together with the Centers for Disease Control and Prevention are evaluating reported cases of rashes associated with recreational activities at Ichetucknee Springs State Park and other springs in Florida. The blue-green algae *Lyngbya wollei* (cyanobacteria) is one of the factors being assessed in preparation for a possible epidemiology study at Ichetucknee Springs.

Monitoring. Two baseline water quality studies have been conducted by DEP Laboratories from several sampling locations in the springshed. Quarterly water quality sampling occurs at four of the springs and USGS discharge monitoring is underway at several of the springs.

Regulation. The Environmental Regulation Commission approved the extension of the Ichetucknee River Outstanding Florida Waters designation 7 miles up gradient to include Rose Sink. This is the first such regulatory protection for a sinkhole in Florida.

Best Management Practices. Landowner assistance, in the form of Florida Springs Initiative funding, was provided to a farmer in the springshed to construct a poultry manure barn to improve management of wastes.

Land Acquisition. The highest priority needs for acquisition in the springshed were two large limerock mines that threatened the springs. The Governor and Cabinet approved the purchase at a cost of $32M and the mines are now state property. The second highest priority purchase was Rose Sink, 7 miles north of the springs. A $1M donation enabled the Trust for Public Lands to

acquire most of the needed acreage around the sinkhole, as well as other tracts in the Ichetucknee Trace. Using Florida Communities Trust funds, the county purchased 900 acres of Alligator Lake that had been diked, drained, and farmed for decades. The tract has been re-flooded and restored.

Land Management. During the past eight years, park staff and volunteers have conducted a project to restore the headspring. The spring vent is now clear of rubble and the depth has been restored to 25 feet. Volunteers led by the park biologist conduct periodic water lettuce removal projects to protect submerged aquatic plants from shading. The park manager continues to enforce recreation carrying capacity limitations to insure a balance between recreation and preservation of the springs and river. A wastewater improvement project is funded and underway to relocate and replace three septic systems in the park with a single nitrogen-reducing system. DEP has required the removal of refuse from two sinkholes in the springshed.

Land Use Planning. The SRWMD and Columbia County have recently agreed to contribute $1M each annually for 5 years to manage stormwater in the Cannon Creek watershed. The city, county, and the water management district have each conducted stormwater management improvements in the Alligator Lake watershed. DEP is pressing the city of Lake City to upgrade sewage treatment to reduce nutrients flowing to the springs.

Protected Species. Although not classified as endangered, the spring run crayfish and the loggerhead musk turtle are species that warrant monitoring due to their declining numbers. Funding for a monitoring project has been requested. A project to monitor aquatic macroinvertebrates, including snails, has been funded by the Three Rivers Trust.

Silver Glen Springs

Pristine water quality – but still threatened by unrestricted recreation access.

Left: Silver Glen Spring, Marion County.
Photo by Harley Means, FGS

Right: Recreation use at Silver Glen Springs on July 4, 2002.
Photo from SJRWMD

Silver Glen Springs consists of two vents, Natural Well and Main. The combined flow from these vents exceeds 100 cubic feet per second making it a first magnitude spring. Water discharges into a semi-circular spring pool and flows down the spring run approximately 3,300 feet until it enters Lake George. The spring run crosses the Marion County and Lake County boundary just prior to its entering Lake George.

The land adjacent to the spring and spring run is owned by the Federal Government and is part of the Ocala National Forest. A private landowner owns a portion of the south bank of the spring run. Access to the spring can be gained by boat or by land. A private concession manages a small park at the headspring area for the Ocala National Forest.

Silver Glen's springshed is located primarily within the Ocala National Forest, Juniper Prairie Wilderness Area. The land is managed as a native forest which is reflected in the water quality of Silver Glen Springs. Nitrate-nitrogen levels in Silver Glen Springs (Total N) are below 0.05 mg/L, which is considered to be at or near background levels. Other chemical parameters suggest that the water coming from Silver Glen Springs is relatively pristine. This natural setting attracts a diversity of wildlife, including manatees that use a portion of the spring run. While many Florida springs are threatened from pollution of ground water, Silver Glen Springs faces threats from continued unrestricted recreation access.

Threats

Although the springshed for Silver Glen Springs is predominantly national forest, threats to the spring and spring run exist from unrestricted recreation access. This spring is heavily used by boaters on holidays and warm, sunny summer days. As many as several hundred boats of all sizes have anchored along the spring run in the past. As a result of this and other recreational activities, extensive damage to the native vegetation has occurred.

Exotic plants and animals are invading the system and replacing the native species. *Hydrilla*, an exotic invasive aquatic plant, was present in ~20% of the spring run in 2003. This figure may be higher today.

Swimmers also enter the spring from the uplands and cause damage to the native vegetation as well as causing erosion in and around the main spring vent. Algae is proliferating in areas disturbed by swimmers and boaters. Large areas devoid of native vegetation now harbor thick mats of black, filamentous algae.

Strategies

Land Acquisition. The U.S. Forest Service (USFS) owns the uplands adjacent to Silver Glen Springs. The State of Florida owns the submerged portion of the spring and spring run. A private landowner owns land along the south bank of the spring run and uses it as a hunting and fishing lodge. They have been stewards of the land and have cooperated with the USFS and DEP over the years. A portion of the springshed is still in private ownership. Although most of the springshed is already protected as public lands, the state could pursue conservation easements on these remaining privately owned lands. It would be a unique opportunity to publicly own or control an entire springshed of a first magnitude spring

Monitoring. The USGS monitored spring discharge intermittently from 1931 to 1984. Since then, bi-yearly discharge monitoring has been conducted. Additionally, the Florida Geological Survey (FGS) has conducted quarterly discharge monitoring since 2004. Water quality monitoring has been conducted sporadically prior to 1984. Since then the SJRWMD and FGS have conducted quarterly monitoring of water quality.

Land Management. The federal and state landowners and land managers must come to agreement on how best to manage Silver Glen Springs. In 2003, the Florida Springs Initiative funded a carrying capacity study of Silver Glen Springs. The report outlined strategies for minimizing impacts to the spring from boaters and swimmers. To date these strategies have yet to be implemented. Action needs to be taken to implement the strategies outlined in the carrying capacity study. Access to the main spring vent and the well by motorized boats is restricted. Access to the well by swimmers and divers is restricted. Restrictions on the size and number of boats allowed in the spring run are needed. Access to the swimming area needs to be limited and may need a designated entry point to avoid further erosion and trampling of aquatic vegetation. Sanitary facilities need to be accessible to boats that are moored in the spring run.

Silver Springs

Historic spring studied since the late 1800s, now a flagship for springs protection through local government action.

Left: Silver Springs, 1900s.
Photo from Putnam County Archives

Right: Silver Springs, today.
Photo by Steve Specht, Silver Springs Attraction

Lady Hardy was one of many early visitors to the Silver Springs. Describing her visit to Silver Springs in *Deep South*, published by Chapman and Hall, Ltd. in 1883, Lady Hardy wrote:

> "I wonder if I can convey to any one an idea of the Ocklawaha river ... ... its fairest wonders are at our starting point, Silver Springs. ... It seems as though all the jewels from all quarters of the globe had been gathered together and melted down, and poured into the great earth hollow we are gliding over. The spring is eighty feet deep, the water so clear that the sweet fairy flowers at the bottom of it seem to lie close at hand; you feel as though you could lean over and pluck one from the bed, which seems to be formed of holes, arches, and deep crevasses of many-coloured rocks; variegated blues and greens and greys, all amalgamating together, beneath the soft rippling water...."

Located in Marion County, the Silver Springs Group contributes a major source of water to the Ocklawaha River. The springs constitute one of the best-known spring systems in Florida. With a discharge of about 550 million gallons per day, the spring group is the largest inland spring in Florida. While the springs are of great importance as a water resource that sustains flow in the Ocklawaha River and a significant tourist industry near Ocala, perhaps their greatest importance lies in their human and scientific history.

The spring water clarity and abundant life resulted in Silver Springs becoming Florida's first tourist attraction. Steamboats brought tourists to the springs as early as 1860. Books and articles describing early travelers' experiences at the springs began to circulate in the late 1870s and it became a fully developed attraction with a hotel and glass-bottomed boats by the mid-1880s. With this worldwide fame and outstanding environmental quality, scientists began to visit and evaluate the springs. LeConte may have been the first scientist to visit the springs (Table 2), and publications that discussed the springs began in 1908. These early investigations of the springs are important because they give us an accurate baseline for environmental quality. No other spring system in Florida has been studied so thoroughly or for as long as has Silver Springs. Even so, we have allowed serious damage to occur over the last 50 years.

Threats

There are three, seminal, environmental events (see Table 2) that highlight the way in which these world-class springs have been allowed to deteriorate and what can be done to restore them if the public and government have the will to do so. The first event was a study of the ecology of the springs by H.T. Odum in 1957. This study established a baseline for water quality and the ecology of the spring system that was unique in springs study. Odum's seminal work allowed us to understand the structure and function of the food chain in a Florida spring, and demonstrated the reasons for the biological diversity and abundance that tourists had admired since the late 1800s.

As of 2006, the St. Johns River Water Management District is completing a 50-year retrospective of Odum's study. This important follow-up study clearly demonstrates how far Silver Springs has been allowed to deteriorate. For example, the follow-up study has found that since Odum's study:

- With the exception of nitrate-nitrogen, water quality in the multiple spring boils has remained relatively unchanged.
- Nitrate-nitrogen concentrations have doubled since the 1950s and increased by a factor of 26 since the turn of the 20th century (0.04 mg/L in 1907, 0.46 mg/L in 1953, 1.05 mg/L in 2005).
- Nighttime concentrations of dissolved oxygen have declined downstream of the spring boils.
- Secchi depth in the Main Boil (light penetration depth) appears to have decreased
- Current summer estimates of submerged plant biomass are within 3% of the estimates reported by Odum in 1957 at the same time period. However, current estimates of winter biomass indicate a 35% drop from summer observations. Historically in Odum's work, no seasonal variability was observed.
- Estimates of summer epiphyte algal biomass in the current study are three times higher than reported by Odum's work in 1957, but winter estimates were relatively similar, particularly in light of the differences in sampling methods. The current study indicates that benthic algal biomass rivals that of the epiphytic algal biomass.
- Insect emergence rates have apparently declined.
- The rate of floating plant export, which reflects the amount of plant growth in the springs has increased about three times since Odum's estimates.
- Particulate export (microscopic algae) has declined by about 72%.
- Species richness of fish and birds were similar to values from the 1950s, although changes in biomass of some fish species have occurred.
- Ecosystem metabolism has decreased significantly in the springs with lower gross primary productivity, community respiration, net production, and ecological efficiency.

Clearly, the ecological and chemical quality of Silver Springs water has changed in many ways since the 1950s and there has been a shift toward increased algae production. Final conclusions of the report will be made available in summer 2006.

G.G. Phelps of the U.S. Geological Survey completed a hydrogeologic baseline study in 1993. She investigated sources of contamination in this study and drew important conclusions concerning the hydrogeology of the springs. Phelps completed a second study of Silver Springs

in 2004. The latter study focused on water quality in the springs and within the ground water system that flows to the springs. Her two studies also clearly document the dramatic changes that are occurring in Silver Springs, but the most recent report included startling results – trace chemical indicators of human activity, including DEET, were widespread in ground water and in the springs. The presence of anthropogenic chemicals in ground water and spring discharge clearly demonstrate the linkage between the springs and human activities within the springshed and show that the way to protect Florida's springs must begin by managing the springshed to reduce ground water contamination.

Strategies

Land Use Planning. Because of the Phelps studies and an increasing awareness of the damage being done to Silver and Rainbow Springs, the Marion County Commission has undertaken establishment of spring protection zones for these two springs. This third major event in Silver Springs history will try to address development through the use of existing and new land-use, zoning, comprehensive planning, and other measures to reduce the loads of nutrients and other anthropogenic chemicals in ground water and the springs. The spring protection zones also account for flow in caves and caverns so that the effects of catastrophic pollutant releases to ground water will be minimized.

An action team of the Silver Springs Basin Working Group reviewed future stormwater management plans for State Roads 35 and 40 with the Florida Department of Transportation. They identified a major stormwater outfall that affects the Silver River, and local agencies and DOT are cooperating to create a major stormwater retrofit project in conjunction with Marion County's Phase II NPDES permit activities.

Land Management. Numerous water lettuce removal projects have been completed in cooperation with the Friends of Silver River, the Silver Springs Basin Working Group, and civic groups.

Land Acquisition. Two land acquisition applications to Florida Forever (the state land acquisition program) were sponsored by the Silver Springs Basin Working Group. One of the applications, the Seldin tract, was purchased by the State in June 2005 and is managed by the Marion County Parks and Recreation Department. It comprises 350 acres adjacent to Silver River State Park in close proximity to the headspring. The second application is for the purchase of the Avatar tract which has vested development rights for 8,000 lots on several thousand acres. This property includes areas where recharge to the aquifer is high and karst features making it a highly vulnerable area. To date no agreement has been reached on acquisition of the Avatar tract.

Working Group. Since 1999, the Silver Springs Basin Working Group has established a presence and focal point for local entities concerned with the long-term welfare of Silver Springs and Silver River. Activities have included developing a map display of recharge areas, advocating funding for ecological and nitrate-nitrogen studies, and coordinating and participating in numerous land use planning, management, and education programs.

Education & Outreach. The Florida Springs Initiative, in conjunction with the St. Johns River Water Management District, funded the production of exhibits and a short education video concerning Marion County's springs and the challenges that confront them. The Silver Springs Basin Working Group established an information library for the spring and its springshed within the Silver River Museum, held a business outreach event in 2001 entitled "Taking Care of Business" emphasizing the link between the condition of Silver Springs and tourism in the local economy, started an Old Timers Day event that brings long-term residents to the spring to share stories and relate valuable information about changes, and sponsored numerous boat trips on the Silver River for state legislators, their aides, and other elected officials. Other events held at the Museum and Attraction include the Marion Springs Festival and annual Earth Day programs.

Regulatory. In 2003, The University of Florida Levin Law School's Conservation Clinic worked with the Silver Springs Basin Working Group to draft legislation to protect the quality of Florida's springs. This work included drafting a model "Florida Springs Protection Act" and commentary. The project also included detailed analysis of existing Florida statutes and regulations relevant to protecting spring water quality such as those promulgated by the DEP, WMDs, DCA, and local land use planning agencies (see Appendix D). The resulting legislation was submitted during the 2005 session of the State legislature, however the legislation did not move forward during the session.

Table 2. Scientific and Environmental Timeline at Silver Springs.

Year	Event
1859	Early scientist John LeConte visits site. Calls it "The most remarkable and interesting phenomena presented by this spring, is the truly extraordinary transparency of the water...." (Sellards quote)
1883	Lady Duffus Hardy publishes *Down South* and describes spring system
1884	G.M. Barbour publishes *Florida for Tourists, Invalids, and Settlers,* which describes springs
1889	J.W. Davidson publishes *The Florida of Today* with descriptions of springs
1908	First *Florida Geological Survey Bulletin* by E.H. Sellards describes springs
1927	USGS hydrologist O.E. Meinzer describes spring as one of the largest in U.S.
1947	Florida Geological Survey publishes *Springs of Florida* (Bulletin 31)
1957	H.T. Odum publishes *Trophic structure and productivity of Silver Springs, Florida* (Ecological. Monographs 27:55-112)
1973	USGS hydrogeologist G.L. Faulkner first describe springshed (730 sq. mi.) and fracture flow to springs as part of Cross Florida Barge Canal study
1977	Florida Geological Survey publishes *Springs of Florida* (Bulletin 31 revised)
1993	USGS hydrogeologist G.G. Phelps publishes first comprehensive hydrogeologic study of springs
1993	Silver Springs cave map circulated by local cave divers
2002	FGS publishes *First Magnitude Springs of Florida* (Open File Report 85) as the first product of the Florida Springs Initiative
2003	St. Johns River Water Management District publishes *Springs of the St. Johns River Water Management District*

Year	Event
2004	Herring and Davis publish inventory of rare and endemic plants and animals in Silver Springs and River
2004	W.A. King publishes *Through the Looking Glass of Silver Springs: Tourism and the Politics of Vision* describing the evolution of the attraction and its societal implications
2004	USGS hydrogeologist G.G. Phelps publishes ground water quality study of springs and springshed
2004	Florida Geological Survey publishes *Springs of Florida* (Bulletin 66)
2005	Marion County publishes *Water Resources Assessment and Management Study: Water Resources Inventory and Analysis*, including an evaluation of resources near the springs
2005	Marion County Commission adopts resolution instructing staff to develop a Springs Protection Plan and associated actions
2005	*Marion County Springs Protection Program Report* published; springshed delineated through hydrogeologic analysis and ground water flow modeling
2006	SJRWMD and UF complete the Silver Springs 50-year Retrospective Study that documents changes in water quality and ecological diversity in springs.

* This conclusion applies only to major chemical constituents. See work by Phelps relative to trace constituents.

V. Strategies for Springs Protection & Restoration

The following five strategies represent the current consensus from experts and key stakeholders regarding what needs to be done to protect Florida's springs. The Florida Springs Task Force chose not to prioritize actions steps. Although this implies that all action steps are equally important, the order of the action steps within each strategy (and under each goal) generally indicates a logical order in which they need to be completed. Action steps marked with an asterisk (*) are new actions added since the 2000 Springs Report. An implementation table of all the strategies (including participants) can be found in Appendix H.

1. Education & Outreach Strategies

1.1. Education

Public sentiment is everything. With it nothing can fail. Without it nothing can succeed.
– Abraham Lincoln

Education is the most important springs protection strategy. Local officials can make informed decisions about land uses in springsheds if they understand the relationship between land uses within springsheds, their effects on ground water, and that the water quality from springs is a key indicator of the drinking water quality in a springshed. Homeowners, farmers, golf course managers, and public works officials will reduce their use of fertilizers if they understand the negative impacts of their actions. The successful resolution of many other threats to springs is dependent on the actions of an educated public.

Education can nurture citizens' appreciation of Florida's springs and bring about cooperation and voluntary compliance. Educational activities carried out on behalf of Wakulla, Silver, and Ichetucknee springs have resulted in substantial public support and increased protection. Education can build public support for land acquisition, restoration, and other protective actions for springs. With public support, lawmakers and policymakers are likely to provide funding that will benefit Florida's springs.

DEP Florida's Springs website, a project of the Florida Springs Initiative www.floridasprings.org

The public must be informed that Florida's springs are in trouble from human impacts. Individuals must also be able to make the connection between their own behaviors and the problems seen in springs, so that they are more likely to change those behaviors. Population growth in Florida means an ever-growing audience of people who need ongoing information about springs protection.

A positive message of hope must be delivered – we can protect Florida's springs if we work together. Communication of fundamental concepts is an important goal of a coordinated education program.

The following three major concepts must form the foundation of every Florida springs education program.

1. A spring and its ecosystem are only as healthy as its springshed.
2. Human activities within springsheds can and do have adverse impacts upon the quality and quantity of ground water, thereby affecting spring flow, water quality, and spring ecosystems.
3. Protection of water quality and quantity must occur in the springsheds before the water reaches the spring.

Since the program began, the Florida Springs Initiative (FSI) has made significant progress in the area of education. However, many of the action steps in this strategy remain critical to ongoing education programs. The FSI is now entering the next generation of education and outreach. A number of lessons regarding the effectiveness and long-term impact of education and outreach have been learned from first generation efforts. These lessons are guidelines for future education and outreach, including the following highlighted areas of need:

Springs Education in Schools – Unique natural places such as springs can play a major role in building interest in science among students. Springs science literacy must begin early and should be incorporated into formal learning settings. Partnerships between schools and state-managed springs for long-term, field-based environmental science programs can enrich science education in Florida, provide service learning opportunities for students, and build lasting support for stewardship of Florida's springs. We need to enhance the formal education process to build springs science literacy among the population.

Springshed Tours – Springshed tours are one of the most effective methods for education and outreach. The tours allow participants to physically see and experience the range of land use practices in the springshed, visit the critical points of ground water/surface water interaction, and meet the people who live, work, and play in the springshed.

Informing Public Officials – Prudent land use planning decisions can protect and improve water quality, quantity, and ecological resources of a springshed. Ongoing programs that inform local officials are needed. Workshops on springs protection strategies for public officials and local government should be held in counties and municipalities with significant springs resources. In addition, a locally specific educational presentation can inform decision makers about springs in their area and what practical policy components will best protect their springs.

Public Awareness Projects – Public awareness projects reach a broad and continually growing audience with important messages. Additional projects that are needed to deliver these messages regularly include media kits to target and create press coverage, a distribution plan to provide central access to springs resource educational materials, and a dedicated webmaster for the Florida Springs website to provide timely updates to this dynamic teaching tool.

Interpretive Programs Specific to Springs in Parks – In most parks with large springs, the spring is a dramatic feature or focal point. Development and implementation of interpretive programs specific to spring resources can increase visitors knowledge of springs issues and protection strategies as well as build support for stewardship of Florida's springs. Glass-bottom boat tours and interpretive programs should be designed to examine issues related to the spring and its connection to the springshed. Focused interpretive programs, which include person-to-person interactions, guided walks, etc., are needed at parks with springs.

Action Steps for Education

Education action steps are organized by target audience: homeowners, general public, students, visitors to public springs, and local government. Action steps that specifically address business and industry leaders (including planners, developers, and farmers) can be found in section 1.2 Spring Basin Working Groups and section 3. Land Use Planning & Management Strategies.

➢ Goal: Educate homeowners and associated groups

1.1.1. Educate homeowners and associated groups (homeowners associations, consumers, landscape and lawn care companies, garden clubs) on fertilizer best management practices, including slow-release, no fertilizer, and other alternatives for residential lawns and gardens.

Status: Ongoing. The booklet *What You Need to Know About Fertilizing and Watering Your Lawn and Landscape to Protect Florida's Springs* educates homeowners about best management practices for lawn care. Developed by the Nutrient Remediation Workgroup through the SWFWMD with some FSI funding, this booklet is available in both print and PDF format (see Appendix D).

Next Steps: The booklet may be more technical than necessary to meet homeowners' needs (see Actions 1.1.2 and 1.1.4 for suggested next steps).

1.1.2. *Develop a user-friendly version of the booklet, *What You Need to Know About Fertilizing and Watering Your Lawn and Landscape to Protect Florida's Springs,* to meet the needs of homeowner use.

Status: New Action. As noted in Action step 1.1.1, this booklet may be more technical than necessary to meet homeowners' needs.

Next Steps: Update and revise as needed to meet the needs of the homeowner audience. The format needs to be Florida springs specific and simple and inexpensive to produce.

1.1.3. *Fund the DEP Spring Ambassador Program to educate homeowners (including large landowners) in springsheds about threats to the springs and what they can do to protect springs.

Status: Ongoing. Spring Ambassadors were employed for Ichetucknee, Wakulla, Jackson Blue, and Manatee springs. Only Manatee and Wakulla springs still have ambassadors.

Next Steps: Ambassadors are needed for Ichetucknee, Volusia Blue, and Jackson Blue springs. This is a very effective program that should be expanded.

1.1.4. *Coordinate with the Florida Yards and Neighborhoods program to design effective strategies to reach homeowners with springs information, including providing resources and support for existing programs, and providing resources to Spring Ambassadors.

Status: New Action. Similar water conservation programs can be integrated into springs protection efforts to maximize success.

Next Steps: Produce and distribute leaflets and brochures from other education efforts. For example, WMDs have long-term water conservation education efforts with similar audiences and messages for preserving ground water. The focus should be on springs. Make this information available on DEP and agency websites.

➢ Goal: Educate the public about springs protection

1.1.5. Conduct an aggressive public education program on the benefits of water conservation.

Status: Ongoing. SWFWMD and SJRWMD have educational water conservation programs in place.

Next Steps: Implement similar programs throughout the state. Encourage the establishment and enhance the effectiveness of community education and outreach programs, especially using models such as the National Groundwater Foundation's Groundwater Guardian Program.

1.1.6. Fund the production of a high-quality, made-for-television video to educate Floridians about the values, function, and protection needs of springs. Produce an updated version every five years.

Status: Achieved – Needs Update. *Water's Journey: The Hidden Rivers of Florida*, a high quality, video/DVD (~60 minutes) was partially funded by the FSI and produced in 2003. The film was broadcast statewide on PBS in October 2003, and nationwide beginning in November 2003. It has also aired at many conferences and professional and civic organization meetings. Other videos have been developed (such as *Protecting Florida Springs*) that are of shorter length and were distributed for educational purposes.

Next Steps: Continue to use and distribute these videos. Encourage and provide funding support for the production of other related videos that highlight specific topics/issues related to springs. Some of these videos should be of different lengths so they can be used in a variety of ways.

1.1.7. Compile and publish an update to the 1977 *Florida Geological Survey's Geological Bulletin No. 31 Revised, Springs of Florida*.

Status: Achieved – Needs Update. *Springs of Florida Bulletin No. 66* (the update to FGS Bulletin No. 31 Revised) is an up-to-date database of 463 springs, which includes water quality and discharge data for Florida's 33 first magnitude springs and other selected springs. The bulletin was produced and published by the FGS in 2004. The document is available online (see Appendix D). Other FGS publications are available, including *First Magnitude Springs* 2002 (OFR-85) and F*lorida Spring Classification and Glossary* 2003 (SP 52).

Next Steps: Continue to update the online database on a regular basis as new data are collected. Process and report data in a timely fashion.

1.1.8. Provide and publicize user-friendly, online information about springs and the issues that threaten them.

Status: Achieved – Needs Update. The Florida Springs website and the interactive Wakulla Springs feature are state-of-the-art productions funded by the FSI. The website includes four classroom activities for K-12 students. Another FSI funded website project addresses Florida-Friendly Landscaping. See Appendix D for website addresses.

Next Steps: Provide funding for a dedicated Webmaster for the Florida Springs website to provide timely updates to this dynamic teaching tool.

1.1.9. *Provide user-friendly stand-alone graphs based on available data to illustrate discharge and water quality trends and make them available online.

Status: New Action.

Next Steps: These graphs should be stand-alone graphics that can be used in slide presentations, exhibits, etc., to make FGS data accessible in a user-friendly format. Long-term (30-60 year) rainfall patterns should be included with this issue, as misinterpretation of spring flow data may occur without considering the multi-decadal oscillations in rain and stream flow.

1.1.10. Generate periodic "Springs Condition Index" depicting relative water quality trends (current and future).

Status: Ongoing. The Springs Report Card was being developed for 33 first magnitude springs but later evolved into a trend analysis and stream condition index. The FSI continues to collect water quality data to be utilized in creating trend analyses.

Next Steps: Develop a "springs condition index" for large publicly owned springs, not just first magnitude springs. Include springsheds and spring runs. The parameters should show areas where improvement can be made through protection and restoration strategies. Post on bulletin boards at springs.

1.1.11. *Develop materials that interpret and explain TMDLs and MFLs in a way that can be readily understood by the public.

Status: New Action. Where available, WMDs are currently providing MFL data in monthly reports that are available on their websites. However, the reports lack interpretation and context, thus the data alone may be misinterpreted.

Next Steps: Provide explanation, interpretation, and context for MFLs and TMDLs so that the public can understand what the data means for springs. This should be in a format (such as online or in a brochure) that is easily referred to in other documents. (See also Regulation Action Step 4.2.2.)

1.1.12. Conduct a Florida Springs Conference at three-year intervals.

Status: Ongoing. A Florida Springs Conference was held in 2000 and 2003, and both were coordinated by DEP.

Next Steps: Another conference is being planned for Spring 2007. FSI will seek a conference organizer.

1.1.13. Erect signs within springsheds with the name of the springshed on it to raise awareness of the geographic location of these springsheds.

Status: Ongoing. Springshed road signs have been installed on state, federal, and county roads that cross the springsheds of Wakulla, Wekiwa, Ichetucknee, Volusia Blue, and Jackson Blue springsheds. Projects are underway for Manatee and Fanning springsheds. The original wording suggested for the signs in the 2000 report was revised to be simple and easy to read from a traveling vehicle.

Next Steps: Needs to be done for other major springs.

1.1.14. *Develop media kits to create opportunities for interviews and appearances by spring specialists, should include PSAs and Press Releases.

Status: New Action. Public appearances have taken place in Lake City for Ichetucknee Springs, in Tallahassee for Wakulla Spring, and in Marianna for Jackson Blue Spring. Nestles funded a Public Service Announcement (PSA) about lawn care in springsheds. Radio and TV appearances on talk programs reach thousands of people.

Next Steps: Develop two media packets: one for general springs issues that can be used statewide, and one specifically for major springs. Information should be obtained from appropriate spring specialists. Specific, beneficial, and technically valid actions need to be identified for these PSAs, such as "Top 5 ways to improve or protect this spring." Messages also need to be consistent.

1.1.15. *Develop a distribution plan to provide central access to springs resource educational materials.

Status: New Action.

Next Steps: This plan should include a central clearinghouse such as an online catalogue. An inventory of existing stock is needed.

➢ Goal: Educate students about springs

1.1.16. *Conduct environmental science literacy programs (such as enrichment programs and service learning projects) as part of the statewide Learning in Florida's Environment Program (LIFE) coordinated by the DEP Office of Environmental Education.

Status: Ongoing. Two programs are underway. The Ichetucknee Springs Parknership builds on the existing Parknership between Ft. White High School and Ichetucknee Springs State Park and targets students and teachers. The Office of Environmental Education and Wakulla Springs State Park have implemented the Wakulla Springs Service Learning Project in conjunction with the Riversprings Middle School's Service Learning Project in collaboration with UF-IFAS Leon and Wakulla county extension offices.

Next Steps: Additional programs are needed in other areas.

1.1.17. Develop and conduct field trips and classroom presentations.

Status: Ongoing. The FSI funds and conducts field trips to educate students about springs in association with the DEP Office of Environmental Education as part of the two LIFE programs mentioned in Action Step 1.1.16.

Next Steps: Coordinate with other environmental education programs. Encourage and provide support for local groups and science teachers who have developed their own programs. Include classroom appearances by springs specialists. Agencies can provide field experiences and presentations for schools and other youth groups.

1.1.18. *Develop a Florida Springs Curriculum.

Status: Ongoing. Under Development by the Northeast Florida Education Consortium, the *Florida Springs Curriculum* is an interdisciplinary unit that is designed for use in middle schools. A draft version has been completed and is being tested by teachers in 2005. The curriculum will be ready for the 2006-07 school year.

Next Steps: Create a distribution system. Include existing literature and other springs education materials in the curriculum package for teachers.

➢ Goal: Educate visitors about threats to and protection strategies for public springs

1.1.19. *Install outdoor exhibits at springs parks.

Status: Ongoing. Outdoor exhibits have been installed to educate visitors about spring protection at 24 state, federal, county, and private spring parks.

Next Steps: Add and maintain exhibits as needed. Continue to look for interpretive opportunities as needed, such as exhibits that show conduits that are under park grounds.

1.1.20. *Conduct springshed interpretive programs for visitors to state parks.

Status: Area of Need. Few are scheduled at this time.

Next Steps: Springshed interpretive programs should be routinely scheduled and conducted for visitors to state parks with springs. Programs should include information on the springshed. Park rangers should be trained to conduct these programs.

➢ Goal: Inform local government

1.1.21. Develop a booklet that provides land use planning guidance to local governments and enables them to identify and plan for the protection of springsheds.

Status: Achieved – Needs Update. The manual *Protecting Florida's Springs: Land Use Planning Strategies and Best Management Practices* was produced in 2002 by the Department of Community Affairs and funded by FSI. It was distributed to planners and developers and is also available online. It provides tools to protect springs through land use planning and development standards as part of the Comprehensive Plan process (see 3. Land Use Planning & Management Strategies).

Next Steps: This manual needs to be updated in 2007 after continued refinement through programs such as the Model Land Development Code program.

1.1.22. *Develop tools to keep local government officials and inter and intra government agencies periodically informed of FSI programs.

Status: New Action. This has been done informally in the past. Some local governments and local agency offices are not familiar with the FSI.

Next Steps: This should include program specific information on the FSI for local governments (county and municipal) and agency district offices (DEP, FWC, etc). Include a county specific educational presentation that can be given to County Commissioners and other local government officials to inform them about springs in their area.

1.1.23. Conduct workshops on springs protection strategies for local government elected officials and staff in each county with springs and/or in a springshed.

Status: Ongoing. Local Government Springs Workshops have been conducted by FSI staff, NWFWMD, Hillsborough County Utilities, and the Santa Fe and Silver Springs Basin Working Groups in 6 counties. The FSTF and FSI continue to conduct meetings and provide field trips for elected officials and staff to discuss protection strategies.

Next Steps: Workshops need to be conducted or repeated for the counties located within springs areas (see Figure 1, page 82). Workshops should be coordinated with county and municipal programs where appropriate (including Utilities, Groundwater Guardians, etc.) and should address elected officials, agency staff, regional planning councils, leadership groups, and others. A series of PowerPoint presentations should be specifically designed to educate these groups and included in the workshops.

1.1.24. *Fund and implement a reporting procedure for current springs information to provide springs specialists with access to research results, monitoring projects, protection successes, threats, new regulations, recently acquired lands, etc.

Status: New Action. There is currently no networking or communication process that keeps springs specialists up to date.

Next Steps: Develop a communication process such as an Internet wiki, forum, or message board, or a monthly newsletter.

1.2. Spring Basin Working Groups

Places need keepers – people who know how things are changing, whether from bad to good, or vice versa. People who have their eyes on the place and their hearts in it. The land itself needs people who know it, care about it, keep track of it, and work on its behalf. – Scott Russell Sanders, author and essayist

Participation by spring stakeholders is imperative for effective spring protection. No single government agency has the authority or resources required to provide adequate protection for a spring. Stakeholder groups are the most effective means of bringing together the experts and responsible agencies to share information about the springshed, identify threats to the waters flowing to the springs, and develop and implement solutions to overcome the threats. Effective working groups are composed of federal, state, and local government agencies and private sector stakeholders having information or responsibilities concerning the function of the springshed.

The Santa Fe Springs Working Group discussing protection of the waters flowing to Poe, Gilchrist Blue, and Ginnie springs.

Important non-governmental stakeholders include agricultural, development and commercial interests, and environmental organizations, non-profit groups, and citizens. One key to the success of these basin working groups is the selection of a coordinator who is able to guide and unite the diverse interests in the springshed to achieve springs protection successes. It is also critical that stakeholder representatives actively collaborate on tasks and support state level actions.

Important working group coordinator activities include:

1. Identify and maintain a contact list of springshed stakeholders.
2. Compile, present, and distribute springshed maps and reports.
3. Identify threats to the ground water in the springshed.
4. Plan and facilitate working group meetings of stakeholders within the springshed.
5. Organize and conduct a spring "Old Timers Day" and/or "Spring Appreciation Day" for each springshed on an annual basis.
6. Support land acquisition efforts in the springshed by providing guidance to the DEP acquisition staff.
7. Identify Springs Champions to receive Florida Springs Task Force awards.
8. Identify research and monitoring projects underway and projects needed within the springshed.
9. Conduct field trips of the springshed.
10. Give presentations to the public and organizations in the springshed.
11. Work to develop trust and rapport with community leaders, including the city manager, county manager, county commissioners, business leaders, agency heads, etc.

Every spring does not need a working group, but most major springs or spring groups with large springsheds can benefit from this process. In rural areas there may not be enough stakeholders to form the critical mass necessary for a successful working group, and a Spring Ambassador effort (see Action Step 1.1.3) or a regional working group may be more effective. In addition, some areas benefit from having both an ambassador and a working group (i.e., Wakulla). Ongoing working groups are acting on behalf of Wakulla Spring, Ichetucknee Springs, Silver Springs, and springs of the lower Santa Fe River.

Action Steps for Spring Basin Working Groups

- **Goal: Form and support working groups to protect major springs and spring groups**

1.2.1. Fund coordination of spring basin working groups and dedicate DEP staff time to this effort.

Status: Ongoing. Basin working group coordination is underway and funded by FSI for Wakulla, Ichetucknee, Silver, and lower Santa Fe River springsheds. Currently there are two working group coordinators. DEP staff work closely with the coordinators.

Next Steps: Additional working groups are needed, such as at Rainbow Springs, Volusia Blue Spring, and Jackson Blue Spring. FSI staff should attend and/or observe meetings at least once per year to get input on local issues and identify similarities statewide.

1.2.2. Provide technical assistance and training in support of the formation and facilitation of working groups.

Status: Ongoing. Current working group coordinators are adequately trained.

Next Steps: Create a formal training program to train new working group coordinators. Provide or ensure consistent training for all working group coordinators. Maintain a list of agency contacts for technical assistance and participation in working group activities (such as giving presentations).

1.2.3. *Provide formal opportunities for working groups to share information and success stories, such as a session or round table discussion at the Springs Conference or other events.

Status: New Action. At this time, this occurs only informally at water resource related gatherings.

Next Steps: This should also include Spring Ambassadors. A session can also inform stakeholders.

Implementation Table – Education & Outreach Strategies

Action Number	Action Description	Status	Participants
1. Education & Outreach Strategies			
1.1. Education			
Goal: Educate homeowners and associated groups			
1.1.1	Educate homeowners and associated groups (homeowners associations, consumers, landscape and lawn care companies, garden clubs) on fertilizer best management practices, including slow-release, no fertilizer, and other alternatives for residential lawns and gardens.	Ongoing	DEP, FYN, NGO
1.1.2	*Develop a user-friendly version of the booklet, *What You Need to Know About Fertilizing and Watering Your Lawn and Landscape to Protect Florida's Springs*, to meet the needs of homeowner use.	New Action	DEP, FYN
1.1.3	*Fund the DEP Spring Ambassador Program to educate homeowners (including large landowners) in springsheds about threats to the springs and what they can do to protect springs.	Ongoing	DEP
1.1.4	*Coordinate with the Florida Yards and Neighborhoods program to design effective strategies to reach homeowners with springs information, including providing resources and support for existing programs, and providing resources to Spring Ambassadors.	New Action	DEP, FYN, WMD
Goal: Educate the public about springs protection			
1.1.5	Conduct an aggressive public education program on the benefits of water conservation.	Ongoing	DEP, WMD, Utility, Private, NGO
1.1.6	Fund the production of a high-quality, made-for-television video to educate Floridians about the values, function, and protection needs of springs. Produce an updated version every five years.	Achieved – Needs Update	DEP, Private
1.1.7	Compile and publish an update to the 1977 Florida Geological Survey's *Geological Bulletin No. 31 Revised, Springs of Florida*.	Achieved – Needs Update	DEP, FGS
1.1.8	Provide and publicize user-friendly, online information about springs and the issues that threaten them.	Achieved – Needs Update	DEP, NGO
1.1.9	*Provide user-friendly stand-alone graphs based on available data to illustrate discharge and water quality trends and make them available online.	New Action	DEP, FGS
1.1.10	Generate periodic "Springs Condition Index" depicting relative water quality trends (current and future).	Ongoing	DEP
1.1.11	*Develop materials that interpret and explain TMDLs and MFLs in a way that can be	New Action	DEP

Action Number	Action Description	Status	Participants
	readily understood by the public.		
1.1.12	Conduct a Florida Springs Conference at three-year intervals.	Ongoing	DEP, NGO
1.1.13	Erect signs within springsheds with the name of the springshed on it to raise awareness of the geographic location of these springsheds.	Ongoing	DEP, DOT
1.1.14	*Develop media kits to create opportunities for interviews and appearances by spring specialists, should include PSAs and Press Releases.	New Action	DEP
1.1.15	*Develop a distribution plan to provide central access to springs resource educational materials.	New Action	DEP
Goal: Educate students about springs.			
1.1.16	*Conduct environmental science literacy programs (such as enrichment programs and service learning projects) as part of the statewide Learning in Florida's Environment Program (LIFE) coordinated by the DEP Office of Environmental Education.	Ongoing	DEP, State Park, School, Extension
1.1.17	Develop and conduct field trips and classroom presentations.	Ongoing	DEP, FGS, State Park, School, Extension, NGO
1.1.18	*Develop a Florida Springs Curriculum.	Ongoing	DEP, NGO
Goal: Educate visitors about threats to and protection strategies for public springs.			
1.1.19	*Install outdoor exhibits at springs parks.	Ongoing	DEP, State Park, County Park, Private Park
1.1.20	*Conduct springshed interpretive programs for visitors to state parks.	Area of Need	State Park, County Park, Private Park
Goal: Inform local government			
1.1.21	Develop a booklet that provides land use planning guidance to local governments and enables them to identify and plan for the protection of springsheds.	Achieved – Needs Update	DCA
1.1.22	*Develop tools to keep local government officials and inter and intra government agencies periodically informed of FSI programs.	New Action	DEP
1.1.23	Conduct workshops on springs protection strategies for local government elected officials and staff in each county with springs and/or in a springshed.	Ongoing	DEP, WMD, Utility, Local Gov't
1.1.24	*Fund and implement a reporting procedure for current springs information to provide springs specialists with access to research results, monitoring projects, protection successes, threats, new regulations, recently acquired lands, etc.	New Action	DEP

Action Number	Action Description	Status	Participants
1.2. Spring Basin Working Groups			
Goal: Form and support working groups to protect major springs and spring groups.			
1.2.1	Fund coordination of spring basin working groups and dedicate DEP staff time to this effort.	Ongoing	DEP
1.2.2	Provide technical assistance and training in support of the formation and facilitation of working groups.	Ongoing	DEP
1.2.3	*Provide formal opportunities for working groups to share information and success stories, such as a session or round table discussion at the Springs Conference or other events.	New Action	DEP

*New action added since the 2000 Springs Report.
Note: See Appendix H for a list of participants referenced in this table.

2. Research & Monitoring Strategies

2.1. Research

The pursuit of truth shall set you free – even if you never catch up with it. – Clarence Darrow

Florida's population is increasing by nearly 1000 new residents every day and demand for water resources is increasing.[21] The impacts of human activities on the land are complicated by Florida's karst setting. Since the formation of the Florida Springs Initiative (FSI), 44 research and monitoring projects have been initiated (see Appendix A). Although these projects have provided new insights, many important questions remain unanswered. For example, much is unknown about how surface water and ground water interact in springsheds. In order to fully understand these systems, scientific research is needed. Important questions can only be answered through carefully designed scientific research projects. These questions define the long-term research and monitoring program and fall into four broadly defined areas.

1. Hydrogeology & Spring Flow: What factors consume water from and contribute water to Florida's springs?
2. Water Quality: What are the origins, dynamics and effects of contaminants, including nitrogen and other nutrients, on Florida's springs systems?
3. Biological Systems: What are the impacts of changing water quality and quantity on the natural communities and species occurring within spring systems?
4. Protection Management & Engineering: What are the most effective management and engineering solutions to protect springs?

Locating subsurface conduits with radio telemetry and cave divers, Manatee Spring. Wells were installed into three conduits utilizing this technology to better monitor water quality and discharge at Manatee Spring. Photo by: Harley Means, FGS

The action steps presented in the following sections (Research, Monitoring, and Support) can be seen as a 5-year plan for Research & Monitoring Strategies. A detailed list of questions for each of these areas is included in Table 3. The knowledge gained by investigating these questions will lead to the continued development of efficient protection strategies for Florida's springs.

Table 3. Research & Monitoring Questions.

Hydrogeology & Spring Flow Questions
▪ What physical and geological characteristics control mixing of ground and surface water in Florida karst systems?
▪ How much surface water is entering the aquifer through swallets in springs areas?
▪ How does water from different sources mix within the aquifer?
▪ How does mixing influence spring water quality and quantity?
▪ What is the travel path and travel time of water as it moves through the aquifer to the springs?
▪ What are the long-term effects of ground water use on springs?
▪ How does climate variability affect spring water quality and quantity?
▪ What are the most reliable methods for delineating springsheds?
▪ How do springsheds change in response to rainfall and climate?
▪ What criteria and methods do we use to develop effective MFLs for springs (as compared to methods used for surface water bodies)?
▪ How do anthropogenic contaminants interact with aquifer rocks, confining units, and overburden?
▪ How are human activities affected by reductions in spring flows?
Water Quality Questions
▪ What are potential and existing pollutants in spring water?
▪ What are the origins of nutrients (natural and anthropogenic) that discharge from springs?
▪ By what pathways do nutrients enter spring water?
▪ How does water withdrawal change the water quality at the source of water?
▪ What are the causes and effects of salinity increases in springs systems?
▪ How do water withdrawals alter flow within the aquifer, allowing lower quality water in other parts of the aquifer to move in and impact spring water quality?
▪ What effect does water coming up from deep in the aquifer system have on long-term changes in spring chemistry?
▪ How is spring water quality affected by natural processes such as normal climate variation and seasonal change?
▪ What criteria should be used to determine springs systems as Impaired Waters?
▪ How does ground water discharge from springs affect surface water quality?
▪ Are water quality measures, such as TMDLs, effectively protecting water quality?
▪ How are human activities affected by reduced water quality?
Biological Systems Questions
▪ What are the current ecological conditions of spring systems?
▪ What are the links between human actions and adverse biological responses?

▪ What are the limiting nutrients (nitrate-nitrogen or phosphate) in individual springs?
▪ What effects do excess nutrients have on spring ecosystems?
▪ What is the structure of the food web in springs ecosystems?
▪ Can excess nitrogen be tolerated by spring ecosystems?
▪ What effects do contaminants have on spring ecosystems and their constituent elements?
▪ What are the distributions of spring/cave/estuary plants and animals?
▪ What populations are considered threatened or endangered?
▪ What assessment tools can be used to determine adverse impacts from human activities?
▪ What assessment tools can be used to measure responses to attempts at restoration of the springs' ecology?
▪ What are the most sensitive indicator species that can provide information on degradation of water quality in springs?
▪ What are the effects of exotic, invasive, and nuisance species (including algae) on springs ecosystems?
▪ Are ecological conditions in springs systems changing?
▪ What are the native species diversity / biomass ratios of healthy Florida springs?
▪ Are the critical, functional roles of springs for individual species and natural communities viable? (e.g., warm season cold-water refuges for striped bass)
Protection Management & Engineering Questions
▪ What human activities impact springs the most?
▪ What are the best management and engineering strategies to protect springs?
▪ Do the current strategies work?
▪ What is the best way to assess the effectiveness of engineering strategies?
▪ What portions of springsheds need to be protected, and how can they be protected?
▪ How can land use practices and BMPs be improved to minimize adverse effects on springs?

Notes: This is not an all inclusive list. The term "springs areas" refers to the areas in Figure 1 (page 82).

Action Steps for Research

➢ Goal: Improve understanding of hydrogeology and flow of springs

2.1.1. Delineate springsheds for all of Florida's first magnitude and other selected springs through mapping (cave diving exploration), dye studies, and other means and include the fluctuation in boundaries due to natural and anthropogenic variations in recharge.

Status: Ongoing. Springsheds have been delineated for the following springs: Volusia Blue Spring, Gainer Springs Group, Wakulla Spring, Jackson Blue Spring, Alexander Spring, Silver Springs Group, Silver Glen Springs, Rainbow Springs Group, King's Bay Springs Group, Homosassa Springs Group, Chassahowitzka Springs, Weeki Wachee Springs, Madison Blue Spring, Troy Spring, Ichetucknee Springs Group, Fanning Spring and Manatee Spring. Springshed boundaries fluctuate with variation in recharge and human factors. It is important to identify the fluctuations and related changes and methodology because ground water delineation is different than surface water delineation.

Next Steps: DEP should coordinate with WMDs to prepare a schedule for delineation of priority springs throughout the state. Springshed delineation is currently in progress and needs to be completed for the following springs: Wacissa Spring Group, Lime Run, Lafayette Blue, St. Marks Rise, Morrison Spring, and a number of others on the middle Suwannee River. Additional springs that need delineation include: Spring Creek Springs Group, Santa Fe Spring, Tree House Spring, Columbia Spring, Hornsby Spring, Devil's Ear Spring, Devil's Eye Spring, July Spring, and others as needed.

2.1.2. Conduct hydrogeologic investigations to determine the relationships between ground water levels and spring flows.

Status: Ongoing. State and federal agencies are working on research that will describe the relationship between ground water levels and spring flows.

2.1.3. *Assess spring runs to identify factors (siltation, damming, trash, etc.) that may impair spring flows and access.

Status: New Action. Many springs and spring runs have been intentionally or unintentionally altered to promote recreation, discourage access, etc. When runs are dammed or disrupted through these actions, flows are altered and natural systems are disrupted.

Next Steps: Spring runs should be evaluated to identify these factors and the extent to which they impair natural systems.

2.1.4. *Statistically analyze the existing water level and flow data to detect the presence of trends.

Status: New Action. Water level data has been collected from an established network of monitoring wells (see action 2.3.2) and now needs to be analyzed. WMDs and others have completed some analyses for other efforts on wells located in springsheds.

Next Steps: Obtain trend studies previously completed by WMDs and others. Synthesize these into the springs research initiatives and post them on the DEP Springs website. Identify and assign wells to respective springsheds. Identify wells that are used for determining spring flow through regression analysis.

2.1.5. *Identify and develop data sets to determine historic flow and ground water level baselines.

Status: New Action. Historic baselines give a long-term perspective that is sometimes necessary to help understand why spring flow and ground water levels have declined.

Next Steps: Identify and develop reliable data sets, then collect data and set baselines.

2.1.6. *Identify improved methods of gaging flow, especially with estavelles.

Status: New Action. AVM (acoustic velocity meter) gauges work well in rivers, but do not work as well in springs because the water is clear. SJRWMD has a project with USGS to evaluate indirect methods of estimating spring flow from wells.

Next Steps: Support continued measurement of spring flow and investigate ways of improving methods. Include discharge measurements at 2nd magnitude springs not currently being measured. Identify where data is needed and how much data is needed.

2.1.7. *Identify relationships between spring flow and protected, rare, endemic, and managed species in spring systems.

Status: New Action.

Next Steps: Studies should be designed to assess interrelationships between these species and spring flows.

2.1.8. *Identify the relationship between spring flow and non-consumptive uses (including recreation and aesthetics).

Status: New Action.

Next Steps: Studies should be developed to assess the importance of spring flow to recreational users (e.g., swimmers, divers, site-seers) and to assess how changes in spring flow affects aesthetic values.

2.1.9. *Identify the geological characteristics and human factors affecting and controlling the mixing of surface water and ground water and the mixing of differing ground water sources to determine impacts on spring water quality and quantity.

Status: New Action. This applies to river sink and rise systems such as the Santa Fe River at O'Leno State Park.

➢ Goal: Conduct water quality research

2.1.10. Design an analyte list for each spring based on information generated by the survey of land uses within the springshed.

Status: Achieved. A standardized analyte list for all major springs is currently in use (Appendix E). This analyte list includes field analytes, major ions, nutrients, and bacteriological analytes (trace metals were also analyzed in previous years). Individual analyte lists are prepared based on compounds found at individual springs.

Next Steps: Review trend analysis to determine if analytes need to be added or dropped. The addition of customized analytes for each spring should be considered on a case-by-case basis.

2.1.11. *Identify anthropogenic compounds present in springs systems.

Status: New Action. See Appendix E for a Table of Analytes sampled for in spring water monitoring. While nitrate-nitrogen has received research focus, phosphorus requires attention as well. Wekiva River and Rock Springs both exhibit total phosphorus levels considerably higher than reference systems such as Alexander and Juniper springs. Jan Stevenson's work for DEP found that algal production in 56% of the 28 springs sampled were phosphorus limited.

Next Steps: Develop methods for determining naturally derived phosphorus from anthropogenic. Include a phosphorus binding capacity study in a karst area that will answer the question, "At what point is the ability of the soils and geology to bind phosphorus overwhelmed by phosphorus loading?"

2.1.12. *Facilitate research into the effects of anthropogenic compounds (including pesticides, pharmaceuticals, endocrine disrupters, etc.) on spring systems.

Status: New Action. USGS has conducted some work, but more work needs to be done.

Next Steps: Anthropogenic compounds found in spring systems should be evaluated to assess their effect on spring systems.

2.1.13. *Develop mapping criteria that identify specific land use activities that impact springshed water quality and quantity.

Status: New Action. Department of Revenue land use classification mapping is not at the level of detail to meet this criteria. In addition, much of the data is not digital.

Next Steps: This should be a coordinated effort with all agencies, including local governments, RPCs, DCA, DEP, and DOT.

2.1.14. Characterize how land use affects water quality in relationship to aquifer vulnerability.

Status: Ongoing. Initial land use mapping (which is below the level of detail required, see Action Step 2.1.13) has been done for the following springsheds: Volusia Blue Spring, Gainer Springs Group, Wakulla Spring, Rainbow Springs Group, King's Bay Springs Group, Homosassa Springs Group, Chassahowitzka Springs, Weeki Wachee Springs, Jackson Blue Spring, Madison Blue Spring, Troy Spring, Ichetucknee Springs

Group, Fanning Spring, and Manatee Spring. The statewide Florida Aquifer Vulnerability Assessment (FAVA) is complete and under preparation for publication. The FAVA project produces maps that predict the relative vulnerability of Florida's principal aquifers to surface sources of pollution. A FAVA-type study has been completed and published for the Wekiva Study Area. FAVA II, which includes refinements of the statewide FAVA maps for the Surficial Aquifer System, the Intermediate Aquifer System and the Floridan Aquifer System, will produce aquifer vulnerability maps of sub-regional aquifers, such as the Biscayne Aquifer and the Sand and Gravel Aquifer. Three county-scale FAVA-type maps will also be developed for Citrus, Levy, and Wakulla counties, all of which contain numerous springs and therefore springsheds. The sub-regional and county-scale assessments produce more detailed FAVA-type maps as compared to the statewide maps.

Next Steps: Conduct analysis of connectivity between FAVA mapping and Land Use mapping. In addition, land use maps need to be updated on a 5 year cycle because land use is constantly changing. State agencies (in coordination with each other) should develop a funding and staffing strategy to establish a statewide GIS land use coverage for 2004 and a protocol for update of the GIS coverage of land use on a five year cycle.

2.1.15. Identify and investigate water quality problems detected through monitoring, which may vary considerably from spring to spring, based on each individual case.

Status: Ongoing. Funded projects falling under this general category include: study to determine average residence times of ground water discharging from springs; quality of ground water in Silver Springs springshed with an emphasis on the occurrence and distribution of nitrate-nitrogen; hydrogeology of O'Leno State Park and its relationship to ground water contamination and nutrient discharge from three first magnitude springs; and upper Floridan Aquifer System nutrient monitoring.

Next Steps: The following research steps need to be employed: 1) Document/confirm extent of water quality problem (may include confirmation re-sampling); 2) Investigate to determine possible sources (point or non-point); 2a) Point – confirm point source(s) through water tracing; 2b) Non-point – determine land use patterns/density might be contributing to the problem. (See action steps in Regulatory Strategies for regulatory methods to address water quality problems.)

2.1.16. Identify indicator species best suited to determining potential water quality problems.

Status: Ongoing. Emerging research indicates that nitrate-nitrogen and other anthropogenic chemicals in springs may be having toxic effects on spring plants and animals.

Next Steps: Additional obligate species should be used as indicator species to monitor springs water quality. Specifically, the relationship between nutrients and productivity in these species should be evaluated.

2.1.17. *Identify relationships between water quality and protected, rare, endemic, and managed species in spring systems.

Status: New Action.

2.1.18. *Determine relationship between water chemistry and system ecology.

Status: Ongoing. Degradation of water quality can adversely affect springs plants and animals. The overwhelming water quality issue observed through routine water sampling in springs involves elevated nitrate-nitrogen levels. DEP and WMDs need to understand relationships between nutrient concentrations and attributes of algal and vascular plants in springs to better manage nutrient loading and maintain the ecological integrity of Florida springs. Research to determine these relationships is underway, but due to the complexity surrounding this issue, additional research is needed. .

Next Steps: Employ an adaptive management approach by learning from current research and formulating future research needs. Springs should be sampled for the full suite of parameters for which there exist water quality concerns (including metals, pesticides, and other organic pollutants, etc.) to better assess other adverse water quality issues

2.1.19. *Identify the relationship between spring water quality and non-consumptive uses (including recreation and aesthetics).

Status: New Action.

Next Steps: Studies should be developed to assess the importance of water quality to recreational users (e.g., swimmers, divers, site-seers) and to assess how changes in water quality affect aesthetic values.

➢ Goal: Improve understanding of springs ecology

2.1.20. *Develop methodologies for assessing the condition of biotic systems in spring systems, and enhance to include assessment of restoration efforts.

Status: New Action. Spring systems support numerous biological communities, including bacteria, algae, vascular plants, invertebrates, and vertebrates (such as reptiles and fish). To be useful for resource management decisions, it is important to identify attributes of biological community structure and function (called metrics) which consistently respond to adverse human influences. DEP has developed benthic invertebrate-based bioassessment methods for streams and rivers, known as the Stream Condition Index. Methods for evaluating attached algae communities are currently underway. Recently developed methods using vascular plants in lakes are amenable to adaptation in springs systems. However, quantitative methods for vertebrates are less well developed.

Next Steps: Coordinate with the DEP Biocriteria Committee to utilize bioassessment methods applicable to springs as they are developed, and consider developing methods for vertebrate communities not currently investigated. Effective assessments of each of these biological communities must involve the use of standardized methods capable of producing data with acceptable precision and accuracy. These methods must be repeatable over time.

2.1.21. *Obtain data describing the specific environmental needs of cave dependent species.

Status: New Action.

Next Steps: Develop and implement a plan to catalog troglobitic populations and occurrences and evaluate nutrient transport to these species.

2.1.22. Identify protected, rare, endemic, and managed species and the springs systems they inhabit.

Status: Ongoing. Some studies have been done to identify endemic cave animals and other organisms that inhabit springs and spring runs.

Next Steps: Create a baseline inventory of protected, rare, endemic, and managed species in first magnitude and selected other springs with repeated sampling events every two to five years. List the species identified that are at risk in a particular spring system. Add identified species to the FNAI database.

2.1.23. Identify threats to the spring-related habitats of the species identified above and develop and implement strategies to address the threats.

Status: Area of Need. Some threats are being addressed through the adoption of MFLs.

Next Steps: Interagency coordination. Other action steps need to be done first in order to complete this step.

2.1.24. *Characterize dependence of plants and animals on water quality and quantity.

Status: New Action.

Next Steps: Develop a study plan and methods to assess this dependence. Conduct research.

- **Goal: Evaluate best management practices and engineering designs and provide for modifications as necessary to improve springs protection**

2.1.25. Evaluate wastewater treatment technologies (onsite and centralized) to determine the level of contaminant reduction in discharge and the impacts on springs.

Status: Ongoing. Onsite wastewater treatment is a highly competitive field that is being researched and pursued by private industry. FSI works with the DOH Bureau of Onsite Sewage Programs to identify the best available technologies for springsheds. Cities such as Tallahassee and High Springs are monitoring the ground water around sprayfields to determine impacts of centralized wastewater treatment on ground water and springs.

Next Steps: Initiate evaluation. See also Action Step 2.1.29.

2.1.26. *Scientifically evaluate the use and effectiveness of agriculture BMPs within springsheds.

Status: New Action. Agriculture BMPs are currently implemented in areas where agricultural land use is concentrated, however no scientific study has been developed to evaluate the effectiveness of these BMPs.

Next Steps: Fund agricultural BMP studies to assess specific agricultural land use practices (including row crops, concentrated animal feed lots, animal waste sprayfields, and other agricultural practices that apply fertilizers and pesticides) and whether or not

these are effectively protecting ground water in spring areas. Once studies are completed, revise BMPs as needed for ground water protection. (See also action steps in 3.4 Agriculture BMPs).

2.1.27. *Scientifically evaluate the use and effectiveness of silviculture BMPs within springsheds to ensure ground water protection, with special emphasis on the application of fertilizer and pesticides.

Status: New Action.

Next Steps: Initiate evaluation. Make evaluation data available to agencies and the public. Provide these protocols to state and local permitting authorities for inclusion in future permitting criteria. (See also action steps in 3.5 Silviculture BMPs)

2.1.28. *Scientifically evaluate the use and effectiveness of golf course BMPs within springsheds to ensure surface water and ground water protection.

Status: New Action. Much research on this topic exists, however some BMPs (such as the IFAS Golf Course Manual) were not designed to protect springs.

Next Steps: Initiate evaluation. Provide these protocols to state and local permitting authorities for inclusion in future permitting criteria. (See also action steps in 3.8 Golf Course BMPs)

2.1.29. *Scientifically evaluate the use and effectiveness of municipal and domestic (septic), wastewater management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.

Status: New Action. Land application of biosolids is generally one of the first measures proposed to reduce nutrient inputs from wastewater management

Next Steps: Initiate evaluation. Based on the evaluation, modify land application and level of treatment. Provide these protocols to state and local permitting authorities for inclusion in future permitting criteria. (See also action steps in 3.2 Wastewater Management)

2.1.30. *Scientifically evaluate the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.

Status: New Action.

Next Steps: Initiate evaluation. In order to verify effectiveness of stormwater management practices, verification monitoring must be implemented (see Action Step 2.2.15). Special circumstances may dictate more frequent monitoring. DEP, WMDs, and local and regional governments need to coordinate their programs to accomplish this (there are some areas of conflict). In unconfined areas, stormwater facilities should treat water to tertiary standards before being released. This additionally could be used for re-use water. Provide these protocols to state and local permitting authorities for inclusion in future permitting criteria. (See also action steps in 3.6 Stormwater Management)

2.2. Monitoring

Monitoring is an essential part of protecting Florida's springs. Monitoring gives us a record of the dynamics by which we can understand springs; it also identifies problems and their sources – all of which are used to develop management objectives and protection strategies. Monitoring addresses the four research areas mentioned in the Research section: Hydrogeology & Spring Flow, Water Quality, Biological Systems, and Protection Management and Engineering.

The protection of spring flow is essential to the water quality, ecological health, recreational, and aesthetic values of Florida's springs. The collection and analysis of spring and ground waters for potential contaminants is an essential part of assessing the condition of Florida's springs, and in a more general sense, our drinking water. In addition, an understanding of the system's biological components is essential to successfully manage an ecosystem. Monitoring allows scientists to distinguish a healthy spring system from one that is out of balance. Finally, an Integrated Monitoring Protocol for collecting these various types of data using standardized methods will promote collection of meaningful data and improve understanding of the relationship between water quality and quantity in spring systems.

FGS quarterly sampling crew sampling water quality in Silver Springs. Photo by: Harley Means, FGS

The Department of Environmental Protection (DEP), Florida Geological Survey (FGS), water management districts (WMDs), U.S. Geological Survey (USGS), universities, and local governments all collect spring flow, water quality, and biological data (Appendix F). Data must be collected using similar protocols and then integrated into a common database to construct an overall view of the condition of springs systems. Reports and data results also need to be made available to scientists, springs managers, and the general public in a timely manner.

Action Steps for Monitoring

➢ **Goal: Monitor spring flow**

2.2.1. Establish stream flow gaging stations at a network of springs selected to represent most of the springs in the State.

Status: Achieved. Gaging stations have been established at most clear-water first-magnitude springs. DEP is working cooperatively with the USGS and WMDs to maintain these stations. The need for maintaining these stations and/or adding additional stations is evaluated annually. Also, FGS is currently addressing offshore spring discharge through ongoing reconnaissance.

Next Steps: The list of springs with stream flow gauging stations should be expanded to include all springs that are on a WMD priority list for MFLs. Spring flows should be monitored to detect flow trends relative to minimum flow standards. Determine loading of potential contaminants in receiving waters, and correlate water quality with quantity.

2.2.2. Establish a network of monitoring wells to provide baseline data to determine if water levels are declining.

Status: Ongoing. Most WMDs have established water level well networks and release biannual (wet season – dry season) maps showing the potentiometric surface of the Floridan Aquifer System within their geographic boundaries. Within five first-magnitude springsheds in the SRWMD, an enhanced well network has been developed which should provide even more detailed aquifer level data.

Next Steps: Identify gaps, if any, in the existing well networks. Continue monitoring and evaluating networks.

2.2.3. Request assistance from spring owners and managers in reporting observations and changes of water quality and quantity.

Status: Ongoing. This has been done by personal visits and contacts with DEP Springs Initiative staff through mailouts and announcements, and especially by Spring Ambassadors.

Next Steps: Expand this effort by providing data sheets to park employees and private spring owners. Upload into an online database that can be accessed by interested parties. Create a SpringWatch program. Create a rapid response team and procedure to address significant/reported changes.

2.2.4. Conduct long-term thermal and flow monitoring of all spring systems used as thermal refuges by protected and endemic species.

Status: Ongoing. Monitoring of flow and discharge occurs for most first magnitude and other selected springs, some on a quarterly basis and some on a more frequent basis.

Next Steps: FWC needs to identify all springs utilized as thermal refuges by manatees and provide the list to USGS, FGS, and WMDs so that a priority list can be made for springs that require discharge monitoring.

➢ Goal: Monitor water quality

2.2.5. Develop a water quality monitoring plan for all clear water first magnitude and other selected springs that are sampled.

Status: Ongoing. A generic plan for sampling all first magnitude and other selected springs is currently in use. See Appendix E for a list of analytes that are monitored. See Appendix F for a list of monitored springs in Florida.

Next Steps: Develop spring-specific monitoring plans. Add more springs to the monitoring list based upon need. Include an analyte this as part of this plan (see Action Step 2.1.10).

2.2.6. *Monitor anthropogenic compounds in springs systems.

Status: New Action. See Appendix E for a Table of Analytes sampled for and Appendix F for a list of monitored spring sites. The SWFWMD has been sampling for both priority pollutants and nitrogen isotopes at springs in that District on a rotating basis, alternating years between the two for a given set of springs so that a complete rotation is accomplished about every 5 years. The N-isotope data set should prove useful in determining changes in sources as land use patterns evolve in a springshed. While nitrate-nitrogen has received focus, phosphorus requires attention as well. Wekiva River and Rock Springs both exhibit total phosphorus levels considerably higher than reference systems such as Alexander and Juniper springs. Jan Stevenson's work for DEP found that algal production in 56% of the 28 springs sampled were phosphorus limited.

Next Steps: Expand monitoring for anthropogenic compounds to all major springs statewide. Monitor, summarize, and analyze information and make information available to the public.

2.2.7. Collect spring flow data whenever water quality sampling is performed, where practical.

Status: Ongoing. Gaging stations have been established at most clear-water first-magnitude springs. Discharge measurements are collected at the time of water quality sampling. See Appendix F for a list of monitored springs in Florida with sampling frequency.

Next Steps: Expand the list of springs to be monitored for discharge and install gaging stations where needed. Continue to monitor spring discharge. Evaluate methods that can serve as a proxy for spring discharge, such as well water level data used to produce rating curves.

➢ Goal: Conduct biological monitoring in spring systems

2.2.8. *Repeat biological inventories of springs and spring runs on a periodic basis to create a baseline from which to compare future data. Include algae, aquatic plants, benthic macroinvertebrates, and appropriate vertebrate wildlife in the monitoring program.

Status: Ongoing. Currently, no comprehensive inventory exists. Past and current projects include: fish and bivalve surveys at 16 springs; baseline inventories of aquatic snails at 14 springs and spring runs; apple snail abundance and recruitment study in 6 first-magnitude springs; a survey of frog diversity at Florida springs; biological inventories of spring caves associated with Holmes Creek, the Ocklawaha, Choctawhatchee, Econfina, St. Johns, Apalachicola, Suwannee, and Withlacoochee rivers with special emphasis on troglobitic invertebrates.

Next Steps: Interagency collaboration. Continue data collection and summarize and report findings, as appropriate. Include SAV mapping. Methods used must be repeatable, with known effort level.

2.2.9. Conduct bio-assessments and monitor indicator species at first magnitude and other selected springs.

Status: Ongoing. The DEP Bureau of Laboratories performs biannual stream bio-assessments in most first-magnitude spring runs, with a focus on invertebrates and algae. Note that several first-magnitude springs do not have lengthy runs, or discharge directly into lakes, large rivers or coastal waters.

Next Steps: Broaden sampling intervals to include seasonal variations in the breeding cycles of all organisms that utilize spring systems. Biological monitoring in adjacent terrestrial ecosystems may be needed to see if animals are migrating into terrestrial habitats and vice-versa.

2.2.10. Coordinate with cave divers to receive observation reports on submerged cave species. Post the reports on the DEP website.

Status: Ongoing. A form for cave divers to use for reporting in-cave biological observations has been placed on the National Speleological Society's Cave Diving Section website since 2002 (see Appendix D for website address).

Next Steps: Collate, analyze, and publish the results of this survey.

- **Goal: Integrate monitoring of spring flow, water quality, and biological systems to help in understanding the relationship between water quality and quantity in spring systems and their associated ecosystems**

2.2.11. Identify metric(s) from integrated monitoring data to report on spring condition.

Status: Area of Need. DEP and FGS are collecting the necessary data to identify metrics.

Next Steps: Identify metrics.

2.2.12. *Develop and utilize uniform, consistent methods for data collection across agencies.

Status: Ongoing. Current data collection methods are fairly consistent, especially within DEP and hired contractors.

Next Steps: Interagency Coordination. Evaluate current DEP SOPs for spring water quality sampling and update when needed. Encourage all agencies that collect spring water quality data to utilize standardized SOPs to ensure data are collected in a consistent manner.

- **Goal: Monitor best management practices and engineering designs to collect data on their performance**

2.2.13. *Monitor new wastewater treatment technologies to determine the level of contaminant reduction in the discharge and the impacts on springs.

Status: New Action.

Next Steps: (See action steps in 2.1 Research and 3.2 Wastewater Management)

2.2.14. *Monitor the use and effectiveness of municipal and domestic (septic) wastewater management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.

Status: New Action. Land application of biosolids is generally one of the first measures proposed to reduce nutrient inputs from wastewater management.

Next Steps: (See action steps in 2.1 Research and 3.2 Wastewater Management)

2.2.15. *Monitor the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.

Status: New Action.

Next Steps: In order to verify effectiveness of stormwater BMPs, verification monitoring must be implemented. This should include the use of nested wells, lycimeters, soil coring, and monitoring to evaluate soil capacity, and throughput to treat metals, hydrocarbons, phosphorus, and nitrogen sourced nutrients. Inspection and compliance of stormwater treatment facilities should occur with a minimum of 5-year inspection plans. Special circumstances may dictate more frequent monitoring. DEP, WMDs, and local and regional governments need to coordinate their programs to accomplish this (there are some areas of conflict). In unconfined areas, stormwater facilities should treat water to tertiary standards before being released. This additionally could be used for re-use water. (See action steps in 2.1 Research and 3.6 Stormwater Management)

2.2.16. *Monitor the use and effectiveness of agriculture BMPs within springsheds.

Status: New Action.

Next Steps: (See action steps in 2.1 Research and 3.4 Agriculture BMPs)

2.2.17. *Monitor the use and effectiveness of silviculture BMPs within springsheds to ensure ground water protection, especially concerning application of fertilizer and pesticides.

Status: New Action.

Next Steps: (See action steps in 2.1 Research and 3.5 Silviculture BMPs)

2.2.18. *Monitor the use and effectiveness of golf course BMPs within springsheds to ensure surface water and ground water protection.

Status: New Action.

Next Steps: (See action steps in 2.1 Research and 3.8 Golf Course BMPs)

2.3. Research & Monitoring Support

Research and monitoring are important in order to understand both the existing and changing conditions in Florida spring systems. The information gained from such work allows scientists to predict potential impacts to spring systems from activities within springsheds, and provides for the development of effective springs protection strategies. Funding for research and monitoring must continue if Florida's precious springs are to be preserved for future generations.

Action Steps for Research & Monitoring Support

➢ **Goal: Support research and monitoring projects**

2.3.1. Provide support to scientists, engineers, and policymakers for the development of proposals to address important research and monitoring questions.

Status: Ongoing. Collaboration is ongoing with DEP, FGS, and other agencies that work with members of the FSTF to fulfill this charge. In 2006, the FSTF created a Research and Monitoring Coordination Committee of the FSTF to guide research efforts and provide a forum for dialog and coordination of efforts

Next Steps: Formalize the process and include dialogue with WMDs, counties, FWC, USGS, academic and other researchers. The FSTF Research and Monitoring Coordination Committee will create a mechanism to frame and prioritize research questions.

2.3.2. Provide recurring funding to support research and monitoring projects.

Status: Ongoing. The FSI has allocated approximately $1.6M per year to springs research and monitoring activities. This FSI funding is leveraged through matching funds and enhancement programs to provide additional research.

Next Steps: Identify and pursue additional funding options to compliment FSI funding, including leveraging possibilities, funds spent by other agencies on springs and springs-related projects, cooperative funding, and matching funds. Details on funding are included in section 5. Funding Strategies.

2.3.3. Establish a grant program for graduate student research and monitoring.

Status: New Action.

➢ **Goal: Ensure the prompt dissemination of research data and reports**

2.3.4. *Disseminate data and reports for public and scientific access.

Status: New Action. Research data and reports should be distributed to the public and other interested parties. DEP has begun converting reports into PDF format, consistent with the efforts of other agencies (USGS, WMDs, etc.) that make PDF reports available to the public online. The water-quality data necessary to statistically determine trends for the inclusion in the DEP 2006 305(b) report has been collected since 2001.

Next Steps: Post research reports on the DEP Springs website for access by scientists, managers, and the public as an online bibliography or library, include links to springs resources and reports from USGS, WMDs, and others. Include data on the condition of Florida's springs in the DEP's 305(b) report, which provides statewide water quality information to the U.S. Congress on a biennial basis.

2.3.5. Provide springs water quality, discharge, and biological data in a timely manner through an internet accessible centralized database.

Status: Ongoing. DEP is currently developing a centralized database system to collect and store all types of data. DEP sends data updates to the national database on an annual basis. The USGS and WMDs make data available on their websites.

Next Steps: Review and release current data in a timely manner. DEP should complete the new database. All agencies need to make data available in an accessible database. One agency needs to be responsible for providing easy access to historical data.

2.3.6. Provide periodic reports on the status of monitored springs and include recommendations on monitoring needs.

Status: Area of Need. A report of this type has not yet been prepared. Water quality data collection is currently taking place in preparation for the development and publication of status reports. (See Action Step 1.1.9 and 1.1.10 for related education tools.)

Next Steps: Status reports should address monitoring status and needs. DEP should prepare these on a 3 to 5 year basis. The FSTF Research & Monitoring Committee will identify which springs to report on.

- **Goal: Support projects that explore and map cave systems to help understand the hydrogeology of Florida karst systems**

2.3.7. Facilitate qualified cave exploration and access to restricted springs and improve coordination between the cave diving community and the scientific community.

Status: Ongoing. FSI has supported exploration access to restricted springs. Protocols have been developed for cave mapping. FGS and the National Speleological Society – Cave Diving Section (NSS-CDS) collaborated on creating a cave glossary. The theme at the NSS-CDS Annual Memorial Day Workshop 2004 was "The Science of Cave Diving." A series of presentations were made by DEP scientists and managers, followed by presentations by cave divers. This followed a 2003 symposium sponsored by the Hydrogeology Consortium and hosted by the scientific community with similar goals. In addition the 2003 Springs Conference brought together cave divers and hydrogeologists to discuss how each group can better cooperate. The sessions developed sets of recommendations on how to proceed.

Next Steps: Future Springs Conferences need to include and invite cave divers to discuss measures to increase protection of springs. Efforts should be made to improve qualified cave diver access into restricted springs where research needs are apparent.

Implementation Table – Research & Monitoring Strategies

Action Number	Action Description	Status	Participants
2. Research & Monitoring Strategies			
2.1. Research			
Goal: Improve understanding of hydrogeology and flow of springs.			
2.1.1	Delineate springsheds for all of Florida's first magnitude and other selected springs through mapping (cave diving exploration), dye studies, and other means and include the fluctuation in boundaries due to natural and anthropogenic variations in recharge.	Ongoing	FGS, WMD, USGS
2.1.2	Conduct hydrogeologic investigations to determine the relationships between ground water levels and spring flows.	Ongoing	FGS, WMD, USGS, University
2.1.3	*Assess spring runs to identify factors (siltation, damming, trash, etc.) that may impair spring flows and access.	New Action	DEP, WMD, Private
2.1.4	*Statistically analyze the existing water level and flow data to detect the presence of trends.	New Action	DEP, WMD, University, USGS
2.1.5	*Identify and develop data sets to determine historic flow and ground water level baselines.	New Action	FGS, USGS, WMD, University
2.1.6	*Identify improved methods of gaging flow, especially with estavelles.	New Action	USGS, University
2.1.7	*Identify relationships between spring flow and protected, rare, endemic, and managed species in spring systems.	New Action	DEP, WMD, University
2.1.8.	*Identify the relationship between spring flow and non-consumptive uses (including recreation and aesthetics).	New Action	WMD, University
2.1.9.	*Identify the geological characteristics and human factors affecting and controlling the mixing of surface water and ground water and the mixing of differing ground water sources to determine impacts on spring water quality and quantity.	New Action	FGS, DEP, WMD, USGS, University
Goal: Conduct water quality research			
2.1.10	Design an analyte list for each spring based on information generated by the survey of land uses within the springshed.	Achieved – Needs Update	DEP, FGS, WMD
2.1.11	*Identify anthropogenic compounds present in springs systems.	New Action	DEP, FGS, USGS, WMD, University
2.1.12	*Facilitate research into the effects of anthropogenic compounds (including pesticides, pharmaceuticals, endocrine disrupters, etc.) on spring systems.	New Action	DEP, USGS, University
2.1.13	*Develop mapping criteria that identify specific land use activities that impact springshed water quality and quantity.	New Action	DEP, USGS, WMD, FGS, University

Action Number	Action Description	Status	Participants
2.1.14	Characterize how land use affects water quality in relationship to aquifer vulnerability.	Ongoing	FGS
2.1.15	Identify and investigate water quality problems detected through monitoring, which may vary considerably from spring to spring, based on each individual case.	Ongoing	DEP, USGS, WMD
2.1.16	Identify indicator species best suited to determining potential water quality problems.	Ongoing	DEP, FWC, University, USGS
2.1.17	*Identify relationships between water quality and protected, rare, endemic, and managed species in spring systems.	New Action	DEP, FWC, University
2.1.18	*Determine relationship between water chemistry and system ecology.	Ongoing	DEP, FWC, University
2.1.19	*Identify the relationship between spring water quality and non-consumptive uses (including recreation and aesthetics).	New Action	DEP, WMD, University
Goal: Improve understanding of springs ecology			
2.1.20	*Develop methodologies for assessing the condition of biotic systems in spring systems, and enhance to include assessment of restoration efforts.	New Action	DEP, WMD, FWC
2.1.21	*Obtain data describing the specific environmental needs of cave dependent species.	New Action	DEP, FWC
2.1.22	Identify protected, rare, endemic, and managed species and the springs systems they inhabit.	Area of Need	Contractor, DEP, FWC
2.1.23	Identify threats to the spring-related habitats of the species identified above and develop and implement strategies to address the threats.	Area of Need	DEP, FWC
2.1.24.	*Characterize dependence of plants and animals on water quality and quantity.	New Action	FWC
Goal: Evaluate best management practices and engineering designs and provide for modification as necessary to improve springs protection.			
2.1.25.	Evaluate wastewater treatment technologies (onsite and centralized) to determine the level of contaminant reduction in discharge and the impacts on springs.	Ongoing	DEP, DOH, Private
2.1.26	*Scientifically evaluate the use and effectiveness of agriculture BMPs within springsheds.	New Action	DEP, DACS
2.1.27	*Scientifically evaluate the use and effectiveness of Silviculture BMPs within springsheds to ensure ground water protection, with special emphasis on the application of fertilizer and pesticides.	New Action	DEP
2.1.28.	*Scientifically evaluate the use and effectiveness of Golf Course BMPs within springsheds to ensure surface water and ground water protection.	New Action	DEP
2.1.29.	*Scientifically evaluate the use and effectiveness of municipal and domestic (septic), wastewater management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.	New Action	DEP, DOH

Action Number	Action Description	Status	Participants
2.1.30.	*Scientifically evaluate the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.	New Action	DEP, WMD, Local Gov't
2.2. Monitoring			
Goal: Monitor spring flow			
2.2.1.	Establish stream flow gaging stations at a network of springs selected to represent most of the springs in the State.	Achieved – Needs Update	USGS
2.2.2.	Establish a network of monitoring wells to provide baseline data to determine if water levels are declining.	Ongoing	WMD, FGS, USGS
2.2.3.	Request assistance from spring owners and managers in reporting observations and changes of water quality and quantity.	Ongoing	DEP, Private, WMD
2.2.4.	Conduct long-term thermal and flow monitoring of all spring systems used as thermal refuges by protected and endemic species.	Ongoing	WMDs, FWC, USGS
Goal: Monitor water quality			
2.2.5.	Develop a water quality monitoring plan for all clear water first magnitude and other selected springs that are sampled.	Ongoing	WMD, FGS, USGS
2.2.6	*Monitor anthropogenic compounds in springs systems.	New Action	DEP, WMD, USGS
2.2.7.	Collect spring flow data whenever water quality sampling is performed, where practical.	Ongoing	FGS
Goal: Conduct biological monitoring in spring systems.			
2.2.8.	*Repeat biological inventories of springs and spring runs on a periodic basis to create a baseline from which to compare future data.	Ongoing	DEP, WMD
2.2.9.	Conduct bio-assessments and monitor indicator species at first magnitude and other selected springs.	Ongoing	DEP, WMD,
2.2.10.	Coordinate with cave divers to receive observation reports on submerged cave species. Post the reports on the DEP website.	Ongoing	DEP, Cave Divers
Goal: Integrate monitoring of spring flow, water quality, and biological systems to help in understanding the relationship between water quality and quantity in spring systems and their associated ecosystems.			
2.2.11.	Identify metric(s) from integrated monitoring data to report on spring condition.	Area of Need	DEP, WMDs, USGS
2.2.12.	*Develop and utilize uniform, consistent methods for data collection across agencies	Ongoing	DEP, WMDs
Goal: Monitor best management practices and engineering designs to collect data on their performance.			
2.2.13.	*Monitor new wastewater treatment technologies to determine the level of contaminant reduction in the discharge and the impacts on springs.	New Action	DEP, University, DOH
2.2.14.	*Monitor the use and effectiveness of municipal and domestic (septic) wastewater	New Action	DEP, DOH

Action Number	Action Description	Status	Participants
	management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.		
2.2.15.	*Monitor the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.	New Action	DEP, DCA
2.2.16.	*Monitor the use and effectiveness of agriculture BMPs within springsheds.	New Action	WMD, DEP, University
2.2.17	*Monitor the use and effectiveness of silviculture BMPs within springsheds to ensure ground water protection, especially concerning application of fertilizer and pesticides.	New Action	WMD, DEP, University
2.2.18.	*Monitor the use and effectiveness of golf course BMPs within springsheds to ensure surface water and ground water protection.	New Action	University, DEP, WMD
2.3. Research & Monitoring Support			
Goal: Support Research and Monitoring Projects			
2.3.1.	Provide support to scientists, engineers, and policymakers for the development of proposals to address important research and monitoring questions.	Ongoing	DEP, FGS, WMD, USGS
2.3.2.	Provide recurring funding to support research and monitoring projects.	Ongoing	FGS, WMD, USGS
2.3.3.	*Establish a grant program for graduate student research and monitoring.	New Action	University, FGS, USGS, WMD
Goal: Ensure the prompt dissemination of research data and reports.			
2.3.4.	*Disseminate data and reports for public and scientific access.	New Action	DEP, WMD, USGS
2.3.5.	Provide springs water quality, discharge, and biological data in a timely manner through an internet accessible centralized database.	Ongoing	DEP
2.3.6.	Provide periodic reports on the status of monitored springs and include recommendations on monitoring needs.	Area of Need	DEP
Goal: Support projects that explore and map cave systems to help understand the hydrogeology of Florida karst systems.			
2.3.7.	Facilitate qualified cave exploration and access to restricted springs and improve coordination between the cave diving community and the scientific community.	Ongoing	NSS/CDS

*New action added since the 2000 Springs Report.
Note: See Appendix H for a list of participants referenced in this table.

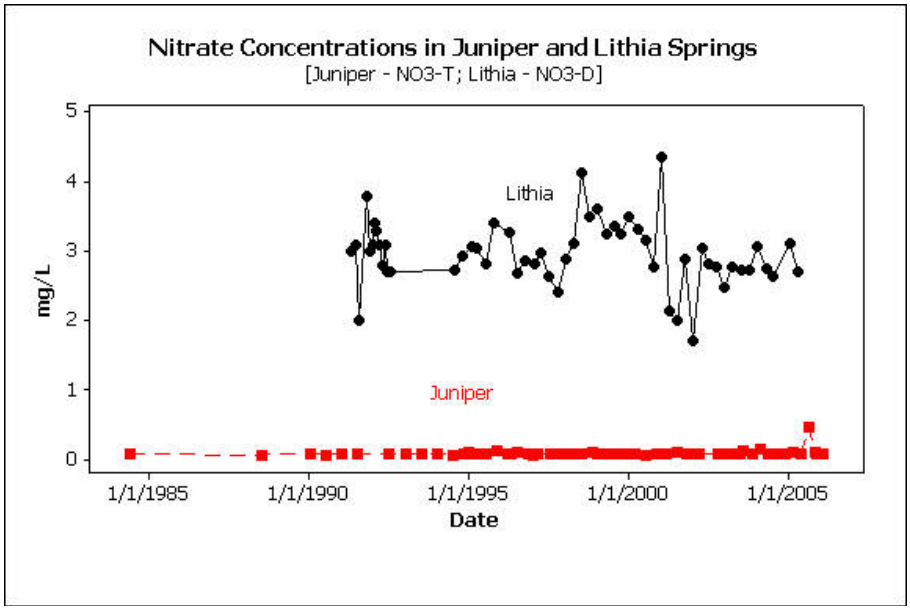
3. Land Use Planning & Management Strategies

3.1. Land Use Planning

An ounce of prevention is worth a pound of cure. – Benjamin Franklin

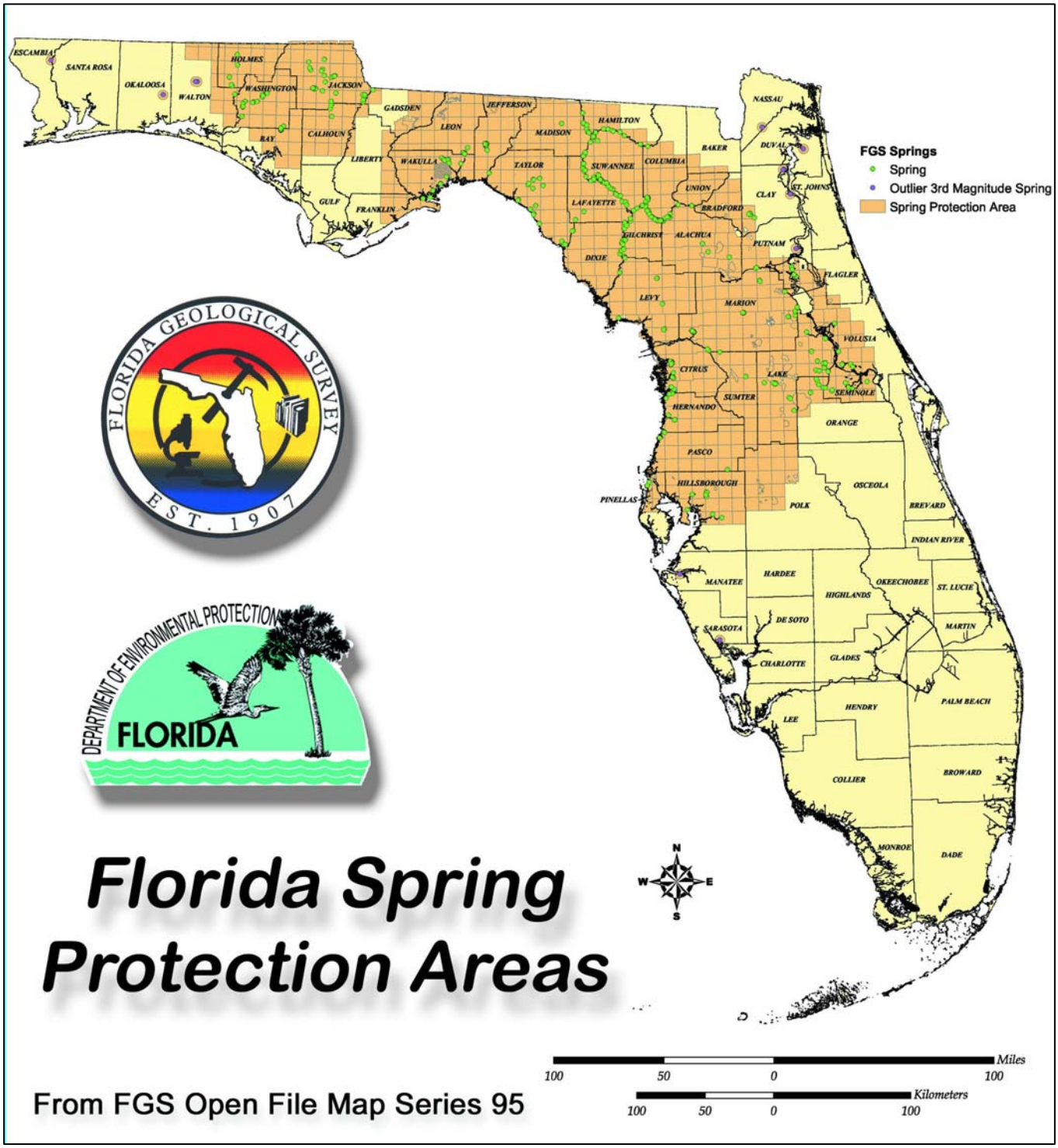
Both the quality and quantity of spring flows have declined notably in many of Florida's springs. Without effective remedial action, further declines can be expected. Urbanization and intensive agricultural practices on the land surface can and do have adverse impacts upon the quality and quantity of ground water, thereby affecting spring flow, water quality, and spring ecosystems. Many dye studies have shown that water travels rapidly from sinkholes to springs in days to weeks. However, based on numerous studies the average age of water is 10 to 30 years in many springs, indicating a delay in both water degradation from past activities and in improvements that can be expected from improved land management practices.

Well over half of Florida's counties – 39 to be exact –contain springs or springsheds (Figure 1). Thus, it is critical to give meaningful technical assistance to local governments through the *Implementation Guide Book for Protecting Florida Springs: Model Land Development Code and Model Comprehensive Plan Objectives and Policies* (Model Land Development Code), a voluntary program initiated by the Department of Community Affairs (DCA) in 2005 with funding from the Florida Springs Initiative (FSI). This voluntary program assists local governments in protecting Florida's springs through effective land use planning. In addition, knowledge gained through the process helps to refine voluntary application of springs protection measures at the local government level. See Appendix D for more information.



Nitrate-nitrogen concentrations in Juniper and Lithia Springs. Juniper Springs is located within the Ocala National Forest with a springshed that is mainly protected in conservation lands. Land uses within Lithia's springshed are mainly agricultural and converting to urban-residential. Research indicates that spring biological communities become degraded as nitrate-nitrogen levels approach 1 mg/L, which is far lower than the current drinking water (ground water) standard of 10 mg/L (Ch. 52-550 and 62-520 FAC). Source: FGS; Lithia Spring data from SWFWMD; Juniper Spring data from SJRWMD

Figure 1. Springs Areas by County



Source: FGS. Supporting information for this figure can be found in Appendix G.

Action Steps for Land Use Planning

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

- **Goal: Local governments will adopt springshed protection programs as part of local comprehensive plans and land development regulations**

3.1.1. Identify the most vulnerable areas of springsheds and assist local governments in creating zones of special consideration for land use planning or regulation.

Status: Ongoing.

Next Steps: Develop FAVA on a county level. Three county-scale FAVA-type maps will be developed for Citrus, Levy, and Wakulla counties, all of which contain numerous springs and therefore springsheds. The sub-regional and county-scale assessments produce more detailed FAVA-type maps as compared to the statewide maps.

3.1.2. Develop criteria for state agencies to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments that potentially impact springs.

Status: Ongoing.

Next Steps: During comprehensive plan review the DCA will recommend the adoption of appropriate elements of the Model Land Development Code into comprehensive plans of counties within springsheds. In addition, results from the Model Land Development Code pilot program will help refine these criteria and how they apply under different local government processes.

3.1.3. Develop criteria for local governments to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments and local land use actions that potentially impact springs.

Status: Ongoing.

Next Steps: Continue working with local governments through the Model Land Development Code pilot program to develop these criteria. Dedicated funding should be available to assist local governments with identification of appropriate land-uses for springs protection.

3.1.4. Develop and implement comprehensive plan policies, ordinances, and LDRs to protect springsheds and karst features with probable direct connections to the aquifer.

Status: Ongoing. The Model Land Development Code creates a buffer area around sinkholes and creates protection zones within spring recharge areas. A proposed springs legislation package was developed by the University of Florida College of Law through the Silver Springs Working Group in the fall of 2004 and was sponsored by House and Senate representatives in the 2005 Session. It included a coordinated statewide effort to identify vulnerable areas and implement springs protection policies through local comprehensive plans. However, the legislation did not move forward during the Session.

Next Steps: Continue working with local governments through the Model Land Development Code program to develop comprehensive plan policy, ordinances, and

LDRs. Form a FSTF subcommittee to review the UF/Silver Springs proposed legislation and consider resubmitting it in revised form.

3.1.5. Develop goals and objectives in the intergovernmental coordination elements of comprehensive plans to cooperatively create approaches and measures needed to protect and restore ground water and springs.

Status: Area of Need. DEP, DCA, and DOT are currently working with two counties and municipalities to accomplish this. The springs protection legislation submitted in 2005 (see Action Step 3.1.4) included a requirement that all local governments with springs or their contributing areas consider adopting new goals and objectives for springs protection in their comprehensive plans.

Next Steps: DCA and DEP should work with pilot counties and communities to assist in developing goals and objectives.

3.1.6. Identify and inform local governments of land uses that are known to adversely affect spring water quality.

Status: Area of Need. Some projects have identified land uses that adversely affect water quality and local governments are informed.

Next Steps: Additional projects should be designed that identify potential hazards. Local governments will be informed as information becomes available. (See also action steps in 1.1 Education.)

➢ Goal: Implement enhanced springs protection measures at the regional level

3.1.7. Revise Regional Planning Council Strategic Regional Policy Plans to recognize the aquifer(s) as a natural resource of regional significance in springs areas.

Status: Area of Need. Withlacoochee RPC has done this. Other RPC regional plans have not yet been revised. Not all RPCs specifically identify aquifers as resources of regional significance.

Next Steps: Other RPCs need to revise their SRPP to reflect this.

3.1.8. Consider legislative action to identify the aquifer(s) as a natural resource of regional significance in all Strategic Regional Policy Plans in spring areas and provide enhanced protection for these resources under that process.

Status: Area of Need.

Next Steps: This can also be done as part of a FSTF subcommittee review of potential legislation (see Action Step 3.1.4).

➢ Goal: Modify the Development of Regional Impact (DRI) review process to address multi-jurisdictional impacts to springs and springsheds

3.1.9. Modify DRI review criteria to address impacts to ground water resources.

Status: Area of Need.

Next Steps: Determine suitability of land uses prior to the permitting process. The Model Land Development Code for Springsheds, BMPs, and best development practices should be used during the land use planning process.

3.1.10. Continue to develop, evaluate, and revise best development practices and BMPs for application in springsheds.

Status: Ongoing – Area of Need.

Next Steps: A comprehensive evaluation will need to follow any adoption of the Model Land Development Code to ensure that the best development practices and BMPs are having desired effect. (See related action steps in 2.1 Research, 2.2 Monitoring, and the rest of section 3. Land Use Planning & Management)

3.1.11. Reviewing agencies should recommend that local governments include requirements to implement ground water protection BMPs in all DRI development orders in springs areas.

Status: Area of Need.

3.1.12. Propose legislation to prohibit state agencies from issuing permits for activities in springs areas that are inconsistent with the applicable local government comprehensive plan and land development regulations.

Status: Area of Need. Comprehensive Plan FLUM designations can prevent this kind of permit issuance. However, this action may be a legal matter in specific cases, especially with respect to sovereign submerged lands.

Next Steps: Propose legislation causing rulemaking activity to clarify processes for intergovernmental coordination between permit agencies and local governments regarding the consistency of permit issuance with the local government comprehensive plan and land development regulations.

3.2. Wastewater Management

Florida's continued population growth calls for careful infrastructure planning, including wastewater disposal that protects sensitive karst areas and springsheds. Wastewater treatment and disposal systems may present problems in a springshed even if they are designed and properly operating under the standard design. To protect water quality in springs, an added level of treatment or other measures are necessary to minimize nutrient inputs. Contaminants of concern include nutrients such as nitrate-nitrogen and phosphorus, and human pathogens in the form of bacteria and viruses.

Centralized wastewater treatment plants (WWTPs) are available in densely populated areas. Traditionally they have provided secondary treatment, removing biological oxygen demand and suspended solids from the wastewater. The requirement for additional treatment depends on the method of discharge. While underground injection and sprayfields do not usually require additional treatment, discharge to surface water frequently requires advanced wastewater treatment, including nutrient removal. Of most concern for springs protection are sprayfields and infiltration basins, where a high water application rate combined with limited nitrate-

nitrogen removal in the soil above ground water is likely to result in nitrate-nitrogen loading to ground water. Due to the physical separation of wastewater treatment from buildings, higher land use densities are allowed in areas served by WWTPs.

Land application of animal waste. Photo by: Harley Means, FGS

Conventional septic systems (also known as OSTDS), consist of a septic system and drainfield, and are mainly used in rural and suburban areas with low population densities. They are effective at removing pathogens, total suspended solids, and biological oxygen demand (BOD) from domestic wastewater. However, even properly constructed and maintained conventional systems are limited in their capacity to remove nitrate-nitrogen. Well-drained soils where water can percolate rapidly, such as in karst areas, generally provide little nitrate-nitrogen removal. Recent research suggests that systems installed in karst areas provide very low nutrient removal. For example, monitoring of two campground septic systems sited in karst at Manatee Springs State Park showed rapid travel times between the drainfields and downgradient monitoring wells and high nitrate-nitrogen and somewhat elevated phosphorus and fecal coliform concentrations.

Statewide minimum standards for WWTPs (>10,000gpd) and OSTDS (septic systems) leave opportunities for reducing impacts on ground water in sensitive karst areas. These two types of treatment systems are regulated by separate agencies, the Department of Environmental Protection (DEP) and Department of Health (DOH) respectively. Local ordinances or statutes protecting springsheds can play a key role in protecting ground water by requiring better treatment of wastewater and/or reducing the building density and thus the amount of wastewater to be treated and discharged in sensitive areas.

Advances in technology now allow better wastewater treatment than in the past. Centralized WWTPs have a mechanism for upgrades during the permit renewal process. In contrast, septic systems (OSTDS) currently are only required to obtain a construction permit. In particular, septic systems installed prior to 1983 met a less stringent rule regarding surface water setbacks and separation from the wet season water table elevation, resulting in less effective pathogen removal and less natural attenuation. Thus, old systems may require replacement or retrofitting and programs should be developed to facilitate this.

Action Steps for Wastewater Management

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

➢ Goal: Encourage use of efficient nitrogen removal technologies

3.2.1. Within springs areas, permit only nitrogen-reducing performance based Onsite Sewage Treatment and Disposal Systems for new construction, modifications, or to replace failing systems.

Status: Ongoing – Area of Need. Several performance based nitrogen reducing technologies are available. The Model Land Development Code recommends the use of either nitrogen-reducing OSTDS (septic systems) or advanced wastewater treatment facilities within springs protection zones. DCA and DEP will continue to coordinate with DOH in developing recommendations to address onsite systems and wastewater treatment facilities in springsheds.

Next Steps: DOH and DEP should promote and cooperatively fund long-term monitoring programs for new performance based treatment systems installed at public facilities. This would create a new body of information that can be shared with the public, regarding actual nitrogen reductions realized, operation and maintenance costs compared with conventional systems, and long-term changes in performance (if any).

3.2.2. Identify and provide incentives that will encourage the use of more efficient nitrogen and nutrient removal technologies.

Status: Area of Need. No incentives are available at this time.

Next Steps: Explore and identify new options to provide incentives, such as rebate coupons and discounts. Consider existing examples like incentives to upgrade to or install Energy Star appliances.

3.2.3. Promote legislation that would make approval of DRIs and large-scale developments within a springshed contingent upon the construction of a centralized, advanced wastewater treatment plant (AWTP).

Status: Area of Need.

Next Steps: This can be addressed through rule-making with DEP or the FSTF subcommittee review of new springs legislation (see Action 3.1.4).

➢ Goal: Upgrade existing wastewater facilities to state of the practice or similar

3.2.4. Amend existing statutes or ordinances to require OSTDS inspection and maintenance every five years or when property is sold, and upgrade to current standards as needed.

Status: Area of Need. Statutory authority is necessary for a state-wide property transfer program; four counties already have such a program.

Next Steps: This can be addressed through local ordinances, rule-making, or as part of the FTSF subcommittee review of new springs legislation (see Action Step 3.1.4).

3.2.5. *Require local governments within springs areas to upgrade existing wastewater treatment facilities to Advanced Wastewater Treatment Plant (AWTP) and require new wastewater treatment facilities in the springs areas to operate at an AWTP standard and provide water reuse within the springshed.

Status: New Action.

Next Steps: Explore rulemaking with DEP.

➢ Goal: Evaluate and manage nutrient contributions

3.2.6. *Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.

Status: Ongoing.

Next Steps: Develop these plans in concert with other state agencies. The plan should include the following: delineation of the planning area; inventory of potential sources of nutrients; monitoring to track the status of nutrients in ground water and at spring sites; monitoring to determine effectiveness of BMPs; and targeted strategy for the reduction of nutrient loadings. (See related action steps in 3.3 Landscape BMPs, 3.4 Agriculture BMPs, 3.5 Silviculture, and 3.6 Stormwater Management.)

3.2.7. A nutrient management plan should be incorporated in permits that regulate wastewater treatment facilities in springs areas.

Status: Area of Need.

Next Steps: This can be addressed through rule-making with DEP or the FSTF subcommittee review of new springs legislation (see Action 3.1.4).

3.2.8. State parks with springs shall have the best available wastewater treatment technology for nutrient removal or connect to an offsite AWTP.

Status: Ongoing. State parks with springs have recently converted many older septic systems, often with funding from the FSI. These include Florida Caverns (Blue Hole), Volusia Blue, Rainbow, and Wakulla springs projects which connected to municipal central sewer systems, and Wekiwa Springs which is underway. The FSI also funded or helped to fund the upgrade of septic systems at Lafayette Blue, Troy, Manatee, and Fanning Springs state parks, and one is underway at Ichetucknee Springs. Similar upgrades are being considered at other springs state parks as funding is available.

Next Steps: Additional projects are needed for septic system retrofits/sewer system hookups.

3.3. Landscape BMPs

The values and benefits of a spring are found at the spring – scenic beauty, recreation, and wildlife. They are dependent on water. Protection of the water must be applied before it reaches the spring – in the springshed. – James A. Stevenson, DEP

The importance of developing best management practices for residential turf fertilization is highlighted by the results of a study conducted by the Southwest Florida Water Management District (SWFWMD) from 1995 to 1997. The study determined that nitrate-nitrogen levels in water discharging from the Weeki Wachee, Chassahowitzka, and Homosassa springs had increased from less than 0.1 mg/L in the 1960s to approximately 0.5 mg/L in the mid 1990s – a greater than five-fold increase. The study also determined that approximately 360 tons of nitrate-nitrogen was discharging from the springs annually into the Weeki Wachee, Chassahowitzka, and Homosassa rivers.

Furthermore, the study found that although there were a number of different nitrate-nitrogen sources related to human activity in the springshed of these springs, the principal source of nitrate-nitrogen in spring discharge was inorganic nitrogen fertilizers applied to lawns. At that time, 440 tons were being applied annually to residential turf in the portions of the springshed closest to the springs. The study concluded that much of the fertilizer applied to residential turf was leaching through the soil into ground water without being absorbed by the turf. Strategies to increase the efficiency of fertilizer use and to reduce the need for fertilizers are essential to the survival of Florida's springs.

Florida Friendly Landscaping website, a project of the Florida Springs Initiative http://floridayards.org/

Due to concerns about health, the environment, and pesticide resistance, pest control practices once taken for granted are now under scrutiny. Pesticides have become an integral part of controlling insects, weeds, fungi, and bacteria in both agricultural and urban settings. The use of pesticides has increased over the last 40 to 50 years and there are increased concerns about the possible harmful effects of increased pesticide concentrations on the environment and human health.[22] Regular preventive pesticide applications are still common for some pests, but are often unnecessary.[23]

Action Steps for Landscape BMPs

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

- **Goal: Encourage efficient and limited application of fertilizer and pesticides in springs areas**

3.3.1. Encourage efficient and limited application of fertilizer on public properties in springs areas and create landscaping conditions and other BMPS where the reduction of fertilizer is appropriate.

Status: Ongoing. State parks generally do not fertilize (or irrigate) except in the few state ornamental gardens. Efforts are ongoing to eliminate fertilizer application by DOT on roadways and are an example for other public properties to follow.

Next Steps: Amend local government, state, and federal land management plans and encourage local government policies. Include this measure in contracts for landscape management.

3.3.2. *Encourage efficient and limited application of pesticides on public properties in springs areas. Create landscaping conditions and other BMPS where the reduction of pesticides is appropriate.

Status: New Action.

Next Steps: Amend local government, state, and federal land management plans and encourage local government policies. Include this measure in contracts for landscape management.

3.3.3. *Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.

Status: Ongoing.

Next Steps: Develop these plans in concert with other state agencies. The plan should include the following: delineation of the planning area; inventory of potential sources of nutrients; monitoring to track the status of nutrients in ground water and at spring sites; monitoring to determine effectiveness of BMPs; and targeted strategy for the reduction of nutrient loading. (See related action steps in 3.2 Wastewater Management, 3.4 Agriculture BMPs, 3.5 Silviculture BMPs, 3.6 Stormwater Management)

➢ **Goal: Minimize fertilizer and pesticide dependent areas in landscape design**

3.3.4. Require the retention of large areas of native vegetation and/or installation of Florida friendly vegetation in common areas within springs areas.

Status: Area of Need. Turf grass and associated management will be addressed in the Model Land Development Code, which currently has an open space requirement of 35%.

Next Steps: Local governments need to amend comprehensive plans and land development regulations.

3.3.5. Develop model deed restrictions that incorporate Florida friendly landscaping principles.

Status: Area of Need. This recommendation is included as part of the Model Land Development Code project.

Next Steps: Coordinate with FYN to develop model deed restrictions that incorporate springs protection through landscape BMPs. (See also Education Action Step 1.1.2)

3.4. Agriculture BMPs

Agricultural activities are known sources of nutrients from animal waste and from commercial inorganic fertilizers. Examples of agriculture best management practices (BMPs) include the use of slow-release fertilizers, leaving vegetated undisturbed buffers around sinkholes and water bodies, and modifying methods of manure management. Implementation of BMPs by owners of agricultural operations located within springsheds is necessary for the protection of springs. Current programs encourage voluntary use of BMPs.

Dairy manure retention at a farm in Suwannee County.
Photo by: Harley Means, FGS

One successful example of a nutrient reduction program directly linked to the water quality of springs is underway in the Suwannee and Santa Fe River basins – an area with more than 200 known springs, many of which have high levels of nitrate-nitrogen. The Suwannee River Partnership, which includes more than fifty agencies and private organizations, is cooperating to reduce nutrient loading through voluntary, incentive-based programs that help farmers and other land users satisfy regulatory requirements for protecting public health and the environment.

The success of nutrient reduction programs is dependent on ongoing financial and technical assistance from federal, state, and regional agencies. Nutrient reduction is a long-term effort. Farmers generally need financial assistance to offset the initial costs of implementing BMPs. Depending on the type of operation, BMPs used in a single springshed may cost hundreds of thousands of dollars, although some BMPs are less costly

The Florida Springs Initiative (FSI) is currently working with the Florida Department of Agriculture and Consumer Service (DACS) on voluntary partnerships, such as the Suwannee River Partnership, that reduce nitrate-nitrogen loading in springsheds. However, there is also a need to evaluate their effectiveness because, like many water quality protection measures, these BMPs were designed with surface water quality in mind and not ground water.

Action Steps for Agriculture BMPs

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

➢ Goal: Reduce nutrient loading from agricultural sources in springs areas

3.4.1. *Scientifically evaluate agriculture BMPs and use the findings to modify agriculture BMPs to ensure ground water protection in springs areas.

Status: New Action. Agriculture BMPs are currently implemented on a voluntary basis and as part of some permit requirements. Some BMP effectiveness verification research is being conducted in certain places around the state, mainly in citrus production settings.

Next Steps: Document the strengths and weaknesses of these BMPs through scientific evaluation. Make data available from monitoring and research that evaluates the effectiveness of the incentive-based nutrient reduction BMPs.

3.4.2. Promote effective incentive-based programs as the preferred method for reducing nutrient loading in springs areas.

Status: Ongoing – Area of Need. The FSI is currently working with DACS to promote voluntary partnerships, such as the Suwannee River Partnership, that reduces nitrate-nitrogen loading in springsheds. DACS has also partnered with USDA-NRCS in the Jackson County Karst Region to provide BMP cost-share for practices that reduce nutrient loading. In addition, the USDA Conservation Reserve Program has enrolled a significant amount of acreage in this region in order to convert historical cropland to pine plantations.

Next Steps: Additional resources are needed to promote such partnerships in other areas of the state. Develop targeted BMP cost-share programs in NWFWMD and SRWMD that are protective of springsheds.

3.4.3. Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.

Status: Ongoing. The FSI is working with DACS and University of Florida Institute of Food and Agricultural Sciences (IFAS) to address these issues. DACS and IFAS also have a number of research projects that evaluate the environmental benefits of using

controlled release fertilizer products compared to conventional, more soluble inorganic fertilizer materials.

Next Steps: DACS needs to develop these plans in concert with other state agencies. The plan should include the following: delineation of the planning area; inventory of potential sources of nutrients; monitoring to track the status of nutrients in ground water and at spring sites; monitoring to determine effectiveness of BMPs; and targeted strategy for the reduction of nutrient loading from agricultural sources, including BMP cost-share programs and educational and technical assistance to implement proven BMPs. (See related action steps in 3.2 Wastewater Management, 3.3 Landscape BMPs, 3.5 Silviculture BMPs, 3.6 Stormwater Management)

3.4.4. Form partnerships of farmers, private organizations, environmental groups, state and federal agencies, and local governments to provide policy and technical guidance for the planning process, and to guide the long-term implementation of an action plan.

Status: Ongoing. The FSI is currently working with DACS on voluntary partnerships, such as the Suwannee River Partnership, to reduce nitrate-nitrogen loading in springsheds.

- **Goal: Protect sinkholes and other sensitive karst features on agricultural lands in springs areas**

3.4.5. Establish a 100-foot naturally vegetated buffer around sinkholes and other karst features that are directly connected to the aquifer.

Status: Ongoing.

Next Steps: NRCS and DACS need to promote inclusion of this buffer in farm management plans. Determine feasibility of designing a more effective buffer around sinkholes and karst windows.

3.4.6. *Encourage and assist private landowners to remove waste from sinkholes and other karst features in springs areas.

Status: Ongoing. Cleanups have been organized and accomplished through working groups in partnership with NGOs such as Current Problems/Adopt-A-River. While agricultural landowners are willing to clean out sinkholes on their property, the cost for hauling and disposing of the waste is high.

Next Steps: Local governments should provide a waiver to the landfill fee. FSI should provide a matching funds program.

3.4.7. Avoid the use of pesticides and fertilizers above known spring cave systems.

Status: Area of Need.

3.5. Silviculture BMPs

Forestry is one of the most compatible land uses for a springshed. However, there is a concern that application of fertilizers and pesticides in karst areas and other vulnerable portions of springsheds may affect spring water quality. Silviculture best management practices (BMPs) include leaving buffers around sinkholes and water bodies, and minimizing the use of pesticides and fertilizers.

Action Steps for Silviculture BMPs

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

➢ **Goal: Implement silviculture BMPs**

3.5.1. At a minimum, all forestry operations in springs areas should adopt the practices outlined in the DACS manual, *Best Management Practices for Silviculture 2003*.

Status: Ongoing. This manual is referenced in DACS rule 5I-6, FAC. See Appendix D

Next Steps: Monitor to confirm compliance near nutrient impaired springs.

3.5.2. *Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.

Status: Ongoing.

Next Steps: DACS needs to develop these plans in concert with other state agencies. The plan should include the following: delineation of the planning area; inventory of potential sources of nutrients; monitoring to track the status of nutrients in ground water and at spring sites; monitoring to determine effectiveness of BMPs; and targeted strategy for the reduction of nutrient loading. (See related action steps in 3.2 Wastewater Management, 3.3. Landscape BMPs, 3.4 Agriculture BMPs, 3.6 Stormwater Management)

➢ **Goal: Evaluate and improve silviculture BMPs**

3.5.3. Scientifically evaluate silviculture BMPs for ground water protection, especially concerning application of fertilizer and pesticides in springs areas.

Status: Area of Need.

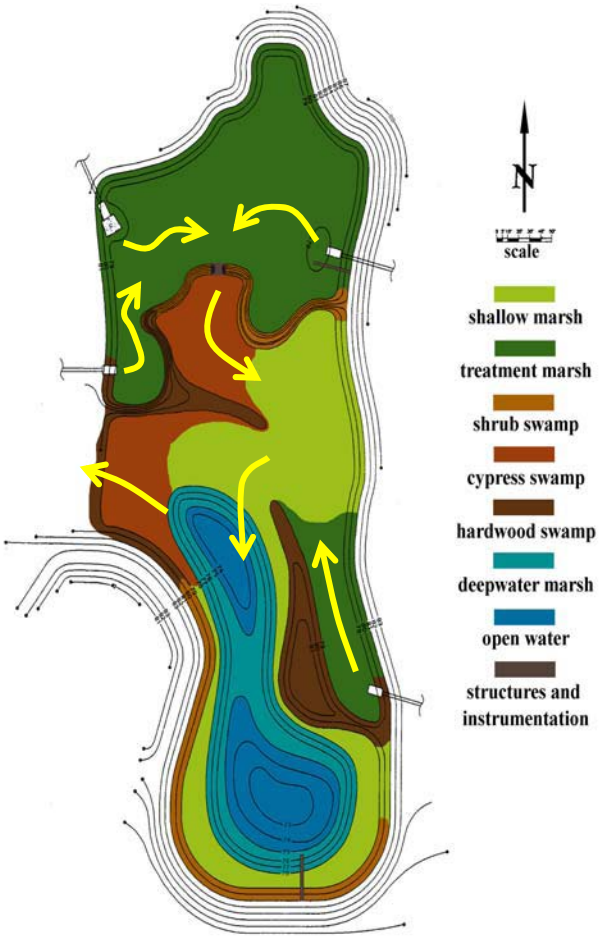
Next Steps: DACS and the forest industry need to implement evaluation in concert with other state and federal agencies. Make evaluation data available to agencies and the public.

3.5.4. Modify BMPs as necessary (based on scientific evidence) to achieve surface and ground water protection.

Status: Area of Need.

3.6. Stormwater Management

Perhaps the single greatest challenge facing springs today is reducing direct and indirect impacts from stormwater. Virtually all human activities in Florida modify natural drainage patterns that alter the way water seeps into the ground and runs off the landscape. In addition to changes in the quantity of water, land use activities can alter water quality as well. These two factors can impact surface waterways, ground water, and ultimately the springs. Few people realize the far reaching impact that stormwater can have on the overall quality and condition of our springs. If we take the time to study and trace the connectivity of the path of stormwater we discover that few if any natural systems in Florida can escape the infiltration of polluted stormwater in areas where stormwater management practices are absent, neglected, or inadequate to protect water resources.



Enhanced stormwater basin design that diversifies topography, directs internal flow and integrates wetland vegetative communities to improve water quality treatment and increase vegetative biodiversity and aesthetics. General flow pattern shown by yellow arrows. Graphic by Mark Clark

Most people are unaware that stormwater runoff is not just relatively clean rainwater that accumulates and eventually runs off during a storm event, but in fact contains particles picked up by the water as well as chemicals dissolved in the water as it moves over the landscape. Stormwater quality can change dramatically when fertilizers, pesticides, and other chemicals are applied, where animal waste is left exposed, and where the character of the land surface is disturbed during construction, tillage, and creation of roadway surfaces. In some instances stormwater laden with contaminants picked up from the land can be as polluted as domestic wastewater (sewage), and shares many of the same characteristics: high bacterial counts, high nutrient concentrations, and low dissolved oxygen. More commonly, contaminant levels in stormwater are much lower; however, even low levels may pose a threat to sensitive water resources.

Stormwater management objectives include flood protection to mitigate for changes in runoff volume due to development, as well as efforts to improve degraded water quality associated with alterations in the landscape. When we create rooftops, driveways, roads, parking lots, and other impermeable surfaces, seepage of rainwater into the ground and aquifer is blocked by impervious surfaces. As a result, a greater volume of water must now runoff and can lead to flooding. In order to better manage the threat of flooding, the state of Florida began

regulating stormwater runoff in the 1980s, requiring developers to construct stormwater ponds (Ch. 62-25 FAC) to capture increased runoff from development. Stormwater basins to a large extent mitigate for changes in runoff volume and effectively control flooding concerns. However, the diffuse seepage of rainfall in the predevelopment landscape is now often redirected to point recharge areas in stormwater basins, and contaminants associated with stormwater must also be treated within these same basins.

Unfortunately, efforts to mitigate for changes in stormwater quantity are not always conducive to efforts that mitigate for changes in stormwater quality. Stormwater systems were not originally designed to protect ground water from nutrients or other pollutants and although significant improvements in our understanding and application of management practices to address water quality are being made, these practices and technologies may not be adequate, especially in certain geologically sensitive areas. As an example, the most common stormwater systems utilized in high recharge soils are dry retention basins. Using this type of system, runoff is directed to the stormwater basins and allowed to infiltrate directly into the soil. These infiltration basins can be effective at treating stormwater by physical filtration as well as sorptive characteristics and microbial processes that occur within the soil. However, contaminants entering the soil are not removed at the same rate and no contaminant is completely removed. In addition, due to the high seepage rates associated with recharge basins, there is a greater likelihood for contaminants to pass through the soil and enter ground water below.

In the springs areas of Florida, the underlying aquifer systems are either **confined** or **unconfined**. Confined areas contain clayey sediments sufficiently thick as to provide some protection to the underlying aquifer systems. These sediments slow down the percolation of contaminant-laden water while filtering out some of the pollutants. However, the underlying aquifer system can still be vulnerable to contamination if karst features, such as sinkholes or swallets, have perforated the confining units. Unconfined areas contain little or no clayey sediments and the limestone that makes up the aquifer system is at or near the land surface. In unconfined or partly unconfined areas, there is a risk that typical stormwater practices do not provide sufficient treatment to protect ground water and springs.

Additionally, stormwater practices have traditionally included sinkholes as stormwater drains due to their high permeability, oftentimes drilling drainage wells into the bottom of sinkholes to increase infiltration rates. This practice of disposing of stormwater directly into sinkholes results in immediate impacts on ground water and local springs.

An additional concern in karst areas is the tendency of solution-pipe sinkholes to form in the bottom of some stormwater basins. When a sinkhole forms, it creates a direct connection between the bottom of the stormwater basin (where pollutants are concentrated) and the aquifer below. Runoff entering the aquifer by this route is untreated. To address this problem, in 1991 the St. Johns River Water Management District (SJRWMD) adopted more stringent criteria within the sensitive karst areas of western Alachua and Marion counties (Ch. 40C-42, FAC and Ch. 40C-41 FAC. Specific minimum design features are listed in 40C-41.063 FAC). These criteria address the potential for sinkhole development, but do not add other requirements that would improve water quality.

Above: Solution pipes like these in the Ocala Limestone at the Haile Quarry, Alachua County, FL, can result in rapid recharge and minimal attenuation of contaminants. Photo by Sam Upchurch

Left: This sinkhole formed in the bottom of a stormwater retention pond. Marion County is developing a springs protection plan that further addresses the need for advanced stormwater treatment techniques. Photo by Harley Means, FGS

In karst areas, alternative stormwater management practices that incorporate best management practices and low impact development concepts would be prudent. Most importantly, source control of contaminants, and efforts to limit new, and reduce existing impervious surface areas should be implemented. Source control and reduction of impervious surfaces addresses the root of the stormwater problem instead of simply focusing on the symptoms after stormwater has runoff the landscape and entered streams, lakes, estuaries or ground water.

Action Steps for Stormwater Management

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

➢ Goal: Implement enhanced stormwater management practices

3.6.1. Develop and adopt a sensitive karst procedure, or equivalent, for the design and construction of stormwater management systems in karst areas.

Status: Area of Need. A sensitive karst procedure has been included in draft ERP but has not been adopted by DEP. Karst areas need to be treated differently than non-karst areas. These areas can be defined by utilizing FAVA mapping at a county level as a guideline to assist in determining vulnerability. Stormwater basins and sinkholes function in the same manner, as point ground water recharge areas, and should be one and the same in how we treat them. For example, we approach protecting a sinkhole by creating berms, buffers, and fences to prevent unnecessary contaminants entering the aquifer, yet stormwater retention ponds are not provided the same protective strategies. To prevent contamination of stormwater basins, while allowing these same basins to mitigate for

runoff volume, we need to reduce contaminant sources and provide adequate treatment prior to recharge.

Next Steps: DEP, WMDs, and regional and local governments need to address this issue by revision to comprehensive plans and additional rulemaking. In unconfined aquifer areas designated as high vulnerability lands identified by FAVA mapping at a county specific level (see Action Step 3.1.1) (not the current state-wide FAVA model) catchment area and stormwater basins should be designed and managed to eliminate or provide adequate treatment of contaminants prior to infiltration or surface discharge of stormwater. Ways to address this in retention basins include: 1) the use of impermeable materials in a section of the basin where enhanced treatment methods could be applied, 2) pretreatment technologies within the stormwater conveyance system that remove contaminants before they reach the basin, and 3) implementation of source control measures within the catchment that eliminate contaminants from ever becoming a component of stormwater runoff within the catchment. In detention basins or in areas were multi-functional benefits and water quality improvements are desired, terracing within the pond and creating a multi-step pre-treatment process to reduce contaminants would be desirable. In addition, integration of native plant species to enhance soil, microbial, and vegetative processes to decrease contaminants prior to discharge should be promoted. Examples of integrated wetlands and enhancements within stormwater ponds exist in other areas of Florida and could be used as demonstration models to accomplish this objective.

3.6.2. Establish a validation procedure for the Sensitive Karst Areas Criteria (FAC Chapter 40C-41.063(7)) to determine its effectiveness at protecting ground water. Adjust the Karst Criteria, based on the results of the validation process.

Status: Area of Need. The Sensitive Karst Areas Criteria for SJRWMD have the primary goal of assuring the long-term structural integrity of a new stormwater pond or basin, in particular the tendency for solution pipes to form in karst areas. The criteria have been in place for more than a decade and are thought to be effective as to this goal. However, it is unknown whether the criteria also afford better ground water protection than conventional stormwater treatment systems.

Next Steps: DEP with SJRWMD and other WMDs need to create a validation process to determine effectiveness, including research on ground water quality underneath established ponds/basins designed using the Karst Criteria compared to conventional systems. Based on the results, modify the criteria.

3.6.3. Apply the validated Sensitive Karst Areas Criteria for stormwater treatment (subsection 40C-41.063(7) FAC) in all springsheds of the state as referenced in the springs area map, including stream-to-sink (swallet) basins and sinkholes.

Status: Area of Need. The Sensitive Karst Areas Criteria are only in effect in the St. Johns River Water Management District in areas where karst occurs at or just beneath the land surface. There is potential for better ground water protection if the criteria are adopted in other Water Management Districts. The criteria do not address the protection of karst features, but only the structural integrity of the area affected by construction of a new stormwater pond/basin. New stormwater design criteria may be needed to protect

karst features, especially sinkholes, from discharge of untreated stormwater. Current stormwater treatment regulations vary and some do not treat stream-to-sink water bodies as more sensitive or in any way different from other water bodies, and require no pre-treatment for discharges to dry sinkholes.

Next Steps: DEP should promote the inclusion of Sensitive Karst Criteria and new karst feature protection measures in all ERPs in Florida's springsheds.

3.6.4. Require pre-treatment design (for example, swales, berms, ponds, or dry basins) to retain runoff that currently discharges directly into karst features such as sinkholes and springs.

Status: Ongoing. A few municipalities and counties do require this.

Next Steps: Continue the Model Land Development Code program and other DCA programs to work with local governments to establish and require pre-treatment design.

3.6.5. Scientifically evaluate stormwater treatment facilities and systems' maintenance practices to ensure they protect surface water and ground water resources in springs areas.

Status: Area of Need.

Next Steps: In order to verify effectiveness of stormwater BMPs, verification monitoring must be implemented (see action steps in 2.1 Research and 2.2 Monitoring). DEP, WMDs, and local and regional governments need to coordinate their programs to accomplish this (there are some areas of conflict). In unconfined areas, stormwater facilities should treat water to tertiary standards before being released. This additionally could be used for re-use water. Local and regional agencies should develop requirements to reuse stormwater (see action steps in 4.1 Water Quality Regulations).

3.6.6. Promote use of native vegetation to assist in stormwater treatment.

Status: Area of Need. Some current rules require the use of turf in retention ponds; this approach is useful for initial bank stabilization. However, active mowing and potential fertilizer application to the turf may be counter productive to water quality and other multifunctional benefits that the basin can provide. Integration of a more diverse vegetative community that requires less management and can provide enhanced water quality and other benefits should be promoted.

Next Steps: Rules should be evaluated by local governments and DEP, especially to promote native vegetation instead of turf grass. In areas defined as high vulnerability regions, turf requiring fertilizers should be disallowed. Retention and detention ponds should be terraced and high uptake Florida-friendly vegetation should be utilized.

3.6.7. *Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.

Status: Ongoing. An effort is underway to make changes to current Environmental Regulation Commission (ERC) language to clearly define the difference between confined and unconfined aquifers within the state and how to minimize nutrient impacts in springsheds in unconfined regions.

Next Steps: Appropriate entities should develop Best Management Practices/nutrient reduction plans with appropriate agencies. These Best Management Practices/nutrient reduction plans should be verified as outlined in Research and Monitoring action steps. The plan should include the following: delineation of the planning area; inventory of potential sources of nutrients; monitoring to track the status of nutrients in ground water and at spring sites; monitoring to determine effectiveness of BMPs; and targeted strategy for the reduction of nutrient loading. This action item will address the more spatially diffuse entry of contaminants into the soil and ground water, and will focus at the point of application where concentrations are often highest and most effectively controlled. (See related action steps in 3.2 Wastewater Management, 3.3 Landscape BMPs, 3.4 Agriculture BMPs, 3.5 Silviculture BMPs.)

3.6.8. *Inspect existing stormwater management systems, retrofit and repair systems that are substandard, and perform maintenance to assure that flood control and water quality benefits are achieved.

Status: New Action. Some existing stormwater management systems (State and County) are in need of repair, are substandard, and/or discharge directly into a sinkhole or other sensitive karst feature. Over time, the system of culverts and ponds can fall into disrepair and accumulate silt and debris, thus requiring repair, retrofit, and maintenance.

3.7. Sinkhole Protection

Next to springs, sinkholes and swallets represent some of Florida's most unique natural resources. These features play a crucial role in the hydrogeology of Florida's karst landscape and are sometimes strikingly beautiful. Sinkholes come in many forms and types and, like springs, are considered windows to Florida's aquifer systems. Some may be filled with sediments while others contain azure blue pools with evidence of flow as ground water passes through these portals. Ground water entering a sinkhole may be destined to ultimately discharge at a nearby spring.

Common throughout a large part of the state, sinkholes can vary in size from the enormous Devils Millhopper in Alachua County to small depressions. Sinkholes are often formed when surface sediments collapse into subsurface voids in the underlying limestone. Sinkholes may connect to a conduit system or may simply be a collapsed void. Most sinkholes provide direct access for surface water to enter the Floridan Aquifer System with little or no filtration or nutrient removal.

This sinkhole near Eustis, Florida has been utilized for many years for the disposal of agricultural wastes (fuel, lubricant, pesticide and herbicide containers). Bedrock and a conduit into the limestone was exposed at the bottom of the sinkhole. Photo by Sam Upchurch

Sinkholes with an exposed or open pool of water represent the most vulnerable type of sinkholes because they are able to convey contaminants to adjacent springs and rivers. Only a fraction of the known sinkholes in Florida constitute this type. Sediment-filled sinkholes are more commonly found in karst landscapes and also allow surface water to flow into the Floridan Aquifer System with little or no reduction in contaminants.

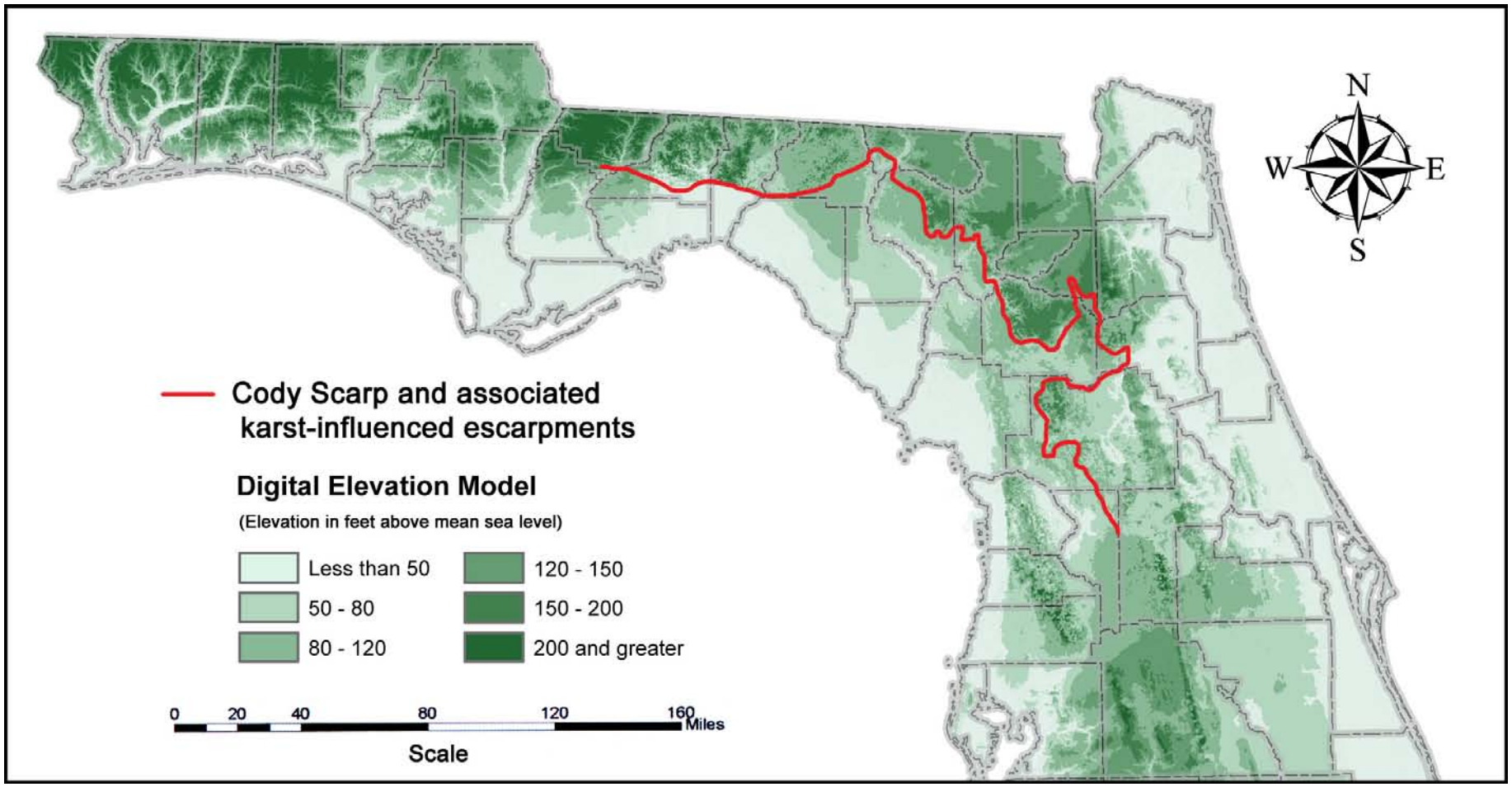
Another type of sinkhole, which is of particular concern, is termed a **swallet**, **swallow hole**, or sinking stream. These features often occur in streambeds that are dry until a major rain event when they become siphons that drain surface water directly into the aquifer system. Some swallets are found in riverbeds where they accept water whenever the river is flowing. Most of these swallets are located near the Cody Escarpment (Figure 2). The base of the escarpment, where the swallets often occur, is defined by the 50-foot to 100-foot land surface elevations. The Cody Escarpment forms the boundary between the uplands and the karstic lowlands). The uplands are characterized by the occurrence of impermeable sediments and many lakes and streams. Streams that flow from the uplands to the karstic lowlands and into sinkholes transport surface water directly into the Floridan Aquifer System.

Dye trace studies conducted at some sinkholes and swallets have shown that ground water flow paths are capable of transporting water many miles before returning to the surface at springs. The importance of these findings cannot be overstated – we now know that what enters our surface streams in the uplands has a direct impact on the quality and condition of our drinking water and springs. In the past, sinkholes (and lime rock mines that were often originally sinkholes) have been utilized by municipalities, landowners, and vandals as dumps.

Geological investigations have shown that there are also many forms of sinkhole-related features. Some of these have a direct connection to the aquifer although this may not be visibly obvious. One of the hidden and subtle expressions of unconfined karst regions is represented by a feature called **epikarst**. An epikarst region contains numerous naturally formed, vertical solution pipes and fractures that provide a direct route for water to rapidly permeate through the thin, sandy soils. Although these features are not commonly thought of as "sinkholes," they pose an equal or greater risk of contamination to the aquifer as traditional sinkholes do.

Epikarst in quarry. Photo by Tom Scott, FGS

Figure 2. Cody Escarpment



Source: FGS

A better understanding of the geology of individual sinkholes, their role, and connectivity to ground water flow paths is essential if we are to protect springsheds and related springs. Sinkholes are highly variable in their origins, connectivity to the aquifer, and relationship to other karst features, including caves. The relative location of a sinkhole in context to ground water flow direction and karst features are all especially relevant to the decision-making process of when and how to protect them.

Action Steps for Sinkhole Protection

➢ **Goal: Identify vulnerable sinkholes and promote and support sinkhole cleanups**

3.7.1. *Identify and prioritize sinkhole connectivity and impact to the aquifer.

Status: New Action. Some sinkhole-related features have a direct connection to the aquifer although they visibly appear not to. Although these features are not commonly thought of as "sinkholes," they pose equal or greater risk of contamination to the aquifer, as do traditional sinkholes.

3.7.2. Encourage and assist private landowners with sinkhole cleanup and protection. After sinkholes are cleaned they should be protected from future dumping.

Status: Ongoing. Trash and other debris has been removed from some sinkholes by working groups, volunteers, environmental groups, and diving groups, including 2 projects funded by FSI in the Wakulla Springshed. The SWFWMD has conducted a pilot sinkhole cleanup project, beginning in 2005 and continuing through 2006. Work has been done on both publicly owned and private lands, cleaning up eight sinks in the District and removing several tons of debris. Other cleanup projects have been identified by the FSI, springs working groups, citizens support organizations (CSOs), and environmental groups.

Next Steps: Continue to prioritize springsheds and identify the high-risk sinkholes that exist within those springsheds (see Action Step 3.7.1). This should be done in order to prioritize sinkhole cleanups. Protection measures include: posting signage, installing fencing and berms, establishing setbacks, establishing fines, and continuing enforcement of illegal dumping laws. (See also Action Steps 3.4.5, 3.4.6, and 3.4.7)

3.8. Golf Course BMPs

With the continuing popularity of golf, and Florida's growing population, many new golf courses are being built in the State. Florida has over 1500 golf courses, representing over 200,000 acres of land use. Studies have shown that chemicals used on golf courses can contaminate ground water and surface water resources. The use of best management practices (BMPs) in the operation and maintenance of golf courses can reduce the potential for negative impacts to water resources. An Integrated Pest Management Plan (IPMP) is the cornerstone of environmentally responsible golf course management. An IPMP guides golf course managers in the responsible storage, handling, and application of chemicals and in the use of native vegetation in golf course landscape plans. Ideally, IPMPs should also include water quality monitoring programs.

Action Steps for Golf Course BMPs

Note: The term "springs areas" as used in this section refers to the areas in Figure 1 (page 82).

➢ **Goal: Encourage the use of Golf Course BMPs**

3.8.1. Work with state agencies to develop and adopt rules for required BMPs for golf course design, operation, and maintenance. Include a resource management plan, an Integrated Pest Management Plan, and a ground water-monitoring plan for the operation of golf courses in Florida.

Status: Ongoing. The FSI is working in cooperation with DCA on the development of golf course BMPs. The FSI is currently funding a project with Audubon International to develop BMPs at Rainbow Springs Golf and Country Club that may be utilized as a template for other projects. A nutrient reduction management plan has been completed and implemented at Rainbow Springs Golf and Country Club. A nutrient management plan has been completed for Rock Springs Golf and Country Club and will be implemented by 2006.

Next Steps: Apply BMPs at golf courses located in springs areas.

3.8.2. *Scientifically evaluate golf course BMPs to ensure surface water and ground water protection in springs areas.

Status: New Action. There is existing research on this topic. However, some BMPs (such as the IFAS Golf Course Manual) were not designed to protect springs.

3.8.3. *Require golf courses in springs areas to use reuse water from AWTPs when available.

Status: New Action. This is occurring in some cases and golf courses are supportive.

Next Steps: State programs are needed to assist with the cost of installing a water line. On a case by case basis, evaluate what alternatives for supply and reuse are available.

3.9. Land Acquisition

One of the regrets of my life is that I was always too poor to buy some of them [springs] back in the days when they were still unspoiled and not worth much money. Their like existed nowhere else in the world. – Archie Carr

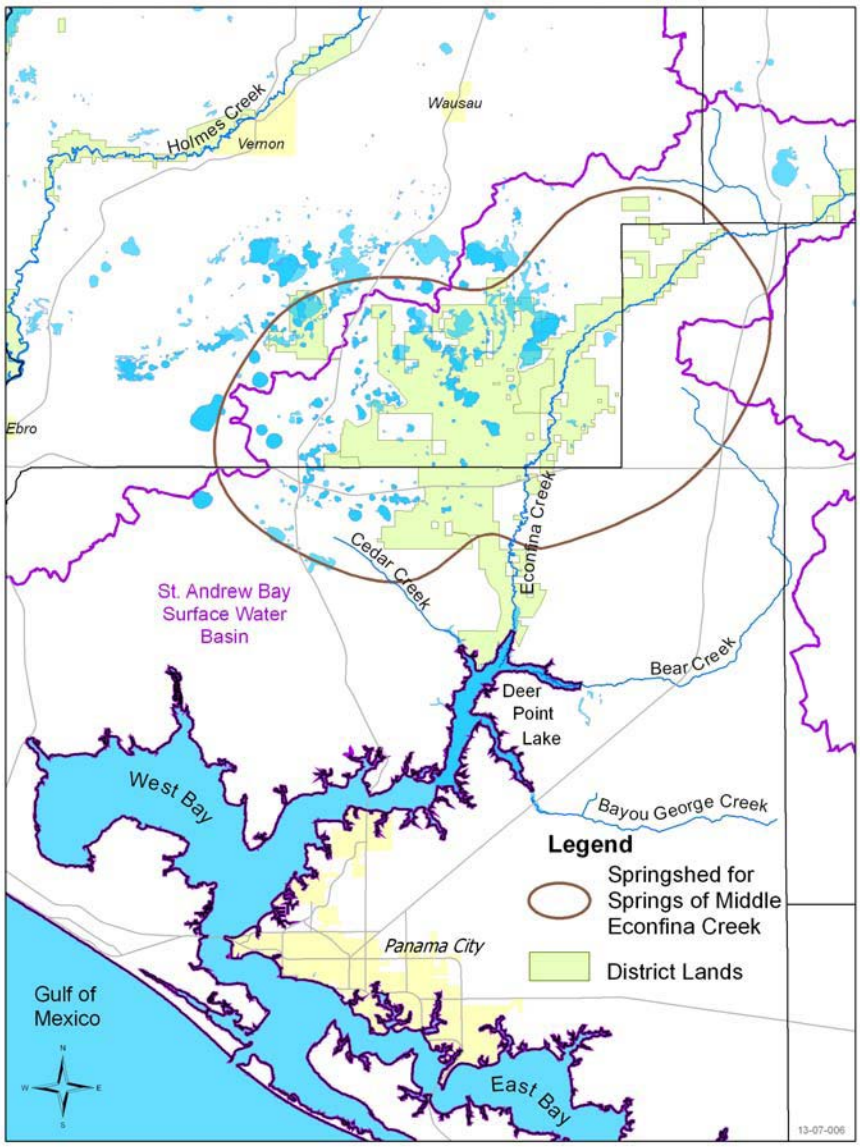
Florida's springs are owned by both public and private entities. In 1949, Manatee Springs was the first spring purchased by the State of Florida. Since then, dozens of springs have been purchased by federal, state, regional, and local governments to provide protection for the springs while making them available for outdoor recreation. Although many private spring owners provide adequate stewardship, not all are able to do so. Some springs have become degraded by misuse and inadequate protection.

The values and benefits of a spring are found at the spring. These values, including scenic beauty, recreation, and wildlife, are dependent on the spring's water.

Acquisition of a spring can ensure protection of the spring itself, but does not ensure protection of the water's quality or quantity. Protection of the water must occur in the springshed, before the water reaches the spring.

The most effective way to protect the quality and quantity of spring water is to acquire land in the springshed and manage it for that purpose. Acquisition of an entire springshed is usually not feasible, but acquisition of the most vulnerable portions may provide substantial protection. Such areas will likely be near the spring and may include sinkholes and other karst features that are hydrologically connected to the spring.

The most successful springshed acquisition to date was achieved by the Northwest Florida Water Management District (NWFWMD) although it was primarily intended to protect the water supply. Through 2005 the NWFWMD has acquired approximately 42,000 acres along the middle Econfina Creek in Washington and Bay counties. This mostly upland purchase protects much of the recharge area for the many Floridan Aquifer System springs found along the middle Econfina Creek, including the first-magnitude Gainer Springs.



The area shown in pale green at the center of the map represents the portion of the Gainer Springs springshed that was acquired by NWFWMD in an effort to protect the water supply for much of Bay County. Such strategies also protect the other values of springs, including recreation and scenic beauty.
Source: NWFWMD

Action Steps for Land Acquisition

➢ Goal: Protect springs, springsheds, and karst features through land acquisition

3.9.1. Identify and acquire the most vulnerable portions of springsheds and give these lands priority ranking in land acquisition programs.

Status: Ongoing. Through public and private environmental land acquisition programs, thousands of acres have been acquired for the purpose of protecting springs and springsheds. Additional acquisition needs are being identified. The Acquisition and Restoration Council (ARC), which guides the Florida Forever program, is now looking at spring recharge lands.

3.9.2. Give priority to the acquisition of springs that cannot be adequately protected and managed by the current owner or are at risk of being developed.

Status: Ongoing. The Florida Forever land acquisition program includes several springs acquisition projects. Springs and areas within springsheds can be added as boundary modifications to the springs projects rather than independent land acquisition projects. This creates a more streamlined process for these parcels and gives them high priority for acquisition.

Next Steps: Evaluate the First Magnitude Springs Florida Forever project to promote acquisition of these springs.

3.9.3. Continue to focus the efforts of state land acquisition programs on spring systems with manatee use.

Status: Ongoing.

3.9.4. Ensure that springs acquired through environmental lands programs are managed by agencies experienced in the sensitive stewardship and use of springs.

Status: Area of Need.

Next Steps: Establish a training program and management plans to ensure proper management. This can be done through Florida Forever in combination with FSI.

3.9.5. When acquisition is not feasible, conservation easements should be sought to protect springs and areas within springsheds.

Status: Ongoing. However, many of the conservation easement agreements for large agricultural parcels allow established practices, such as maintenance of improved pasture for cattle grazing, hay cultivation, silviculture, etc.

Next Steps: State agencies and local governments. In the agreements made between parties, specific details regarding acceptable land use practices and BMPs need to be reviewed and strengthened for springs protection.

3.10. Recreation and Land Management

The springs have been brutalized; but even they could be restored with careful tending.
– Archie Carr

Springs have long been popular recreational sites. Too often, springs with uncontrolled public access become seriously damaged. In the absence of steps, fencing, directional signs, and onsite staff, considerable harm can befall the scenic and biological values of a spring. Typically, vegetation that stabilizes the slope and shoreline becomes trampled and uprooted, foot traffic and stormwater further erode the soils, and the spring begins to fill with sand and debris. Submerged aquatic plants in the spring and spring run become trampled. Vehicle traffic on the uplands around the spring also causes damage. Frequently, littering and dumping further degrade the site. Volusia Blue Spring and the Ichetucknee Head Spring suffered from these problems until they were purchased by the state. These and other springs and sinkholes brought into public ownership eventually benefit from clean-ups and erosion control measures. A few private springs and sinkholes have benefited from Florida Springs Initiative landowner assistance grants.

These steps were built over the eroded bank to prevent further erosion of soil into Cherokee Sink in Wakulla Springs State Park. Photo from Florida Park Service

Action Steps for Recreation Management

> ➢ **Goal: Reduce recreation impacts on springs, protected species, and springs-related habitat**

3.10.1. *Develop a comprehensive training program for springs managers including concessionaires.

Status: New Action.

Next Steps: Consult experienced spring managers for technical assistance on protection and management procedures. Make this training mandatory for state park managers while inviting others such as county parks and privately owned springs.

3.10.2. Springs-related recreational activities should be managed to minimize their effect on protected, rare, endemic, and managed species (including manatees).

Status: Ongoing. State park and federal refuge management plans include management strategies to ensure that recreational activities have a minimal effect on these species.

Next Steps: Strategies should be developed and implemented for springs without management strategies to address recreational impacts on these species. Existing state park and federal refuge management plans should be updated, when appropriate, to ensure that effective strategies are being used.

3.10.3. *Control foot and vehicle traffic through the use of steps, fencing, and directional signs.

Status: Ongoing. Erosion restoration and prevention projects have recently occurred at many state parks with FSI assistance, including De Leon Springs, the Santa Fe River Rise, Rainbow Springs, Manatee Springs, Homosassa Springs, Volusia Blue Spring, Troy Springs, River Rise Preserve, Wekiwa Springs, and Cherokee Sink in Wakulla Springs State Park. In Wakulla County, Tucker Sink also had an erosion control project.

3.10.4. *Minimize the amount of upland/shoreline clearing of vegetation and only clear in the areas where direct access is allowed.

Status: Ongoing. Funded in part by FSI, Current Problems/Adopt-A-River implemented a shoreline restoration program at Poe Springs in 2004, in which mowed areas were significantly reduced to allow the natural vegetation to return, and shorelines were reinforced and replanted with native trees and shrubs.

3.10.5. *Use exhibits, interpretive signs, leaflets, or staff to help educate users about the values of the spring and how to minimize impacts.

Status: New Action. (See action steps in 1.1 Education)

3.10.6. *Use stormwater management and erosion control methods to protect the spring from contamination, sedimentation, and turbidity problems from upland activities. Direct stormwater away from the spring and maintain a buffer between the uplands and the spring and spring run.

Status: Ongoing. FSI-funded erosion control and stormwater projects were completed at Peacock Springs and Manatee Springs state parks.

3.10.7. *If motorboats are permitted, designate and control the number and locations of specific mooring spaces for boats.

Status: New Action.

Next Steps: Include signage that states: when pulling the boat out of the water, do not pull the drain plugs until the boat is away from the boat ramp and on a pervious area. This will prevent pollutants in the bilge water from entering surface waters.

3.10.8. *Provide trash receptacles and routinely empty them to reduce littering.

Status: Ongoing. Most public lands implement this in areas of recreation use.

3.10.9. *Provide a system for human waste disposal.

Status: Ongoing. Most public lands implement this in areas of recreation use.

Next Steps: (See Action Step 3.2.8 in Wastewater Management)

3.10.10. *Delineate a specific swimming area with buoyed lines to reduce impacts of swimming on submerged vegetation in the spring or spring run.

Status: Ongoing. Most public lands implement this in areas of recreation use.

3.10.11. *Prohibit fossil or artifact collecting by the public.

Status: Ongoing. Fossil and artifact collecting are prohibited state wide.

Next Steps: Private and public springs managers should enforce this and post signs to notify the public that it is prohibited.

3.10.12. *Prohibit feeding of wildlife associated with the spring or spring run, including alligators.

Status: Ongoing. Feeding wildlife is prohibited state wide.

Next Steps: Private and public springs managers should enforce this and post signs to notify the public that it is prohibited.

3.10.13. *Control the number of divers in the spring at any one time by requiring that they receive permission from the owner to dive.

Status: Ongoing. Most public lands implement this in areas of recreation use.

3.10.14. *Develop educational programs targeting swimmers, boaters, and SCUBA divers, which focus on the sensitive ecology of spring runs and how to avoid disturbing plants and animals.

Status: Ongoing. Signs have been installed at some public springs.

Next Steps: (See action steps in 1.1 Education)

3.10.15. *Organize an Adopt-A-Spring effort in cases where a spring owner cannot provide adequate control of public access and use.

Status: New Action.

Next Steps: With permission of the owner, volunteers would implement appropriate erosion controls and other access-control BMPs. They could also provide periodic maintenance and repairs.

➢ Goal: Manage springs, protected species, and springs-related habitat

3.10.16. Management plans for State and Federally owned spring systems should include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.

Status: Ongoing. State parks and federal refuges are updating and/or developing site management plans in coordination with local governments, resource protection agencies, and interest groups. Where present or known, species protection strategies are included in these plans.

Next Steps: Spring systems with listed and candidate species in need of management plans should be identified and coordinated plans should be developed. Include coordination with protected species recovery plans where applicable.

3.10.17. *Encourage development of management plans for private and local government owned springs that include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.

Status: New Action.

Next Steps: Funding is needed for these management plans.

3.10.18. Manage aquatic plant control programs in spring areas used by manatees to ensure adequate winter forage for manatees and prohibit control activities when manatees are present.

Status: Ongoing. Some springs used by wintering manatees (Crystal River-Kings Bay springs complex in Citrus County and Volusia Blue Spring in Volusia County) have aquatic plant control programs that consider manatee winter foraging needs and prohibit control activities when manatees are present. Federal aquatic plant control program guidance stipulates that, when manatees are present, control activities must cease.

Next Steps: Develop programs for spring systems currently used by manatees in areas where such programs are absent.

Implementation Table – Land Use Planning & Management Strategies

Action Number	Action Description	Status	Participants
3. Land Use Planning & Management Strategies			
3.1 Land Use Planning			
Goal: Local governments will adopt springshed protection programs as part of local comprehensive plans and land development regulations.			
3.1.1.	Identify the most vulnerable areas of springsheds and assist local governments in creating zones of special consideration for land use planning or regulation.	Ongoing	FGS, DCA, Contractors, Local Gov't
3.1.2.	Develop criteria for state agencies to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments that potentially impact springs.	Ongoing	DCA
3.1.3.	Develop criteria for local governments to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments and local land use actions that potentially impact springs.	Ongoing	DCA, Local Gov't
3.1.4.	Develop and implement comprehensive plan policies, ordinances, and LDRs to protect springsheds and karst features with probable direct connections to the aquifer.	Ongoing	DCA, Local Gov't, FSTF
3.1.5.	Develop goals and objectives in the intergovernmental coordination elements of comprehensive plans to cooperatively create approaches and measures needed to protect and restore ground water and springs.	Area of Need	DCA, DEP
3.1.6.	Identify and inform local governments of land uses that are known to adversely affect spring water quality.	Area of Need	DEP, DCA
Goal: Implement enhanced springs protection measures at the regional level.			
3.1.7.	Revise Regional Planning Council Strategic Regional Policy Plans to recognize the aquifer(s) as a natural resource of regional significance in springs areas.	Area of Need	RPC
3.1.8.	Consider legislative action to identify the aquifer(s) as a natural resource of regional significance in all Strategic Regional Policy Plans in spring areas and provide enhanced protection for these resources under that process.	Area of Need	DEP, FSTF, Legislature

Action Number	Action Description	Status	Participants
Goal: Modify the Development of Regional Impact Review Process to address multi-jurisdictional impacts to springs and springsheds.			
3.1.9.	Modify DRI review criteria to address impacts to ground water resources.	Area of Need	DCA, DEP, DOT, DACS, FWC
3.1.10.	Continue to develop, evaluate, and revise best development practices and BMPs for application in springsheds.	Ongoing – Area of Need	DEP
3.1.11.	Reviewing agencies should recommend that local governments include requirements to implement ground water protection BMPs in all DRI development orders in springs areas.	Area of Need	DCA, DEP, DOT, DACS, FWC
3.1.12.	Propose legislation to prohibit state agencies from issuing permits for activities in springs areas that are inconsistent with the applicable local government comprehensive plan and land development regulations.	Area of Need	DEP, Legislature
3.2. Wastewater Management			
Goal: Encourage use of efficient nitrogen removal technologies			
3.2.1.	Within springs areas, permit only nitrogen-reducing performance based Onsite Sewage Treatment and Disposal Systems for new construction, modifications, or to replace failing systems.	Ongoing – Area of Need	DEP, DOH, DCA
3.2.2.	Identify and provide incentives that will encourage the use of more efficient nitrogen and nutrient removal technologies.	Area of Need	DEP, DOH
3.2.3.	Promote legislation that would make approval of DRIs and large-scale developments within a springshed contingent upon the construction of a centralized, advanced wastewater treatment plant (AWTP).	Area of Need	DEP, Legislature
Goal: Upgrade existing wastewater facilities to state of the practice or similar			
3.2.4.	Amend existing statutes or ordinances to require OSTDS inspection and maintenance every five years or when property is sold, and upgrade to current standards as needed.	Area of Need	DOH, Local Gov't, FSTF, Legislature
3.2.5.	*Require local governments within springs areas to upgrade existing wastewater treatment facilities to Advanced Wastewater Treatment Plant (AWTP) and require new wastewater treatment facilities in the springs areas to operate at an AWTP standard and provide water reuse within the springshed.	New Action	DEP, Local Gov't, DOH
Goal: Evaluate and manage nutrient contributions			
3.2.6.	*Nutrient reduction plans specific to the springshed should be developed for nutrient	Ongoing	Interagency

Action Number	Action Description	Status	Participants
	impacted springs.		Coordination
3.2.7.	A nutrient management plan should be incorporated in permits that regulate wastewater treatment facilities in springs areas.	Area of Need	DEP, FSTF
3.2.8.	State parks with springs shall have the best available wastewater treatment technology for nutrient removal or connect to an offsite AWTP.	Ongoing	DEP, State Parks
3.3 Landscape BMPs			
Goal: Encourage efficient and limited application of fertilizer and pesticides in springs areas.			
3.3.1.	Encourage efficient and limited application of fertilizer on public properties in springs areas and create landscaping conditions and other BMPS where the reduction of fertilizer is appropriate.	Ongoing	DOT, County Park, Private Park, Local Gov't, Contractor
3.3.2.	*Encourage efficient and limited application of pesticides on public properties in springs areas. Create landscaping conditions and other BMPS where the reduction of pesticides is appropriate.	New Action	DOT, County Park, Private Park, Local Gov't, Contractor
3.3.3.	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	Interagency Coordination
Goal: Minimize fertilizer and pesticide dependent areas in landscape design.			
3.3.4.	Require the retention of large areas of native vegetation and/or installation of Florida friendly vegetation in common areas within springs areas.	Area of Need	Local Gov't
3.3.5.	Develop model deed restrictions that incorporate Florida friendly landscaping principles.	Area of Need	DCA, Local Gov't, FYN
3.4 Agriculture BMPs			
Goal: Reduce nutrient loading from agricultural sources in springs areas.			
3.4.1.	*Scientifically evaluate agriculture BMPs and use the findings to modify Agriculture BMPs to ensure ground water protection in springs areas.	New Action	DEP
3.4.2.	Promote effective incentive-based programs as the preferred method for reducing nutrient loading in springs areas.	Ongoing – Area of Need	DEP, DACS, USDA-NRCS, WMD
3.4.3.	Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	DACS, Interagency Coordination
3.4.4.	Form partnerships of farmers, private organizations, environmental groups, state and federal agencies, and local governments to provide policy and technical guidance for the planning process, and to guide the long-term implementation of an action plan.	Ongoing	DEP, DACS, NGO, Private
Goal: Protect sinkholes and other sensitive karst features on agricultural lands in springs areas.			
3.4.5.	Establish a 100-foot naturally vegetated buffer around sinkholes and other karst features	Ongoing	NRCS, DACS

Action Number	Action Description	Status	Participants
	that are directly connected to the aquifer.		
3.4.6.	*Encourage and assist private landowners to remove waste from sinkholes and other karst features in springs areas.	Ongoing	DEP, Local Gov't, NGO, Private
3.4.7.	Avoid the use of pesticides and fertilizers above known spring cave systems.	Area of Need	Private
3.5 Silviculture BMPs			
Goal: Implement silviculture BMPs			
3.5.1.	At a minimum, all forestry operations in springs areas should adopt the practices outlined in the DACS manual, *Best Management Practices for Silviculture* 2003.	Ongoing	DACS
3.5.2.	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	New Action	DACS, Interagency Coordination
Goal: Evaluate and improve silviculture BMPs			
3.5.3.	Scientifically evaluate silviculture BMPs for ground water protection, especially concerning application of fertilizer and pesticides in springs areas	Area of Need	DACS, Private
3.5.4.	Modify BMPs as necessary (based on scientific evidence) to achieve surface and ground water protection.	Area of Need	DACS, Private
3.6 Stormwater Management			
Goal: Implement enhanced stormwater management practices.			
3.6.1.	Develop and adopt a sensitive karst procedure, or equivalent, for the design and construction of stormwater management systems in karst areas.	Area of Need	DEP, WMD, RPC, Local Gov't
3.6.2.	Establish a validation procedure for the Sensitive Karst Areas Criteria (FAC Chapter 40C-41.063(7)) to determine its effectiveness at protecting ground water. Adjust the Karst Criteria, based on the results of the validation process.	Area of Need	DEP, WMD
3.6.3.	Apply the validated Sensitive Karst Areas Criteria for stormwater treatment (subsection 40C-41.063(7) FAC) in all springsheds of the state as referenced in the springs area map, including stream-to-sink (swallet) basins and sinkholes.	Area of Need	DEP, WMD
3.6.4.	Require pre-treatment design (for example, swales, berms, ponds, or dry basins) to retain runoff that currently discharges directly into karst features such as sinkholes and springs.	Ongoing	DCA, Local Gov't
3.6.5.	Scientifically evaluate stormwater treatment facilities and systems' maintenance practices to ensure they protect surface water and ground water resources in springs areas.	Area of Need	DEP, WMD, RPC, Local Gov't
3.6.6.	Promote use of native vegetation to assist in stormwater treatment.	Area of Need	DEP
3.6.7	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	Interagency Coordination

Action Number	Action Description	Status	Participants
3.6.8.	*Inspect existing stormwater management systems, retrofit and repair systems that are substandard, and perform maintenance to assure that flood control and water quality benefits are achieved.	New Action	DOT, County
3.7 Sinkhole Protection			
Goal: Identify Vulnerable Sinkholes			
3.7.1	*Identify and prioritize sinkhole connectivity and impact to the aquifer.	New Action	DEP, FGS
3.7.2.	Encourage and assist private landowners with sinkhole cleanup and protection. After sinkholes are cleaned they should be protected from future dumping.	Ongoing	DEP, Local Gov't, NGO, Private
3.8. Golf Course BMPs			
Goal: Encourage the use of Golf Course BMPs			
3.8.1.	Work with state agencies to develop and adopt rules for required BMPs for golf course design, operation, and maintenance. Include a resource management plan, an Integrated Pest Management Plan, and a ground water-monitoring plan for the operation of golf courses in Florida.	Ongoing	DEP, Private
3.8.2.	*Scientifically evaluate golf course BMPs to ensure surface water and ground water protection in springs areas.	New Action	DEP
3.8.3.	*Require golf courses in springs areas to use reuse water from AWTPs when available.	New Action	DEP
3.9. Land Acquisition			
Goal: Protect springs, springsheds, and karst features through land acquisition.			
3.9.1.	Identify and acquire the most vulnerable portions of springsheds and give these lands priority ranking in land acquisition programs.	Ongoing	DEP, WMD, FCT, Florida Forever
3.9.2.	Give priority to the acquisition of springs that cannot be adequately protected and managed by the current owner or are at risk of being developed.	Ongoing	ARC
3.9.3.	Continue to focus the efforts of state land acquisition programs on spring systems with manatee use.	Ongoing	DEP, WMD
3.9.4.	Ensure that springs acquired through environmental lands programs are managed by agencies experienced in the sensitive stewardship and use of springs.	Area of Need	DEP, Florida Forever
3.9.5.	When acquisition is not feasible, conservation easements should be sought to protect springs and areas within springsheds.	Ongoing	DEP, WMD, Local Gov't
3.10. Recreation and Land Management			
Goal: Reduce recreation impacts on springs, protected species and springs-related habitat			
3.10.1.	*Develop a comprehensive training program for springs managers including concessionaires.	New Action	DEP, FGS, State Park

Action Number	Action Description	Status	Participants
3.10.2.	Springs-related recreational activities should be managed to minimize their effect on protected, rare, endemic, and managed species (including manatees).	Ongoing	State Park, NWR, Local Park, Private Park
3.10.3	*Control foot and vehicle traffic through the use of steps, fencing, and directional signs.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.4	*Minimize the amount of upland/shoreline clearing of vegetation and only clear in the areas where direct access is allowed.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.5	*Use exhibits, interpretive signs, leaflets, or staff to help educate users about the values of the spring and how to minimize impacts.	New Action	State Park, NWR, Local Park, Private Park, NGO, CSO, USFS
3.10.6	*Use stormwater management and erosion control methods to protect the spring from contamination, sedimentation, and turbidity problems from upland activities. Direct stormwater away from the spring and maintain a buffer between the uplands and the spring and spring run.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.7	*If motorboats are permitted, designate and control the number and locations of specific mooring spaces for boats.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.8	*Provide trash receptacles and routinely empty them to reduce littering.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.9	*Provide a system for human waste disposal.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.10	*Delineate a specific swimming area with buoyed lines to reduce impacts of swimming on submerged vegetation in the spring or spring run.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.11	*Prohibit fossil or artifact collecting by the public.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.12	*Prohibit feeding of wildlife associated with the spring or spring run, including	Ongoing	State Park, NWR,

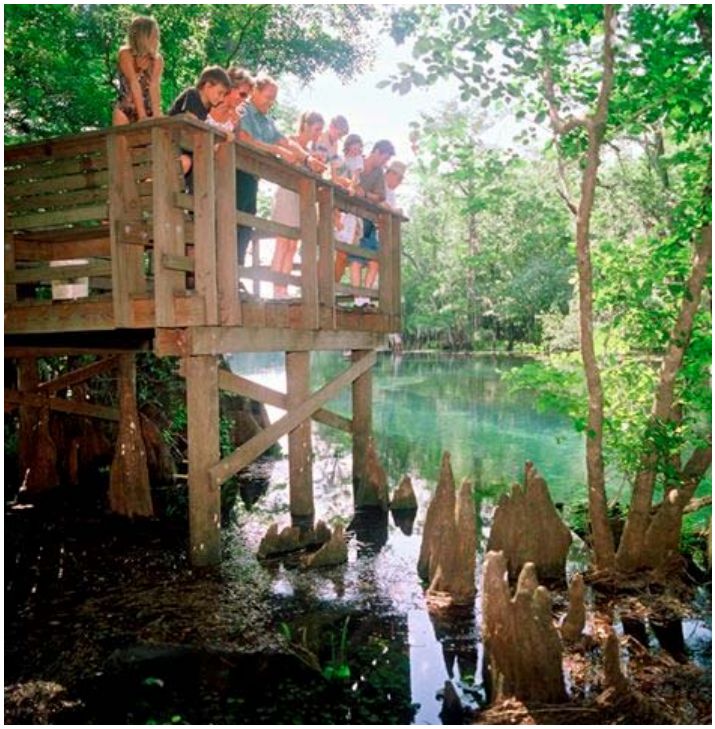
Action Number	Action Description	Status	Participants
	alligators.		Local Park, Private Park
3.10.13	*Control the number of divers in the spring at any one time by requiring they receive permission from the owner to dive.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.14	*Develop educational programs targeting swimmers, boaters, and SCUBA divers, which focus on the sensitive ecology of spring runs and how to avoid disturbing plants and animals.	Ongoing	State Park, NWR, Local Park, Private Park, NGO, CSO, USFS
3.10.15	*Organize an Adopt-A-Spring effort in cases where a spring owner cannot provide adequate control of public access and use.	New Action	State Park, NWR, Local Park, Private Park, NGO
Goal: Manage springs, protected species and springs-related habitat			
3.10.16.	Management plans for State and Federally owned spring systems should include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.	Ongoing	NWR, State Park, USFS, DEP
3.10.17.	*Encourage development of management plans for private and local government owned springs that include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.	New Action	DEP, Local Park, Private Park
3.10.18.	Manage aquatic plant control programs in spring areas used by manatees to ensure adequate winter forage for manatees and prohibit control activities when manatees are present.	Ongoing	DEP, State Park, Local Park, Private Park, USFS, NWR

*New action added since the 2000 Springs Report.
Note: See Appendix H for a list of participants referenced in this table.

4. Regulation Strategies

Sometimes there is no leaving, no looking westward for another promised land. We have to nail our shoes to the kitchen floor and unload the burden of our heart. We have to set to the task of repairing the damage done by and to us. – Janisse Ray, *Ecology of a Cracker Childhood*, 1999

Regulations provide an important legal framework for protecting water resources in Florida, which can be applied to protecting springs and our water supply. The rules for regulatory compliance set specific standards to which stakeholders must abide. Compliance can also be supplemented by other initiatives such as land use planning, voluntary incentive-based programs, education and outreach, and use of best management practices. However, regulations are often necessary for issues that are both complicated and critical. While regulations can be proactive, they often become necessary when other initiatives don't work, or when the density and type of land uses (whether residential, industrial, agricultural, or recreational) increases. The regulatory programs described in this section were originally enacted to protect water resources. However, by themselves the existing regulations do not adequately protect springs. This can be due to limited implementation of regulatory programs, programs designed to address non-spring water resources, or when land use intensity increases beyond what the regulatory mechanism was originally designed to manage. Regulations must in some cases be amended, strengthened, and enforced to protect springs.



People enjoying the view at Manatee Spring in Levy County.
Photo from Florida Park Service

Some of the action steps in the Regulation Strategies are by necessity similar to action steps in Land Use Planning & Management Strategies, especially in cases where land use planning actions (particularly those of DCA) closely relate to regulatory actions.

Current regulatory programs available to protect springs include: the Federal Clean Water Act, the Florida Air and Water Pollution Control Act (Ch. 403 FS), and the Florida Water Resources Act (Ch. 373 FS). These three regulatory programs form the foundation of water quality protection. The Florida Water Resources Act also protects spring flow. In addition, regulatory means for protecting species that inhabit springs are available to ensure the continued existence of these species and their springs-related habitat. These include the Endangered Species Act, Marine Mammal Protection Act, Florida Manatee Sanctuary Act, and others.

An example of how regulations can improve springs protection and restoration is found in the Wekiva River Basin. This basin had more protective measures than just about any other place in Florida, yet the spring conditions and quality continued to decline. The outlook has only recently begun to improve after several task forces were convened, legislation was enacted, and the Wekiva Basin Coordinating Committee was created.

In 2004 the Wekiva River Parkway and Protection Act (Ch. 369.314-369.324 FS) was enacted to provide enhanced protection to springs, streams, and lakes while facilitating construction of an 8-lane elevated expressway across the Wekiva River basin. The SJRWMD immediately began a rapid assessment of pollutants, particularly nitrate-nitrogen and phosphorus, in the Wekiva River and its main upstream tributary (Rock Springs Run) to fulfill the intent of the legislation. The district will propose preliminary Pollutant Load Reduction Goals (PLRGs) for the Wekiva River and Rock Springs Run in 2006 to assist DEP with the development of Total Maximum Daily Loads (TMDLs) for these two spring-run streams, as per the Wekiva legislation. At the federal level, in 2005 the U.S. Environmental Protection Agency (EPA) set a TMDL for nutrients in Wekiva Springs, Rock Springs Run, and Volusia Blue Spring. See Appendix D for more information on regulations mentioned in this section.

4.1. Water Quality Regulations

The Federal Clean Water Act charges the Department of Environmental Protection (DEP) with protecting water quality by regulating point and non-point source pollution, including setting TMDLs for impaired water bodies. DEP is also charged with implementing the TMDL Program under the Watershed Restoration Act of 1999 (Ch. 403.067 FS). DEP implements the TMDL program to identify and restore water bodies that do not meet water quality standards. However, to date only a couple of springs have been considered for protection through the implementation of TMDLs and this is because of their association with the Wekiva River basin and the Wekiva River Parkway and Protection Act of 2004. See Appendix D for more information on TMDLs and related state and federal regulations.

The U.S. Environmental Protection Agency (EPA) and the State of Florida protect ground water quality for drinking water use by setting water quality standards for different pollutants. The DEP and Water Management Districts (WMDs) issue wastewater and environmental resource permits (Ch. 403 FS) to ensure that permitted or regulated activities do not exceed water quality standards. Both of these programs indirectly protect springs by protecting ground water quality.

Car being removed from Cherokee Sink in Wakulla Springs State Park. Photo from Florida Park Service

Currently, the numeric water quality standards for ground water and surface water do not adequately protect springs. A growing body of research has shown a link between ecological impairment and nitrate-nitrogen concentrations ranging from 0.8 mg/L to 1.0 mg/L, which is far lower than the current drinking water (ground water) standard of 10 mg/L for nitrate-nitrogen (Ch. 62-550 and 62-520 FAC).[24] According to FGS data, 40% of 45 springs sampled in 2005 (excluding wells in conduits at Wakulla and Manatee springs) had nitrate-nitrogen concentrations in excess of 1 mg/L.[25] Since ground water and surface water are intimately connected in Florida spring systems, standards should be set to protect the whole system for all uses.

Action Steps for Water Quality Regulations

- **Goal: Implement and/or enforce existing state and federal regulations to protect spring water quality**

4.1.1. *Identify regulations and evaluate the status of existing regulations to assess implementation, adequacy, whether or not they are working and why, and how to improve them.

Status: New Action. Identification of existing regulations is complete, but an evaluation is needed. University of Florida environmental law students completed an initial review of existing regulations as part of preparing the 2005 springs legislation package. Their report is available online (see Appendix D).

Next Steps: FSTF should invite regulatory staff experts to present a review of existing regulations, a summary of successful regulatory programs, a history of failed efforts to write stronger regulations, a summary of the enforcement problems, and ideas for improvements. This can be presented to the FSTF, at a special workshop, or the next Springs Conference.

4.1.2. Implement and enforce existing Federal and State regulations that can be used to protect the quality of ground water that flows to springs.

Status: Area of Need.

Next Steps: Actions need to be taken to implement and/or enforce these regulations. Hold a workshop for regulators and the public. Provide tools to regulators to assist and improve regulatory implementation.

4.1.3. Establish and apply quantifiable ground water and surface water quality standards for nitrate-nitrogen, phosphate, and other contaminants to protect the ecological quality and condition of ground water systems (including aquatic cave species) and surface water systems in springsheds.

Status: Ongoing. Ground water standards for potable supply are based on human health, not ecological condition. This is addressed for the Wekiva River Basin under a state statute (Ch. 369 FS). For surface water standards, DEP has established a Nutrient Technical Advisory Committee (Nutrient TAC) which is currently addressing nutrient criteria development for freshwater lakes and streams. The nutrient TAC meets quarterly, and is provided with information from ongoing nutrient water quality studies of

Florida lakes and streams, including springs nutrient studies, that are being conducted by or funded through DEP. Draft nutrient criteria for lakes and streams are expected to go to the Environmental Regulation Commission (ERC) for revision of the surface water rule in 2008. At the federal level, the EPA has recommended surface water quality criteria, which account for differences between ecoregions and between streams and lakes. For central and north Florida the recommended values are well below 1 mg/L for total nitrogen, and below 50 ug/l for total phosphorus.[26]

Next Steps: Revise ground water and surface water standards to be protective of spring systems. FSTF should coordinate with TAC and request to review and comment on draft criteria. Current contaminants of concern are nitrate-nitrogen, phosphate, and coliforms.

4.1.4. Amend existing Federal and State regulations (in particular, the impaired water rule) as appropriate to protect quality of water flowing to and from springs and to expand the scope of regulatory strategies that can be applied to protect springs.

Status: Area of Need. Research has shown that ecological impairment is occurring at nitrate-nitrogen concentrations ranging from 0.8 mg/L to 1.0 mg/L, which is far lower than the current drinking water (ground water) standard of 10mg/L (Ch. 62-550 and 62-520 FAC). The DEP Surface water Ambient Monitoring Program (SWAMP) is designed to screen water bodies to provide a broad assessment of water quality. Information generated from this program would be used to develop total maximum daily loads (TMDLs), identify water bodies for more detailed studies, and potentially identify water bodies for restoration and rehabilitation. Among other things, SWAMP provides information for management, legislators, other agencies, and the general public primarily through 305(b) reporting.

Next Steps: Develop a strategy for implementation of appropriate ground water standards. Special designations need to be made at the state level, such as designating areas for special water quality standards within a springshed. This action will implement the quantitative ground water quality standards developed in action 4.1.3.

4.1.5. *Identify impaired springs for TMDL listing and develop and implement TMDLs.

Status: New Action. Little progress has been made in adding springs to the TMDL program. The listing of impaired waters and development of TMDLs are based on water quality standards. Because of their unique characteristics relative to other types of surface waters, springs can be ecologically impaired without exceeding these quantitative standards. Springs predominantly have non-point source pollution issues. Data availability is one factor in prioritizing springs for TMDL listings, as only water bodies with sufficient data are evaluated. Currently "priority springs" are defined by the list of springs that are monitored, which includes all clear water first magnitude springs and selected other springs (see Appendix F). As a group the second magnitude springs could potentially be a point of concern in terms of volume and problems seen. The SJRWMD is proposing preliminary Pollutant Load Reduction Goals (PLRGs) for the Wekiva River and Rock Springs Run that will apply to Wekiwa Spring and Rock Spring to assist DEP in developing TMDLs. See Appendix D for more information on TMDLs.

Next Steps: Evaluate springs, identify those that are impaired, and develop TMDLs. TMDLs should evaluate nonpoint pollution sources in detail. TMDL development

should include identification of pollutant loading by land use type. DEP should adopt these TMDLs by rule. After water quality standards have been adopted, impaired springs have been identified, and TMDLs are adopted, action plans should be developed by stakeholders. Stakeholders include state agencies, local governments, agricultural operators, private citizens, and others. Action plans for TMDLs could be developed through the existing Basin Management Action Planning process (Ch. 403.067 FS) or under new legislation. Associated projects should address both surface and ground water quality. Elements could be planning, regulation, restoration, retrofit, and land acquisition.

4.1.6. *Amend Ch 62-520.300(8) (FAC) which states that "...discharge to ground water shall not impair the designated use of contiguous surface waters" to add language that will prevent discharges that will impair ecological quality of known caves, springs, and spring runs.

Status: New Action. DEP has narrative criteria for nutrients requiring in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic plants or animals. Although spring water originates as ground water, nutrients that enter the aquifer through recharge processes may affect the water quality, plants, and animals of springs and spring runs.

Next Steps: DEP should initiate rule revision. Example language could include: "discharge to ground water shall not impair the designated use of contiguous surface waters and in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic plants and animals, thus maintaining the ecological quality of caves, springs, and spring runs."

4.1.7. *Modify rules to establish karst criteria in springsheds for siting of permitted facilities.

Status: Ongoing. Currently, there are some narrow restrictions in DEP rules.

Next Steps: Promote through regulatory agencies the inspection and compliance of stormwater treatment facilities with a minimum of 5-year inspection plans. Special circumstances may dictate more frequent monitoring. Local and regional agencies should develop requirements to reuse stormwater. (See related action steps in 3.6. Stormwater Management.)

➢ Goal: Implement and support local government initiatives to protect spring water quality

4.1.8. *Compile and assess regulatory mechanisms that can be used to protect springs.

Status: New Action. Some counties have begun a process to compile and assess regulatory mechanisms that can be used to protect springs.

Next Steps: Local governments should complete a list and assessment of regulatory mechanisms.

4.1.9. Amend existing local government regulations to protect the quality of ground water in springsheds.

Status: Ongoing. Some counties have initiated this process.

Next Steps: Develop a strategy for implementation of appropriate ground water standards. Designate areas within a springshed for special water quality standards. Identify and use existing Comprehensive Plans and other local ordinances (see related action steps in 3.1 Land Use Planning).

4.1.10. *Establish spring protection zones.

Status: Ongoing. Currently a few counties are in the process of implementing primary, secondary, and/or tertiary spring protection zones.

Next Steps: Encourage other counties to establish spring protection zones.

4.1.11. *Encourage implementation of ordinances so that contaminant producers are not sited in spring protection zones or in springsheds where protection zones are not defined.

Status: Ongoing.

Next Steps: (See related action steps in 3.1. Land Use Planning)

4.1.12. Create ordinances that provide special protection and regulation to springs and springsheds.

Status: Ongoing. Some counties have ordinances in place that provide special protection for springs. A few counties have initiated this process through the DCA Model Land Development Code project (see 3.1 Land Use Planning).

Next Steps: Encourage other counties to adopt springs protection ordinances. (See related action steps in 3.1. Land Use Planning)

4.1.13. *Create ordinances that provide special protection and regulation over karst features including sinkholes, known caves, and conduits.

Status: Ongoing. The Wakulla Spring protection zone has a similar ordinance.

Next Steps: Using Wakulla Spring as an example, promote through regulatory agencies the inspection and compliance of stormwater treatment facilities with a minimum of 5-year inspection plans. Special circumstances may dictate more frequent monitoring. Local and regional agencies should develop requirements to reuse stormwater.

4.2. Spring Flow Regulations

Florida's Water Resources Act (Ch. 373 FS) sets forth a variety of tools that allow the Water Management Districts (WMDs) to protect spring flow, including water supply planning, consumptive use or water use permitting, setting minimum flows and levels (MFLs), and water reservations. At the regional level, WMDs issue Consumptive Use Permits (CUPs) or Water Use Permits (WUPs) to regulate ground water withdrawals.

Chapter 373 FS provides that MFLs will be set for water bodies to prevent "significant harm" to the resource as referred to in the ten water resource values set forth in the State Water Resource Implementation Rule (Ch. 62-40 FAC). However, most springs do not have MFLs. In addition, MFLs can be established at levels below historic or current flow. The combination of existing withdrawals and projected withdrawals could potentially have significant impacts on spring flow around the state in the future, even if the MFL is not reached. One element of Chapter 373.042 FS requires DEP and water management districts to consider, and at their discretion provide for, the protection of non-consumptive uses (such as recreation, aesthetic, and historical/cultural values) in the establishment of MFLs. This consideration might result in higher MFLs that would better protect springs.

Spring flow at Econfina River. Photo by Wes Skiles

Water reservations are another tool in Chapter 373 FS that can be used to maintain flows and levels over and above those determined based on the "significant harm" standard; that is, to protect existing flows or natural hydrologic regimes. To date, the water reservations tool has not been used for springs. The only existing water reservation in the state is at Paynes Prairie Preserve State Park in Alachua County. This tool should be considered as a springs protection method.

While protection for first and second magnitude springs on public lands should be given high priority in order to protect the recreational, aesthetic, and historical/cultural values of these important natural features, it is equally important to protect the unique character of smaller magnitude springs which may be more susceptible to changing ground water conditions.

Action Steps for Spring Flow Regulations

- **Goal: Implement and/or enforce existing state and federal regulations to protect spring flow**

4.2.1. *Review the criteria for significant harm in MFLs to see if they are adequate to protect springs; and if not adequate develop policy guidance based on the review.

Status: New Action. Significant harm is determined by different criteria for each spring system using the criteria specified in Chapter 373 FS and Chapter 62-40 FAC. At present, one criterion is identified as the most sensitive and in effect covers all criteria. The MFL process will continue to evolve and in the future may include more advanced applications such as temporal considerations, forecasting, and decision support.

Next Steps: Utilize results from research and monitoring projects. Develop a list of questions to consider in the review. DEP should review the criteria to make sure that springs are protected as a whole system, and develop guidance and clarification for criteria. Assure that minimum flows for spring systems or minimum levels for aquifers will provide protection for protected, rare, and endemic species threatened by reduced flows. For instance, warm water habitat for manatees is of critical importance.

4.2.2. *Provide reports on MFLs to springs managers and the public.

Status: New Action. WMDs currently provide data (including long term shifts and stage duration) in reports for agency use as part of the CUP process. These are available on WMD websites, but are presented in a technical style that is not readily understandable by the public.

Next Steps: Develop materials that interpret and explain TMDLs and MFLs in a way that can be readily understood by the public (see Education Action Step 1.1.11).

4.2.3. Aggressively pursue water conservation requirements in consumptive use permits for all permitted users.

Status: Ongoing – Area of Need. Some WMDs require water utility permittees to do rate structure audits, which will lead to a rate structure that encourages water conservation.

Next Steps: All WMDs need to require rate structures that encourage water conservation. WMDs should review their water use efficiency programs. See related action steps in 3.1 Land Use Planning.

4.2.4. In WMD Regional Water Supply Plans, maximize strategies for the development of alternative sources of water.

Status: Ongoing. The Water Protection & Sustainability Program (WPSP) established by SB 444, which promotes development of alternative water supplies, has a trust fund that helps pay for the construction of alternative water supply development projects. This will help reduce future demands on ground water. Alternative sources include reclaimed water, surface water, stormwater, brackish ground water desalination, seawater and desalination.

Next Steps: Facilitate high level treatment to maximize water reuse programs.

4.2.5. Consider the use of water reservations, where appropriate, to protect spring flows essential for the "protection of fish and wildlife or the public health and safety" (Ch. 373.223 FS).

Status: Ongoing. The DEP Office of Water Policy is working with the WMDs on policy relating to the use of reservations.

Next Steps: The DEP Office of Water Policy is the lead on such issues and will continue to work with the WMDs on policy relating to the use of reservations and will review reservation rules proposed by the WMDs.

➢ Goal: Implement and support local government initiatives

4.2.6. Encourage local government to implement water conservation regulations.

Status: Ongoing. See related action steps in 3.1. Land Use Planning.

Next Steps: Advocate implementation of recommendations of the Florida Water Conservation Initiative, April 2002 (see Appendix D), and support the Conserve Florida program (Ch. 373.227 FS), which is developing a comprehensive statewide water conservation program for public water supply utilities.

4.2.7. *Develop and promote model xeriscape and irrigation ordinances.

Status: New Action. Landscape irrigation design and landscape design standards are described in Ch. 373.228 FS. DEP and WMDs have been participating in a Landscape Irrigation Design Work Group to implement the statute by developing a list of "Key Principles for Florida Landscape Irrigation" for local governments to use when developing local ordinances.

Next Steps: The Florida Native Plant Society (FNPS) should write and champion model xeriscape and irrigation ordinances and FNPS chapters should lobby locally for adoption.

4.2.8. Develop and implement regulations that will result in increased water-use efficiency.

Status: Ongoing. The Conserve Florida program (Ch. 373.227 FS) is developing a goal-based statewide water conservation program for public water supply utilities (conservation programs are required by WMD consumptive use permitting rules). The program will include standardized definitions and performance measures, a web-based Guide to aid utilities in developing conservation plans, and a state-wide water conservation clearinghouse to collect and disseminate information on conservation, provide technical assistance to utilities in developing conservation plans and programs, evaluate the effectiveness of conservation Best Management Practices, and promote research on key conservation issues.

Next Steps: DEP, WMDs, utilities, organizations, and other stakeholders that participate in Conserve Florida will continue to work toward completion of the Guide, establishment of the Clearinghouse (including identification of a stable, long-term source of funding), and establishment of a process for integrating the program into the WMD consumptive use permitting process.

4.3. Protected Species and Springs-Related Habitat Regulations

Florida's springs and related karst communities (such as aquatic caves, spring-fed streams, and sinkholes) provide important habitat for several state and federally protected species as well as rare, endemic, and managed species. Some of these species are found in only one spring system in the world, for example the Volusia Blue Spring hydrobiid snail. Others, such as the Florida Manatee, depend on the relatively warm waters of spring systems to survive cold winter temperatures. In addition to protecting these species, it is also important to maintain and/or restore species diversity and ecosystem viability through protection of spring systems.

Manatees gathered in Warm Mineral Springs, Sarasota County. Manatees move into spring systems in large numbers during the winter to warm themselves. Photo from Florida Fish and Wildlife Conservation Commission

Regulations such as the Federal Endangered Species Act and Marine Mammal Protection Act, the Florida Endangered and Threatened Species Act and the Manatee Sanctuary Act are available to protect listed, rare, endemic, and managed species and their habitat. In addition, under existing regulations, a water body may be classified as an Outstanding Florida Water (OFW) and receive special water quality protection because of its natural attributes (Ch. 62-302 FAC). Most OFWs are public areas managed by state or federal government. However, other waters may be designated as "special water" OFW if requirements are met. Examples of existing OFWs relevant to springs include the Silver River, Rainbow River, and Santa Fe River.

Many species found in springs, including aquatic snails, are considered to be sensitive indicator species. That is, their status mirrors the health of their spring community. Healthy populations are reflective of viable communities. Declining populations can be indicative of springs that are in poor condition. Solutions for these problems can be complex or simple. For example, the endemic Ichetucknee Siltsnail and its habitat in Ichetucknee Springs State Park are protected from trampling with a simple solution that includes fencing and interpretive signs placed at Coffee Spring.

Action Steps for Protected Species and Springs-Related Habitat Regulations

- **Goal: Ensure protection of protected, rare, endemic, and managed species and their springs-related habitats**

4.3.1. *Seek OFW designation for spring systems with protected, rare, endemic, and managed species, where appropriate.

Status: New Action. This would protect springs, spring runs, karst windows, and the cave systems where the species have been identified.

Next Steps: Evaluate spring systems with these species for OFW designation.

4.3.2. Extend Outstanding Florida Waters (OFW) designations to include springs, spring runs, and karst features that are known to have hydrologic connections to OFWs.

Status: Ongoing. As an example, DEP recently had the Environmental Regulation Commission (ERC) add Rose Sink to the Ichetucknee OFW. The list of hydrologic connections (verified by dye-tracing or exploration) is fairly small now. DEP is in the process of identifying karst windows that have hydrologic connections. Currently, OFW does not apply to water filled caverns.

Next Steps: Make a list and initiate the ERC process to accomplish this action step.

4.3.3. *Revise the OFW rule such that when known and mapped karst features that connect to surface waters are eligible for OFW designation, the karst features can also be so designated.

Status: New Action. The OFW designation is for surface waters only and caves cannot be designated under current rule.

Next Steps: DEP should recommend a rule revision to include such caves.

4.3.4. *Support and encourage a public records exemption for certain data on caves and springs locations, and protected species, to protect landowners, the public, and offshore springs.

Status: New Action. DEP/FGS is having a difficult time collecting cave mapping data because it is proprietary and the owners do not want it released to the public record. FGS has proposed such protection to the DEP the last several years and no action has occurred. Similar protection is provided for historic sites by the Bureau of Historic Preservation. FGS has proposed language for consideration. The FGS as the State's geoscience information repository/research library can archive said data and maps for use in cave and spring hydrogeology assessments, ultimately to support best management practices in conserving and protecting our ground water resources.

Next Steps: FGS, FNAI, and FSTF support to DEP to support such a legislative request. Proprietary cave maps and location information associated with protected and/or endemic cave species should be made available to resource agencies such as FGS and FNAI. Statutory protection should be developed to ensure that this information remains proprietary to sources and management agencies.

4.3.5. *Evaluate existing aquatic plant control regulations and programs to ensure that adequate winter forage is available for manatees.

Status: Ongoing. FWC, DEP, USACE, and county governments do this for Kings Bay, Volusia Blue, Homosassa, and Wakulla springs.

Next Steps: Implement at other springs with manatee use. When chemical treatments are utilized in aquatic plant control, study and assess the impact of the chemical on the spring system as a whole.

4.3.6. *Evaluate regulatory strategies and assess potential application for protection of protected, rare, endemic, and managed species and their springs-related habitat and expand where appropriate.

Status: New Action.

Next Steps: Include springs habitat protection in all management plans, including federal, state, and county plans.

4.3.7. *Use biological survey data to develop criteria for springs regulations to ensure natural ecological community functions.

Status: New Action.

Next Steps: Reference biological, chemical, and physical data as part of the criteria.

4.3.8. *Petition state and federal agencies to list endemic and cave-adapted animals.

Status: New Action. Existing data shows that nearly all of these need to be listed.

Next steps: Pursue listing for endemic and cave-adapted species.

The future of species like these, and the springs they depend on, is in our hands.

Above: Spring-run crayfish, Ichetucknee Springs, Columbia County. Photo by Jim Stevenson

Left: Fire-backed crayfish, Merrits Mill Pond, Jackson County. Photo by Harley Means, FGS

Implementation Table – Regulation Strategies

Action Number	Action Description	Status	Participants
4. Regulation Strategies			
4.1 Water Quality Regulations			
Goal: Implement and/or Enforce Existing State and Federal Regulations to Protect Spring Water Quality.			
4.1.1	*Identify regulations and evaluate the status of existing regulations to assess implementation, adequacy, whether or not they are working and why, and how to improve them.	New Action	DEP, FSTF
4.1.2.	Implement and enforce existing Federal and State regulations that can be used to protect the quality of ground water that flows to springs.	Area of need	DEP, WMD
4.1.3.	Establish and apply quantifiable ground water and surface water quality standards for nitrate-nitrogen, phosphate, and other contaminants to protect the ecological quality and condition of ground water systems (including aquatic cave species) and surface water systems in springsheds.	Ongoing	DEP, FSTF, TAC
4.1.4.	Amend existing Federal and State regulations (in particular, the impaired water rule) as appropriate to protect quality of water flowing to and from springs and to expand the scope of regulatory strategies that can be applied to protect springs.	Area of Need	DEP, DCA, DOH, USACE, EPA.
4.1.5.	*Identify impaired springs for TMDL listing and develop and implement TMDLs.	New Action	DEP, WMD
4.1.6.	*Amend Ch 62-520.300(8) (FAC) which states that "...discharge to ground water shall not impair the designated use of contiguous surface waters" to add language that will prevent discharges that will impair ecological quality of known caves, springs, and spring runs.	New Action	DEP
4.1.7.	*Modify rules to establish karst criteria in springsheds for siting of permitted facilities.	Ongoing	DEP
Goal: Implement and Support Local Government Initiatives to Protect Spring Water Quality			
4.1.8.	*Compile and assess regulatory mechanisms that can be used to protect springs.	New Action	Local Gov't
4.1.9.	Amend existing local government regulations to protect the quality of ground water in springsheds.	Ongoing	Local Gov't, DCA
4.1.10	*Establish spring protection zones.	Ongoing	Local Gov't
4.1.11	*Encourage implementation of ordinances so that contaminant producers are not sited in spring protection zones or in springsheds where protection zones are not defined.	Ongoing	Local Gov't
4.1.12	Create ordinances that provide special protection and regulation to springs and springsheds.	Ongoing	Local Gov't, DCA
4.1.13	*Create ordinances that provide special protection and regulation over karst features	Ongoing	Local Gov't, DCA

Action Number	Action Description	Status	Participants
	including sinkholes, known caves and conduits.		
4.2 Spring Flow Regulations			
Goal: Implement and/or Enforce Existing State and Federal Regulations to Protect Spring Flow.			
4.2.1.	*Review the criteria for significant harm in MFLs to see if they are adequate to protect springs; and if not adequate develop policy guidance based on the review.	New Action	DEP
4.2.2.	*Provide reports on MFLs to springs managers and the public.	New Action	WMD
4.2.3.	Aggressively pursue water conservation requirements in consumptive use permits for all permitted users.	Ongoing – Area of Need	WMD
4.2.4.	In WMD Regional Water Supply Plans, maximize strategies for the development of alternative sources of water.	Ongoing	WMD, DEP
4.2.5.	Consider the use of water reservations, where appropriate, to protect spring flows essential for the "protection of fish and wildlife or the public health and safety" (Ch. 373.223 FS).	Ongoing	DEP, WMD, Legislature.
Goal: Implement and Support Local Government Initiatives			
4.2.6.	Encourage local government to implement water conservation regulations.	Ongoing	WMD, DEP
4.2.7.	*Develop and promote model xeriscape and irrigation ordinances.	New Action	FNPS, DEP
4.2.8.	Develop and implement regulations that will result in increased water-use efficiency.	Ongoing	DEP, WMD, Utility, Private, NGO
4.3 Protected Species and Springs-Related Habitat Regulations			
Goal: Ensure Protection of Protected, Rare, Endemic, and Managed Species and their Springs-related Habitats			
4.3.1.	*Seek OFW designation for spring systems with protected, rare, endemic, and managed species, where appropriate.	New Action	DEP, NGO
4.3.2.	Extend Outstanding Florida Waters (OFW) designations to include springs, spring runs, and karst features that are known to have hydrologic connections to OFWs.	Ongoing	DEP
4.3.3.	*Revise the OFW rule such that when known and mapped karst features that connect to surface waters are eligible for OFW designation, the karst features can also be so designated.	New Action	DEP
4.3.4.	*Support and encourage a public records exemption for certain data on caves and springs locations, and protected species, to protect landowners, the public, and offshore springs.	New Action	FGS, FNAI, FSTF, DEP, Legislature
4.3.5.	*Evaluate existing aquatic plant control regulations and programs to ensure that adequate winter forage is available for manatees.	Ongoing	FWC, DEP, USACE, Local Gov't

Action Number	Action Description	Status	Participants
4.3.6.	*Evaluate regulatory strategies and assess potential application for protection of protected, rare, endemic, and managed species and their springs-related habitat and expand where appropriate.	New Action	DEP, FWC, USFWS, County Park, State Park, Private Park
4.3.7.	*Use biological survey data to develop criteria for springs regulations to ensure natural ecological community functions.	New Action	FWC
4.3.8.	*Petition state and federal agencies to list endemic and cave-adapted animals.	New Action	NGO

*New action added since the 2000 Springs Report.
Note: See Appendix H for a list of participants referenced in this table.

5. Funding Strategies

5.1. Funding for Springs Protection and Restoration Strategies

The value in money lies in what we do with it. – American Proverb

Springs protection goes beyond protecting recreation uses and spring aesthetics. Springs protection is a statewide issue and should address critical water supply issues including water quality and quantity. Over the first five years, the Florida legislature has funded the Florida Springs Initiative (FSI) with about $2.5M per year of the initial $4.5M requested in the 2000 Springs Report. This annual funding has allowed the FSI to meet many of the recommendations in the 2000 Springs Report. However, to fully meet all the recommendations, funding of approximately $6.5M to $16.5M per year is required. The high end of this range includes expanding the research and monitoring program based on the number of first and second magnitude springs in Florida. In addition, the allocation of state agency staff needs to be addressed to fully implement the strategies as they are funded. Currently, FSI has two staff members and two additional staff members are needed. More staff will be needed as program requirements increase.

It is important to note that FSI funding is often leveraged through projects that provide multiple benefits, funds spent by other agencies on springs and springs-related projects, cooperative funding, and matching funds.

The future success of the FSI is dependent upon continued funding support by the Florida Legislature and a permanent dedicated funding source. Research has documented that springs protection and restoration will require a long-term dedicated commitment, thus continued funding is required. In addition, springs protection requires a concerted long-term effort to identify and resolve land use planning issues, much like the Everglades Restoration project and State capital planning projects for roads and schools.

Current FSI funding is provided from general revenue. The FSTF recommends that a permanent dedicated funding source be created in the form of a Springs Protection and Restoration Trust Fund (Trust Fund). While the Trust Fund is growing, it will supplement general revenue funding, which should continue until the Trust Fund reaches levels to adequately fund the FSI.

Several of the recommendations in this report will affect agencies that do not have the resources to implement them. Additional resources will be required and agencies would have to reprioritize their activities in order to fund these strategies. To ensure the continued delivery of quality public services, it is strongly recommended that the proposed Trust Fund provide funding for agencies to implement these strategies. In addition, most research and restoration efforts require multi-year projects, which are better accommodated with a dedicated funding source such as the Trust Fund.

The FSTF also recognizes the need for viable funding sources that are derived from documented impacts to springs. These would fund corrective actions and facilitate cultural change to reduce those impacts, thus involving stakeholders in the solution. This collaboration can fund the

implementation of springs protection and restoration strategies to create a better future for Florida's citizens and the generations ahead.

The following is a summary of the funding required to effectively implement the springs protection and restoration strategies identified in this report.

Education & Outreach Strategies
The successful resolution of many threats to springs is dependent on the actions of an educated public, including local government officials, homeowners, farmers, golf course managers, public works officials, and visitors to public springs. Education can nurture citizens' appreciation of Florida's springs and bring about cooperation and voluntary compliance.

FSI has spent approximately $400,000 per year on Education & Outreach Strategies, funding 28 projects. The FSI has made significant progress in the area of education; however, many of the education programs remain critical in the ongoing effort to reach a broad and continually growing audience with important springs messages. The estimated funding needed to accomplish education and outreach actions during the next 5 years is $900,000 per year.

Research & Monitoring Strategies
Research and monitoring are important in order to understand both the existing and changing conditions in Florida spring systems. The information gained from such work allows scientists to predict potential impacts to spring systems from activities within springsheds, and provides for the development of effective springs protection strategies.

FSI has spent approximately $1.6M per year on Research & Monitoring Strategies. During that time 44 projects were funded and 57 sampling locations were established at first magnitude and other selected springs. Although these projects have provided new insights, many important questions remain unanswered. The estimated funding needed to accomplish research and monitoring actions during the next 5 years is $5M to $15M per year. The high end of this range includes increasing the monitoring program from 57 sites to 150 sites based on the number of first and second magnitude springs in Florida. Current DEP staff levels (2) have the capability of accomplishing several of the actions with increased funding. However, much more can be accomplished with the addition of staff and funding increases up to $15M per year.

Land Use Planning & Management Strategies
Both the quality and quantity of spring flows have declined notably in many of Florida's springs. Without effective remedial action, further declines can be expected. Urbanization and intensive agricultural practices on the land surface can and do have adverse impacts upon the quality and quantity of ground water, thereby affecting spring flow, water quality, and spring-run ecosystems. Effective land use planning and management strategies can reduce impacts to springs and protect them for future generations.

FSI has spent approximately $500,000 per year on Land Use Planning & Management Strategies. Since 2000, 33 projects have been accomplished or are underway, including restoration (10), recreation management and erosion control (9), wastewater improvements (8), and best management practices (6). The primary goal of Land Use Planning & Management

Strategies is to create tools for local governments to implement springs protection. Some land use planning actions are underway at the state, regional, and local government levels, but more are needed to provide careful planning as Florida's population continues to grow. The estimated funding needed to accomplish land use planning and management actions during the next 5 years is $600,000 per year.

Regulation Strategies
Regulations provide an important legal framework for protecting springs and our water supply by setting specific standards to which stakeholders must abide. Current regulatory programs form the foundation for protecting water quality, spring flow, and springs-related species and their habitat. However, by themselves existing regulations do not adequately protect springs. This can be due to limited implementation of regulatory programs, programs designed to address non-spring water resources, or when land use intensity increases beyond what the regulatory mechanism was originally designed to manage. Regulations must in some cases be amended, strengthened, and enforced to protect springs. While the majority of the regulation actions can be accomplished in-house without additional funding, an evaluation of existing regulations will require estimated funding of $50,000.

Action Steps for Funding Springs Protection and Restoration Strategies

➢ Goal: Identify funding sources for FSI programs

5.1.1. Create the Springs Protection and Restoration Trust Fund and finance it with a permanent dedicated funding source. The Trust Fund would be administered by DEP and would subsidize springs initiatives.

Status: Area of Need.

Next Steps: Should be funded from various sources, including utilizing a portion of the documentary stamp tax, enacting user fees and surcharges based on documented impacts to springs in geographic areas shown in the springs area map. User fees or stakeholder surcharges should link funding sources directly to specific actions, thus if the problem decreases or increases then the fee will adjust accordingly.

5.1.2. Seek federal funding to augment the Springs Protection and Restoration Trust Fund.

Status: Area of Need.

Next Steps: Identify cost sharing potential with federal sources. Seek local government and legislative sponsors for funding.

5.1.3. *Documented violations of state rules that impact springs should be required to restore or contribute to the restoration of the impacted springshed.

Status: New Action. Administrative levies are already in place and collected.

Next Steps: Through concent orders, court orders, other corrective actions.

5.1.4. *Encourage the creation of a Florida Springs Foundation to accept contributions for springs protection and restoration.

Status: New Action.

Next Steps: Create incentives for donations.

5.1.5. *Create a mitigation process for new or expanding land use modifications that impact springs.

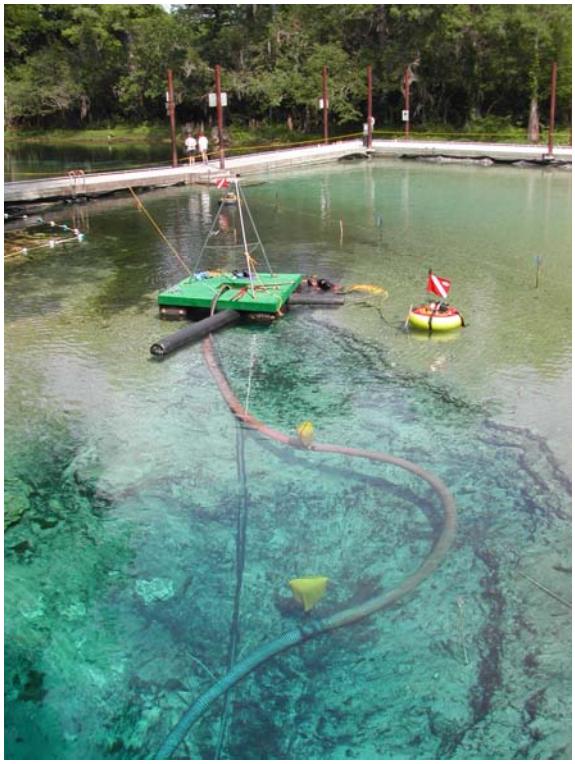
Status: New Action.

Nest Steps: Create an incentive based program to encourage implementation of model land development codes and BMPs. Impacts on the springshed should pay into a fund to mitigate those impacts as a local government funding mechanism. For example, this money could be used by local governments to match FSI funding to implement springs protection and restoration programs.

5.1.6. *Identify options to augment FSI funding.

Status: Ongoing.

Next Steps: Options can include leveraging possibilities, funds spent by other agencies on springs and springs-related projects, cooperative funding, and matching funds.



Restoration projects like these are essential to protecting Florida's springs for future generations.

Above: Shoreline restoration at Poe Springs, Alachua County. Photo by Karen Hill

Left: Spring vent restoration at Fanning Springs, Levy County. Photo by Harley Means, FGS

Implementation Table – Funding Strategies

Action Number	Action Description	Status	Participants
5. Funding Strategies			
5.1 Funding for Springs Protection and Restoration Strategies			
Goal: Identify funding sources for FSI programs			
5.1.1.	Create the Springs Protection and Restoration Trust Fund and finance it with a permanent dedicated funding source. The Trust Fund would be administered by DEP and would subsidize springs initiatives.	Area of Need	DEP
5.1.2.	Seek federal funding to augment the Springs Protection and Restoration Trust Fund.	Area of Need	DEP, Local Gov't
5.1.3.	*Documented violations of state rules that impact springs should be required to restore or contribute to the restoration of the impacted springshed.	New Action	DEP
5.1.4.	*Encourage the creation of a Florida Springs Foundation to accept contributions for springs protection and restoration.	New Action	DEP
5.1.5.	*Create a mitigation process for new or expanding land use modifications that impact springs.	New Action	DEP, DCA
5.1.6.	*Identify options to augment FSI funding.	Ongoing	DEP

*New action added since the 2000 Springs Report.
Note: See Appendix H for a list of participants referenced in this table.

VI. Glossary

Most of the definitions used in this glossary are from the FGS Special Publication No. 52, *Florida Springs Classification Systems and Spring Glossary*, 2003. A few terms were updated by the Florida Springs Nomenclature Committee in December 2005 and those revisions are included.

analyte – The substance in an analysis that is being identified or determined.

aquifer – A body of soil, sediment, or rock that is saturated with water and sufficiently permeable to allow production of water from wells (SDII Global Corp., 2002).

artesian – A modifier that describes a condition in which the potentiometric surface is above elevation of the top of the aquifer (Modified from Field, 1999). It is synonymous with *confined*.

cave – A natural underground opening or series of openings and passages large enough to be entered by an adult person (Modified from Monroe, 1970).

cavern – A cave or conduit system with larger than average size that has been created by the dissolution of limestone or other soluble rock (SDII Global Corp., 2002).

conduit; karst conduit – Large dissolutional voids, including enlarged fissures and tabular tunnels.

In some usage, the term is restricted to voids that are water-filled. Conduits may include all voids greater than 10 mm (one cm) in diameter, but another classification scheme places them between arbitrary limits of 100 mm to 10 m. Whichever value is accepted in a particular context, smaller voids are commonly termed subconduits (Field, 1999).

confined – See *artesian*.

discharge – The rate of flow at a given instant in terms of volume per unit of time (Modified from Bates and Jackson, 1984). It is synonymous with flux.

epikarst – **1**. The zone of weathering that penetrates the upper surface of a limestone stratum. Weathering of limestone results in development of rubble, fine-grained, carbonate-rich silt, clay, and karren (including pinnacles and valleys in the limestone rock surface) (Modified from SDII Global Corp., 2002). **2**. An intensely dissolved zone consisting of an intricate network of intersecting roofless, dissolution-widened fissures, cavities, and tubes dissolved into the uppermost part of the carbonate bedrock.

The dissolution features in the epikarst zone are organized to move infiltrating water laterally to down-gradient seeps and springs or to collector structures such as shafts that conduct the water farther into the subsurface (Huntoon, 2002).

estavelle – **1**. A spring that reverses flow because of relative changes in the elevation of ground-water potentials and stream stage (SDII Global Corp., 2002). **2**. An intermittent spring resurgence or exsurgence, active only in wet seasons (Modified from Field, 1999).

Generally, an estavelle is located near streams or rivers. When the water level of the stream is high (e.g., during flood stage), surface water directly recharges the aquifer.

fissure – Any discontinuity within the rock mass that is either initially open or capable of being opened by dissolution to provide a route for water movement.

Fissures in this sense, applied generally in karst, therefore include the primary sedimentary bedding planes as well as tectonic faults and joints. More specifically, the term has been used to describe voids with an average width dimension of 10 to 100 mm (Modified from Field, 1999).

historical spring magnitude – A special spring classification category based on the median volume of flow from a spring per unit time, based on discharge data obtained prior to the year 2001 (FSNC, 2005). See spring magnitude.

karst – A term describing landforms that have been modified by dissolution of soluble rock (limestone or dolostone) (Modified from SDII Global Corp., 2002).

karst window – **1**. A depression opening that reveals portions of a subterranean flow, or the unroofed portion of a cave (a vertical window). **2**. An opening in natural limestone walls, formed by the joining of subterranean karst grottos as a result of dissolution processes (a horizontal window). Both terms are modified from Field (1999).

Note also that the FSNC believes that flow through an exposed conduit in the aquifer is different from flow onto the Earth's surface. For this reason, the FSNC does not consider a karst window to be a spring. It is an exception to the definition of a spring (See *spring*).

limestone – A sedimentary rock primarily composed of the mineral calcite ($CaCO_3$). Limestone is soluble and often develops karst features when weathered (Modified from SDII Global Corp., 2002).

magnitude – See *spring magnitude*.

nonartesian — A condition in which the upper surface of the zone of saturation forms a water table under atmospheric pressure. The term is synonymous with *unconfined* (Field, 1999).

percolate – See *seep (1)* or *seepage.*

resurgence – re-emergence of ground water through a karst feature, a part or all of whose waters are derived from surface inflow into ponors at higher levels (Modified from Field, 1999).

river rise – see *resurgence* (Field, 1999).

seep – **1**. To move slowly through small openings of a porous material (Field, 1999). **2**. With regard to springs in Florida, a seep is also a noun that infers one or more small openings in which water discharges diffusely ("oozes") from the ground water environment.

Discharge is from intergranular pore spaces in the matrix and flow is typically laminar (FSNC, 2003).

seepage – The infiltration or percolation of water through rock or soil to or from the Earth's surface and is usually restricted to the very slow movement of ground water (Field, 1999).

sink – See *sinkhole.*

sinkhole – A landform created by subsidence of soil, sediment, or rock as underlying strata

are dissolved by ground water.

Sinkholes can form by collapse into subterranean voids created by dissolution of limestone or dolostone or by subsidence as these strata are slowly dissolved away (Modified from SDII Global Corp., 2002).

solution sinkhole – Sinkhole formed by the slow subsidence of soil or sediment as the upper surface of the underlying, water-soluble sediment or rock is removed by dissolution. See *cover-subsidence sinkhole* (SDII Global Corp., 2002).

spring – A point where underground water emerges onto the Earth's surface (including the bottom of the ocean).

The image of a trickle of water springing from a hillside hardly matches that of a vast cave pouring forth a river, but both are called springs. Springs may be exsurgences or resurgences, depending upon the source of their water. They may also be part-time exsurgences and part-time resurgences. In some usages "spring" is restricted to the water that outflows, in other usages the word can refer to the water, the outlet, or the locality of the outflow (Field, 1999).

Note that the FSNC believes that flow through an exposed conduit in an aquifer is different from flow onto the earth's surface. For this reason, the FSNC does not consider a karst window to be a spring. It is an exception to the definition of a spring.

spring boil – Variable discharge from a spring in which hydrostatic pressure is great enough to cause a turbulent discharge (Modified from Field, 1999).

spring complex – See *spring group*. The FSNC encourages the use of spring group and discourages the use of this term.

spring flow – See *discharge.*

spring group – A collection of individual spring vents and seeps that lie within a discrete spring recharge basin (or springshed).

The individual vents and seeps of onshore spring groups almost always share a common spring run, or a tributary to the run. Spring group vents and seeps are often spread over an area of several square miles.

It should be emphasized that the term spring group will be restricted to those vents and seeps that discharge a well-defined springshed. The spring vents or seeps within a springshed may be referred to as springs. As an example, the Rainbow Springs Group will include several spring vents that drain the Rainbow Springs Group basin, and discharge into the Rainbow River spring run.

Note that a springshed is defined only by potentiometric data and not by chemical or other physical characteristics of the spring discharge. However, chemical and additional physical data can, and should, be used to better define individual spring vent basins within a spring group basin. This type of mapping was conducted for the Rainbow Springs Group in Marion County by Jones et al., (1996).

All springsheds have not been mapped. Therefore, if a springshed is not mapped, then it is acceptable to use the term "springs" to refer to multiple vents discharging into a common spring run.

spring magnitude – A category based on the volume of flow from a spring per unit of time.

The classification system (Table 2) used in Florida is based on Meinzer (1927).

Table 2. Spring Magnitude

	Flow	
Magnitude	**Metric Units**	**English Units**
1	≥ 2.832 m^3s	≥ 64.6 mgd (≥ 100 cfs)
2	≥ 0.283 to 2.832 m^3s	≥ 6.46 to 64.6 mgd (≥ 10 to100 cfs)
3	≥ 0.028 to 0.283 m^3s	≥ 0.646 to 6.46 mgd (≥ 1 to 10 cfs)
4	≥ 0.0063 to 0.028 m^3s	≥ 100 to 448gpm (≥ 100 gpm to 1 cfs)
5	≥ 0.631 to 6.308 lps	≥ 10 to 100 gpm
6	≥ 0.063 to 0.631 lps	≥ 1 to 10 gpm
7	≥ 0.473 to 3.785 lpm	≥ 1 pint/min to 1 gpm
8	< 0.473 lpm	< 1 pint/min

m^3s = cubic meters per second
cfs = cubic feet per second
mgd = million gallons per day
gpm = gallons per minute
lps = liters per second
pint/min = pints per minute
lpm = liters per minute

Notes regarding magnitude – One discharge measurement is enough to place a spring into one of the eight magnitude categories. However, springs have dynamic flows. A spring categorized as being a first-magnitude spring at one moment in time may not continue to remain in the same category. Furthermore, recent interest in spring monitoring has resulted in large numbers of discharge measurements since 2000. These post-2000 samples bias the long-term flow calculations with regards to determining the magnitude of the spring, unless corrections are taken. Therefore, the FSNC (2005) decided that the magnitude of a spring is to be based on a weighted median value of all discharge measurements for the period of record.

spring pool – A small body of water, either artificially impounded or naturally occurring, that encompasses one or more spring vents.

It contains spring discharge that flows into a spring run (FSNC, 2003).

spring recharge basin – Those areas within ground- and surface water basins that contribute to the discharge of the spring. The position of the divide is orthogonal to isopotential lines (Hydrogeology Consortium, 2002). It is synonymous with *springshed*.

Note that the position of the recharge basin boundary is time dependent. That is, the boundary is representative of a "snapshot" in time, rather than permanent. Thus, the boundaries of springsheds are dynamic and vary as a result of a changing potentiometric surface. If a spring is found to drain one springshed during times of high potentiometry, and another basin during low times, then the spring should be connected with two springsheds in the spring database (FSNC, 2003).

Whenever practical, descriptive aspects of the recharge basin should be noted in the spring database. The following are examples. The relative recharge to ground water within the basin should be noted. Those portions of the basin where confined and unconfined ground water conditions exist should also be recorded. Finally, ground water vulnerability within the springshed should be noted if possible. A potential tool to predict vulnerability is the Florida Aquifer Vulnerability Assessment (FAVA) model (Baker et al., 2002).

spring run – **1**. A body of flowing water that originates from a karst spring (Field, 1999). **2**. A stream (river, creek, etc.) whose primary (>50%) source of water is from a spring, springs, or spring group (FSNC, 2003).

For example, the Wakulla River, where the predominant source of water is from Wakulla Spring, is a spring run. However, farther down stream, where surface water tributaries, contribute 50% or greater of the flow, the Wakulla River is no longer considered a spring run. A detailed hydrogeologic (e.g., the collection of discharge and seepage data) study may be needed in order to identify boundaries of a spring run (FSNC, 2003).

spring vent – See *vent*.

springs – Multiple spring vents or seeps located in proximity to each other.

The usage of this term is discouraged, but for pragmatic reasons, it cannot be entirely dropped. For example, several vents may discharge into a common spring run and the collection of scientific data (e.g., water samples or discharge measurements) cannot be obtained from individual vents located in the run. However, it may be practical to obtain a composite water sample or composite flow measurement representing several vents. Under this situation, the term springs is acceptable. However, a list of each vent or seep represented by the composite sample should be recorded by the sampler, and ultimately placed into the spring database (FSNC, 2003).

springshed – See *spring recharge basin*.

swallet – The opening through which a stream loses all or part of its water to the subsurface; or a place where a stream may sink into alluvium in a streambed without the presence of a depression. It is synonymous with *swallow hole* (Modified from Neuendorf, Mehl, and Jackson, 2005).

swallow hole – See *swallet*.

unconfined – See *nonartesian*.

vent – An opening that concentrates ground water discharge at the Earth's surface, including the bottom of the ocean.

The spring point of discharge is significantly larger than that of the average pore space in the surrounding rock and is often considered a cave or fissure. Flow from the opening is mostly turbulent (FSNC, 2003).

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VIII. Appendices

Appendix A. Projects Implemented Through FSI Program
Appendix B. Springs Champions Recognized by the FSTF, 2000 - 2006
Appendix C. First Magnitude Springs of Florida by County
Appendix D. Resources for More Information
Appendix E. Table of Analytes for Springs Monitoring
Appendix F. Monitored Springs in Florida (Table and Map)
Appendix G. Springs Areas by County
Appendix H. Implementation Table – All Strategies

Appendix A. Projects Implemented Through FSI

Projects Implemented Through the Florida Springs Initiative

Education and Landowner Assistance

2002-2003	Nutrient Reduction BMPs
2002-2006	Springs BMPs/Land Use BMPs (aka Model Land Development Code Program)
2002	Land Use Management Tool
2004-2006	Golf Course BMPs
2002-2003	Head Spring Restorations
2002	Restoration of Fanning Spring
2002	Removal of Sediments from Alexander Spring
2002	Ichetucknee Restoration
2002	Construction of Monitoring Well along St. Marks River
2004	Gainer Springs Restoration
2004	Poe Springs Restoration
2002-2003	Homeowner Brochure
2002-2006	Water's Journey Video Production
2002-2006	Springs Website Updates
2002-2003	2003 Springs Conference
2002	Springs Recharge Area Brochures
2002-2006	Spring Specific Brochures and Updated Reprints of Ichetucknee, Wakulla and Wekiwa Springs
2002	Two Public Service Announcements
2002-2003	Three Public Workshops for Gainer, Jackson Blue, St. Mark, Wakulla Springs and Spring Creek
2003	Ownership Mapping for 8 Privately Owned First Magnitude Springs
2003	"Portals to the Past" Springs Brochures
2003	Florida Geological Survey Poster
2003	State Fair Exhibit
2004-2006	Springshed Basin Road Signs
2004-2006	Springs Curriculum Development
2004-2006	Florida Springs Website Maintenance
2004	Sponsorship of Wakulla Springs Scientific Conference
2005	Florida Springs Task Force Facilitator
2005	LIFE Program

Research and Monitoring

2001-2006	Quarterly Monitoring and Analysis of First Magnitude Springs and Other Selected Springs
2001-2006	Discharge Monitoring at Select First and Second Magnitude Springs
2001-2006	Biological Monitoring at Select First and Second Magnitude Springs
2001-2006	Springs Assessment in the Northwest Florida Water Management District- Delineation and Characterization of Springsheds; Water Quality and Discharge Monitoring; Spring Inventories
2001-2005	Springs Assessment in the Suwannee River Water Management District- Delineation and

	Characterization of Springsheds; Water Quality and Discharge Monitoring
2001-2004	Springs of Florida Update (FGS Bulletin 66)
2001-2003	Age-Dating at Select First Magnitude Springs
2001-2002	Inventory and Assessment of Florida's First Magnitude Springs (FGS Open File Report 85)
2001-2002	Pesticide Monitoring and Analyses of Water and Sediment from Jackson Blue Spring
2001-2002	Wastewater Constituent Analysis at Silver Springs
2001-2002	Fish and Bivalve Survey at 16 Springs
2001-2002	Baseline Inventories of Aquatic Snails at 14 Springs and Spring Runs
2001-2002	Apple Snail Abundance and Recruitment at 6 First Magnitude Springs
2002-2006	O'Leno Hydrogeology and Nutrient Loading on the Santa Fe River
2002-2006	Relationships Between Nutrients and Algal Growth
2002-2003	Effects of Nitrate on Reproductive Parameters of Eastern Mosquitofish; Effects of Nitrate on Growth and Development of Southern Toads; Survey of Frog Diversity at Select Springs
2002-2003	Manatee Spring Conduits Monitoring
2002-2003	Modeling Flow Contributions to Alexander, Volusia Blue, Silver Glen, and Silver Springs
2002-2003	Impacts of Nitrate on Apple Snails
2002-2003	High Springs Gap Springshed Water Level Monitoring
2002-2003	Biological Inventory of Spring Caves Associated with the Ocklawaha River, Holmes Creek, Choctawhatchee River, Econfina River, St. Johns River, Apalachicola River, Suwannee River, and Withlacoochee River
2002-2003	Impacts of Land Use on the Water Quality of Fanning Springs
2002-2003	Economic Survey of Four Spring Parks
2002-2003	Silver Glen Spring Carrying Capacity Study
2003-2006	Dye Tracing Potential Surface Water Sources for Wakulla Springs; Ground Water Flow Model Development for Wakulla Springs
2003-2005	Silver Springs 50-Year Retrospective
2004-2006	Tracing Reclaimed Water from Lake City Sprayfield into Ichetucknee Springshed
2004-2006	Locating, Identifying, and Describing Stream-to-Sink Features
2004-2006	Cannon Creek and Lime Sink Dye Trace Study
2004-2006	Investigation of Offshore Spring Resources
2004-2005	Wekiwa Basin Delineation using Florida Aquifer Vulnerability Assessment (FAVA)
2004-2005	Radiolocation of Highway Positions over Leon Sinks Cave System
2004-2005	Manatee Springs Bathymetric Survey
2004-2005	Levy Blue Springs Bathymetric Survey
2004-2005	Ichetucknee Springs Dye Trace Study
2004-2005	Reconnaissance for Tallahassee Sprayfield Dye Trace Study
2005-2006	Tallahassee Sprayfield Dye Trace Study
2005-2006	Nutrient Budget for the Ichetucknee Springshed
2005-2006	Water Quality Study of the Ichetucknee River

Division of Recreation and Parks

2002-2006	Working Group Coordination at Silver Springs
2002-2006	Ambassador for Manatee Springs
2002-2006	Working Group Coordinator for Ichetucknee Springs
2002-2006	Silver Springs Outreach/Working Group Coordinator
2002-2003	Working Group Coordination at Rainbow Springs
2002-2006	Ambassador at Wakulla Springs

2003-2006	Working Group Coordination at Santa Fe Springs
2004-2006	Working Group Coordination at Wakulla Springs
2002-2003	Troy Spring Erosion Control
2002	Boardwalk to Control Erosion at DeLeon Spring
2002	Removal of Lime Rock Trails from Spring Wetlands at Homosassa Springs
2002	Fencing Around Ichetucknee and Rose Sinks
2002	Access Ramps and Boardwalks to Cherokee Spring at Wakulla Springs
2004-2006	Wakulla Springs Educational Trail System
2004	Rose Sink Restoration at Ichetucknee Springs
2004-2006	Renovation of Rainbow Springs Education Center
2004	Indian Spring Restoration at Wakulla Springs
2004	Peacock Spring Boardwalk for Erosion Control at Ichetucknee Springs
2002	Video on Volusia Blue Spring
2004-2006	Educational Signage/Kiosks
2002	Identify Invertebrate Communities by Habitat Type and Correlate with Velocity/Spring Flow at Volusia Blue Spring
2002	Water Quality Baseline Sampling in Half Mile Creek at Silver Springs and in Witherington, Barrel and Sulphur Springs at Wekiwa Springs
2002	Baseline Water Quality Well Sampling for Nitrates at DeLeon Spring
2002	Exotic Fish, Exotic Plant and Algae Removal and Erosion Control at Wekiwa Springs
2003	Lafayette Blue Drainfield Relocation
2002	Septic Tank Drainfield and Boat Ramp at Manatee Springs
2002	Sewer Improvements at Rainbow Spring
2002	Sewer Hookup to Park Ranger Residence and Shop and Wakulla Springs
2004	Elimination of Septic and Hookup to Sewer at Park Ranger Residence at Volusia Blue Spring
2004	Removal of Septic Tank and Park Ranger Residence Sewer Hookup at Blue Hole in Florida Caverns
2004	Waterless Urinals at Rainbow Springs
2004	Wekiwa Springs Sewer System Upgrade/Connection
2002	Wakulla Springs Recharge Area Landowner Assistance Program Surveys
2002	Environmental Education at Camp Kulaqua

Appendix B. Springs Champions Recognized by the FSTF, 2000-2006

Florida Springs Task Force Springs Protection and Education Award Recipients

2006 Award Recipients

Florida Department of Transportation District 3: February 2, 2006
Dr. Richard Hamann, University of Florida Levin College of Law: March 21, 2006
John Moran, Nature Photographer: April 18, 2006
Loye Barnard, Save Our Suwannee: April 18, 2006

2005 Award Recipients

David Hornsby, Suwannee River Water Management District: May 12, 2005
Ryan Means, FGS: May 12, 2005
Rebecca Meegan, FGS: May 12, 2005
Todd Kincaid, Hazlett-Kincaid Inc.: May 12, 2005
Bob Ballard, Department of Environmental Protection: May 12, 2005
Marion County Commission: June 21, 2005
Mayor Kirk Eppenstein, City of High Springs: August 25, 2005
Bruce Ritchie, Tallahassee Democrat: October 19, 2005
Jack Leppert, Friends of Wakulla Spring: October 19, 2005
Dorothy Routh, Friends of Wakulla Spring: October 19, 2005

2004 Award Recipient

Ron Miller, President of Homosassa River Alliance: May 20, 2004

2003 Award Recipients

Florida Department of Transportation District 2: Feb 6, 2003
Mike Poucher, National Speleological Society CDS: February 6, 2003
Annette and Mark Long, Citizens: February 6, 2003
Al Burt, Citizen and Poet: April 17, 2003
Manley K. Fuller III, Florida Wildlife Federation: April 24, 2003

2002 Award Recipients

William Shirling, Citizen: March 14, 2002
Wayne Hartley, Park Ranger: May 7, 2002
J. Timothy Collins, Villages of Rainbow Springs: May 8, 2002

2000 Award Recipients

John D. Willis, Columbia Livestock Market: February 9, 2000
Lamar Hires, Dive Rite Inc.: February 9, 2000
Peter L. Butt, Karst Environmental Services: February 9, 2000
Wes C. Skiles, Karst Environmental Services: February 9, 2000
Rick Hughes, Park Ranger: February 9, 2000

Appendix C. First Magnitude Springs of Florida by County

Spring	WMD	Discharge Range (cfs)	Nitrate Concentration and Date Sampled (mg/l)	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
Alachua County								
Hornsby Spring	SRWMD	0 - 250	0.3 (sampled in 2001)	yes	no	yes	no	private
Bay County								
Gainer Group	NWFWMD	150 - 556	0.23 (Vent #1, 2-7-05)	no	yes, quarterly	no	yes	private/State
Citrus County								
Chassahowitzka Group	SWFWMD	31.8 - 197	0.50 (Main, 1-24-05)	no	yes, quarterly	no	yes	State
Homosassa Group	SWFWMD	80 - 165	0.60 (Vent #3, 1-25-05)	yes	yes, quarterly	no	yes	State
Kings Bay Group	SWFWMD	975	0.43 (Hunter Spring, 1-26-05)	yes	yes, quarterly	no	yes	private/State
Columbia County								
Columbia Spring	SRWMD	39.5 - **305.97	0.089 (sampled in 2001)	no	no	yes	no	private
Ichetucknee Group	SRWMD	186 - 197.2	0.66 (Headspring, 1-11-05)	no	yes, quarterly	yes	yes	State
Santa Fe River Rise	SRWMD	**75 - **442.05	0.058 (sampled in 2001)	no	no	yes	no	State
Treehouse Spring	SRWMD	39.9 - 405.96	0.091 (sampled in 2001)	no	no	yes	no	private
Santa Fe Spring	SRWMD	47.9 - 149.99	0.057 (sampled in 2001)	no	no	yes	no	private
Dixie County								
Steinhatchee River Rise	SRWMD	350	0.056 (sampled in 2001)	no	no	no	no	State
Gilchrist County								
Devil's Ear Spring	SRWMD	**120 -	2.0 (1-12-05)	yes	yes, quarterly	yes	no	private

Spring	WMD	Discharge Range (cfs)	Nitrate Concentration and Date Sampled (mg/l)	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
		206.59						
Siphon Creek Rise	SRWMD	120	0.7 (sampled in 2001)	no	no	yes	no	State
Hamilton County								
Alapaha River Rise	SRWMD	508 - 699	0.4 (sampled in 2001)	no	no	no	no	State
Holton Creek Rise	SRWMD	0 - 482	0.004 (sampled in 2001)	no	no	no	no	State
Weeki Wachee Spring	SWFWMD	101 - 275	0.73 (Main, 1-24-05)	no	yes, quarterly	no	yes	State
Jackson County								
Jackson Blue Spring	NWFWMD	56 - 265	3.5 (2-7-05)	yes	yes, quarterly	no	yes	State
Jefferson County								
Wacissa Group	SRWMD	64.5 - 605	0.18 (Blue, 1-9-05)	no	yes, quarterly	no	yes	private/State
Lafayette County								
Lafayette Blue Spring	SRWMD	**45.9 - **162	2.6 (1-13-05)	no	yes, quarterly	no	no	State
Troy Spring	SRWMD	106 - 205	2.1 (7-14-04)	yes	yes, quarterly	no	yes	State
Lake County								
Alexander Spring	SJRWMD	74.5 - 162	0.065 (1-19-05)	no	yes, quarterly	no	no	Federal
Leon County								
St. Marks River Rise	NWFWMD	*336 - *742	0.18 (2-3-05)	no	yes, quarterly	no	no	private
Levy County								
Fanning Springs	SRWMD	51.5 - 139	6.3 (1-10-05)	no	yes, quarterly	no	yes	State
Manatee Spring	SRWMD	110 - 238	2.0 (1-10-05)	yes	yes, quarterly	no	yes	State
Madison County								
Madison Blue Spring	SRWMD	71.4 - 141	2.0 (2-13-05)	yes	yes, quarterly	no	yes	State
Marion County								

Spring	WMD	Discharge Range (cfs)	Nitrate Concentration and Date Sampled (mg/l)	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
Rainbow Springs Group	SWFWMD	487 - 1230	1.4 (Bubbling Spring 1-27-05)	no	yes, quarterly	no	yes	State
Silver Glen Springs	SJRWMD	90 - 129	0.052 (1-19-05)	yes	yes, quarterly	no	no	Federal
Silver Springs Group	SJRWMD	***517 - ***1290	1.2 (Main, 1-20-06)	yes	yes, quarterly	yes	yes	State
Suwannee County								
Falmouth Spring	SRWMD	1.59 - 365	0.39 (sampled in 2001)	yes	no	no	no	State
Taylor County								
Aucilla River, Nutall Rise	SRWMD	360	0.029 (sampled in 2001)	no	no	no	no	private
Volusia County								
Volusia Blue Spring	SJRWMD	63 - 214	0.93 (1-18-05)	yes	yes, quarterly	no	yes	State
Wakulla County								
Spring Creek Group	NWFWMD	307 - 2000	0.053 (2-13-05)	no	yes, quarterly	no	yes	private
Wakulla Spring	NWFWMD	*129 - *1910	0.72 (1-31-05)	yes	yes, quarterly	yes	yes	State

Notes: Data from FGS unless otherwise noted. Nitrate values selected from the most recently released FGS springs quarterly sampling data (Winter 2005) where possible. All other nitrate values are from FGS Bulletin 66, The Springs of Florida.
*Data from NWFWMD
** Data from SRWMD
***Data from SJRWMD

Appendix D. Resources for More Information

Springs Related Resources

Springs Websites & Publications

Florida's Springs
http://www.floridasprings.org

Springs-related Classroom Activities for K-12 students
http://www.floridasprings.org/resources

Florida-Friendly Landscaping
http://www.floridayards.org

Silviculture Best Management Practices (DACS 2003)
http://www.fl-dof.com/forest_management/bmp/index.html

Fact Sheet: Florida Springs Interdisciplinary Science Study (USGS 2001)
http://fl.water.usgs.gov/PDF_files/fs008_03_katz.pdf

Springs of Florida, Bulletin No. 66 (Florida Geological Survey 2004)
http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm

Florida Springs Database
http://www.thiswaytothe.net/springs/index.shtml

Florida Springs Map and Guide
http://www.floridasprings.net

Ichetucknee Springs Basin Working Group
http://www.ichetucknee.info

Groundwater Guardians Program, The Groundwater Foundation
http://www.groundwater.org/gg/gg.html

Florida Water Conservation Initiative Final Report (DEP 2002)
http://www.dep.state.fl.us/water/waterpolicy/docs/WCI_2002_Final_Report.pdf

Total Maximum Daily Loads (TMDLs) for nutrients in Wekiva Spring, Rock Springs Run, and Volusia Blue Spring in the Middle St. Johns River Basin (U.S. EPA 2005)
http://www.epa.gov/Region4/water/tmdl/florida/documents/FINAL_Springs_TMDL.pdf

Florida's Total Maximum Daily Loads (TMDL) Program: The First 5 Years (DEP 2005)
http://www.dep.state.fl.us/water/tmdl/docs/2005TMDL_Report_final_2-25-05.pdf

What You Need to Know About Fertilizing and Watering Your Lawn and Landscape to Protect Florida's Springs (S 623 S6) (Nutrient Remediation Working Group)
Southwest Florida Water Management District (Phone: 1-800-423-1476)
http://www.swfwmd.state.fl.us/publications

For more resources, see the government agency websites listed below. Many offer publications and materials online or you can request hard copies in the mail.

Spring Water Data

USGS Water Data (Water Quality, Water Use, Ground Water, Surface Water)
http://fl.water.usgs.gov/Water_data/water_data.html

USGS Real-Time Data for Florida Streamflow (Spring Discharge)
http://waterdata.usgs.gov/fl/nwis/current/?type=flow&group_key=basin_cd

National Speleological Society's Cave Diving Section (Report Form)
http://www.nsscds.org/springreports/reports.htm

Government Agency Websites

DEP Springs Protection
http://www.dep.state.fl.us/springs

DEP Water Resource Management
http://www.dep.state.fl.us/water/default.htm

Florida Geological Survey
http://www.dep.state.fl.us/geology

Water Management Districts (map and links to the five districts)
http://www.sfwmd.gov/histo/3_5wmd_map.html

Florida Park Service
http://www.floridadep.org/parks/default.htm

Florida Department of Community Affairs
http://www.dca.state.fl.us

Florida Department of Agriculture and Community Services
http://www.doacs.state.fl.us

Florida Fish and Wildlife Conservation Commission
http://www.doacs.state.fl.us

Regional Planning Councils
http://www.dca.state.fl.us/fdcp/DCP/Partners/regional.htm

USGS Water Resources of Florida
http://fl.water.usgs.gov

Regulation Websites and Publications

Florida Administrative Code
http://fac.dos.state.fl.us

Florida Statutes
http://www.leg.state.fl.us/statutes

DCA: Model Land Development Code
http://www.dca.state.fl.us/fdcp/springs

DCA: Wekiva Parkway and Protection Act
http://www.dca.state.fl.us/fdcp/DCP/wekiva/wekivaact/index.cfm

Implementation of the Model Land Development Code for Florida Springs Protection
(University of Florida College of Law Conservation Clinic 2004)
http://www.law.ufl.edu/conservation/pdf/model_land.pdf

DEP: Total Maximum Daily Loads (TMDLs)
http://www.dep.state.fl.us/water/tmdl

U.S. EPA: Florida TMDLs Website
http://www.epa.gov/Region4/water/tmdl/florida/index.htm

Watershed Restoration Act of 1999 (TMDLs)
http://www.sfwmd.gov/org/wrp/fwra.html

DEP: Outstanding Florida Waters (OFWs)
http://www.dep.state.fl.us/water/wqssp/ofw.htm

DEP: Minimum Flows and Levels (MFLs)
http://www.dep.state.fl.us/water/waterpolicy/mfl.htm

DEP: Water Conservation
http://www.dep.state.fl.us/water/waterpolicy/conservation.htm

DEP: Environmental Regulation Commission
http://www.dep.state.fl.us/legal/ERC/ERC.htm

Appendix E. Table of Analytes for Springs Monitoring

Core and Extended Analytes for Florida Springs Water Quality Monitoring Network

CORE INDICATORS	Dissolved/Total/ Field
Calcium	D, T
Magnesium	D, T
Sodium	D, T
Potassium	D, T
Chloride	D, T
Sulfate	D, T
Fluoride	D, T
Alkalinity (as $CaCO_3$)	D, T
Nitrate + Nitrite (as N)	D, T
Ammonia	D, T
Kjeldahl Nitrogen	D, T
Total Phosphorous	D, T
ortho-Phosphate	D
Specific Conductance	D
Organic Carbon	T
Dissolved Solids	T
Suspended Solids	T
Turbidity	T
Color	T
Total Coliform	T
Fecal Coliform	T
Enterococci	T
Water Temperature	F
pH	F
Specific Conductance/Salinity	F
Dissolved Oxygen	F
Secchi Depth	F*
Estimated Sample Depth	F
Stage	F*
Discharge	F*

EXTENDED INDICATORS (2003-2005)	Dissolved/Total/ Field
Aluminum	D, T
Arsenic	D, T
Barium	D, T
Boron	D, T
Cadmium	D, T
Cobalt	D, T
Chromium	D, T
Copper	D, T
Iron	D, T
Manganese	D, T
Nickel	D, T
Lead	D, T
Selenium	D, T
Tin	D, T
Strontium	D, T
Zinc	D, T

T = total sample
D = dissolved or filtered sample
F = field measurement
* = measurement collected whenever possible

Notes: Core Indicators are sampled quarterly; Extended Indicators (currently trace metals) are also sampled quarterly but may periodically change.

Appendix F. Monitored Springs in Florida (Table and Map)

Table of Springs Water Quality and Discharge Monitoring with Sampling Frequency

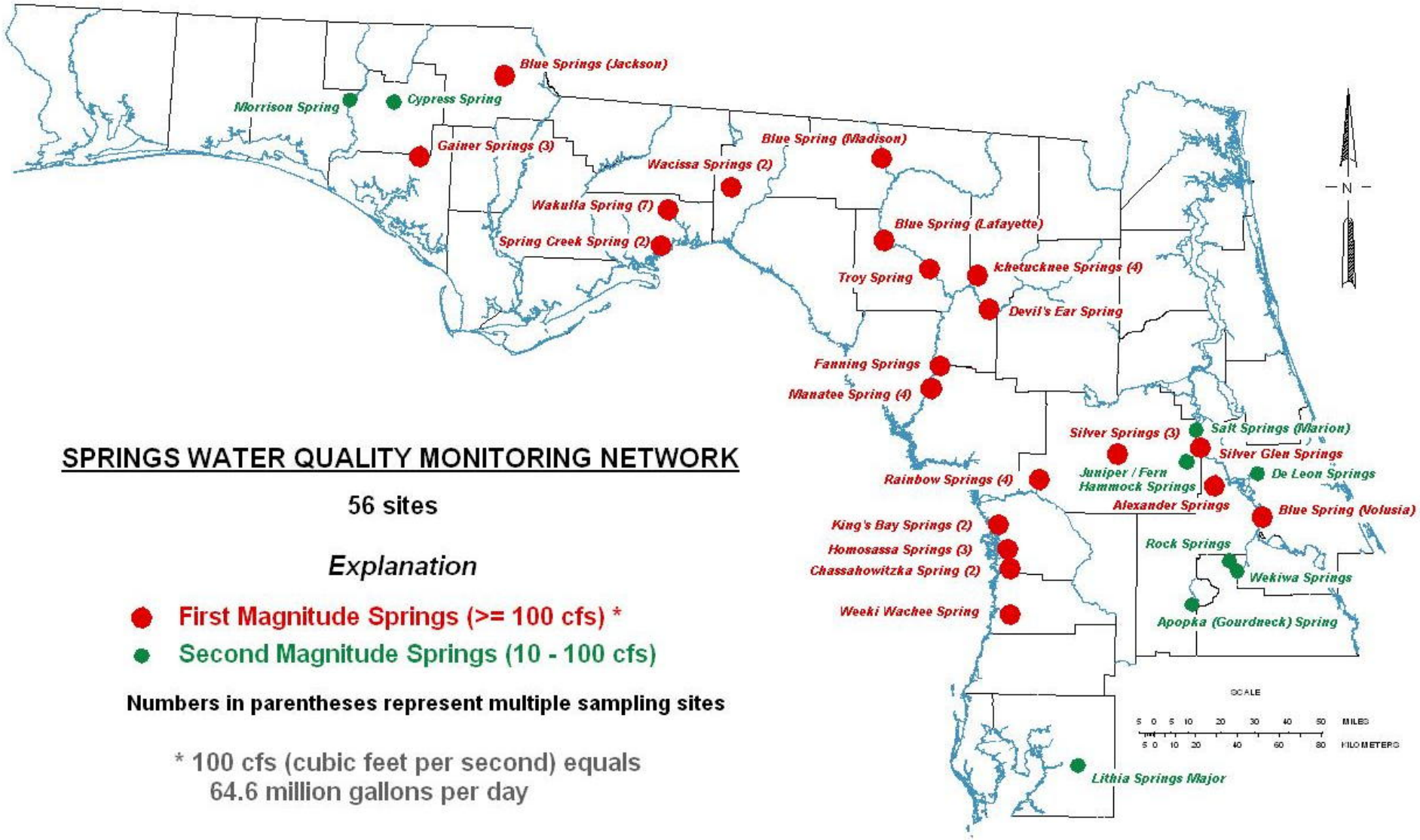
Site Name	County	Water Quality	Discharge
Alexander Springs	Lake	Quarterly	Quarterly
Apopka (Gourdneck) Spring	Lake	Quarterly	None
Cypress Spring	Washington	Quarterly	Quarterly
DeLeon Springs	Volusia	Quarterly	Quarterly
Devil's Ear / Devils Eye / July Spring System	Gilchrist	Quarterly	None
Fanning Springs	Levy	Quarterly	Quarterly; Continuous
Fern Hammock	Marion	Quarterly	None
Jackson Blue Spring	Jackson	Quarterly	Quarterly; Continuous
Juniper Spring	Marion	Quarterly	Quarterly
Lafayette Blue Spring	Lafayette	Quarterly	Quarterly
Lithia Springs Major	Hillsborough	Quarterly	Quarterly
Little Fanning Spring	Levy	None	7 times/year
Madison Blue Spring	Madison	Quarterly	Quarterly; Continuous
Marion Salt Springs	Marion	Quarterly	Quarterly
Morrison Spring	Walton	Quarterly	Quarterly
Rock Springs	Orange	Quarterly	Quarterly
Silver Glen Springs	Marion	Quarterly	Quarterly; Continuous
Troy Spring	Lafayette	Quarterly	Quarterly; Continuous
Volusia Blue Spring	Volusia	Quarterly	Quarterly; Continuous*
Weeki Wachee Spring	Hernando	Quarterly	Continuous
Wekiwa Springs	Orange	Quarterly	Quarterly
Chassahowitzka Springs Group			
Chassahowitzka Main Spring	Citrus	Quarterly	Continuous as group
Chassahowitzka Spring No.1	Citrus	Quarterly	Quarterly; Continuous as group
Gainer Springs Group			
Gainer Spring No. 1C	Bay	Quarterly	Quarterly as group
Gainer Spring No. 2	Bay	Quarterly	Quarterly as group
Gainer Spring No. 3	Bay	Quarterly	Quarterly as group
Homosassa Springs Group			
Homosassa Spring No. 1	Citrus	Quarterly	Continuous as group
Homosassa Spring No. 2	Citrus	Quarterly	Continuous as group
Homosassa Spring No. 3	Citrus	Quarterly	Continuous as group
Ichetucknee System			
Blue Hole Spring	Columbia	Quarterly	Continuous
Cedar Head Spring	Columbia	None	Continuous
Coffee Spring	Columbia	None	7 times/year
Devil's Eye Spring	Columbia	None	Continuous
Ichetucknee Head Spring	Suwannee	Quarterly	Quarterly; Continuous
Ichetucknee River at Dampier's Landing	Columbia	None	Continuous
Ichetucknee River at U.S. 27	Columbia	None	Continuous

Site Name	County	Water Quality	Discharge
Mill Pond Spring	Columbia	Quarterly	Quarterly; Continuous
Mission Spring	Columbia	Quarterly	Continuous
Kings Bay Springs Group			
Hunter Spring	Citrus	Quarterly	Continuous as group
Tarpon Hole Spring	Citrus	Quarterly	Continuous as group
Manatee Spring			
Manatee Spring	Levy	Quarterly	Quarterly; Continuous
Manatee- Blue Water Tunnel	Levy	Quarterly	None
Manatee- Sewer Tunnel	Levy	Quarterly	None
Manatee- Main Tunnel	Levy	Quarterly	None
Rainbow Springs Group			
Rainbow Bubbling Spring	Marion	Quarterly	Quarterly; Continuous as group*
Rainbow Spring No. 1	Marion	Quarterly	Continuous as group*
Rainbow Spring No. 4	Marion	Quarterly	Continuous as group*
Rainbow Spring No. 6	Marion	Quarterly	Continuous as group*
Silver Springs Group			
Main	Marion	Quarterly	Continuous as group*
Reception Hall	Marion	Quarterly	Continuous as group*
Blue Grotto	Marion	Quarterly	Continuous as group*
Spring Creek Springs Group			
Spring Creek Rise (Spring #1)	Wakulla	Quarterly	None
Spring Creek Rise (Spring #2)	Wakulla	Quarterly	None
Wacissa Springs Group			
Big Spring	Jefferson	Quarterly	Quarterly
Wacissa Head/Spring No. 2	Jefferson	Quarterly	None
Wakulla Spring			
Wakulla Spring	Wakulla	Quarterly	Quarterly; Continuous**
Wakulla Tubing A/D-Tunnel	Wakulla	Quarterly	Continuous**
Wakulla Tubing A/K-Tunnel	Wakulla	Quarterly	Continuous**
Wakulla Tubing B-Tunnel	Wakulla	Quarterly	Continuous**
Wakulla Tubing C-Tunnel	Wakulla	Quarterly	Continuous**
Wakulla Tubing D-Tunnel	Wakulla	Quarterly	Continuous**
Wakulla Tubing K-Tunnel	Wakulla	Quarterly	Continuous**

* Continuous discharge measurements collected by the U.S. Geological Survey but not funded through the Florida Springs Initiative.

** Florida Geological Survey collects continuous flow data from the conduits/tunnels using Falmouth meters; Northwest Florida Water Management District collects continuous flow data from the main spring vent using a S4 velocity meter; U.S. Geological Survey collects continuous flow data for Wakulla Springs at the Highway 365 bridge near Crawfordville, Florida, using a Sontek Sidelooker Acoustic Velocity Meter.

Map of the Springs Water Quality Monitoring Network



Appendix G. Springs Areas by County

OPEN FILE MAP SERIES NO. 95

FLORIDA GEOLOGICAL SURVEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Florida Springs Protection Areas

Greenhalgh, T. H., P.G. #1277 and Baker, A. E., February 9, 2005

Walter Schmidt
State Geologist and Chief

Colleen M. Castille
Secretary

Introduction

The Florida Springs Protection Areas map was created by the Florida Geological Survey (FGS) at the request of the Florida Department of Community Affairs. The purpose of the map is to identify areas that contribute flow to Florida springs and to provide a published resource for land use decision-makers as they work to protect and restore both the quantity and quality of water discharging from Florida's springs.

A springshed is defined as "those areas of surface water and ground-water basins that contribute to the discharge of the spring." (Copeland, 2003). To delineate a springshed or a spring protection area one must have an understanding of the hydrogeology of the study area, potentiometric surface maps, knowledge of internally drained areas and conduit connections. Consideration should be given to aquifer recharge, aquifer vulnerability and the uncertainty in the data. Expert knowledge should be used to refine the delineated protection area boundaries where appropriate. Current and future research will improve our understanding of springsheds/protection areas and their boundaries; as a result the Florida Springs Protection Areas map will be periodically updated.

This map was created by compiling available springshed maps from the Water Management Districts, the US Geological Survey and the Florida Department of Environmental Protection. Utilizing geographic information system software or GIS, these springsheds were projected onto a map of the State of Florida. To delineate springsheds for the remaining springs, additional geologic data layers were utilized, Including FGS spring locations, the thickness of overburden on the Floridan Aquifer System (FAS) and the thickness of Intermediate Confining Unit sediments.

Realizing that springshed boundaries are dynamic due to changes in climate (seasonal and long-term) and pumpage, a township buffer is applied to address lateral uncertainty. For the non-outlier springs. After applying the township buffer, best professional geologic judgment and expert hydrogeologic knowledge were used to further refine the delineated spring protection areas. Specifically, areas were excluded where the FAS is overlain by very thick confining. Utilizing the 2000 FAS potentiometric surface map, regional ground-water divides were used to refine some of the springs protection area boundaries.

In the springs protection area, the "sole source" of drinking water and the source of spring discharge is groundwater. Whether pumped from a well or flowing from a spring vent, it is the same ***water***. Numerous contaminants including bacteria, metals, nutrients and pesticides are detected in spring waters. These contaminants and potentially others may be found in ground water within the protection area. Utilizing this map, citizens and the government can better protect the natural treasures we call springs as well as their drinking water.

A step by step outline of the process used to create this map is shown in the insets.

References

Aucott, W.R., 1988, Areal Variation in Recharge to and Discharge from the Floridan Aquifer System in Florida: U.S. Geological Survey Water Resource Investigations Report 88-4057, 1 map.

Cichon, J.R., Wood, H.A.R., Bakor, A.E., and Arthur, J.D., 2004, Application of Geologic Mapping and Geographic Information Systems to Delineate Sensitive Karst Areas for Land-Use Decisions, American Geological Institute website, http://www.agiweb.org/environment/publications/mapping/graphics/florida.pdf, 2004.

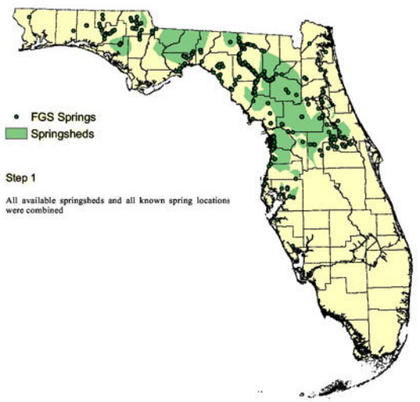
Copeland, R., 2003, Florida Spring Classification System and Spring Glossary: Florida Geological Survey Special Publication No. 52, p. 14

Todd, D.K. 1980. Groundwater Hydrology. John Wiley & Sons, New York, 535 pp.

Qualification

This geologic data was developed by the Florida Department of Environmental Protection (FDEP) - Florida Geological Survey (FGS) to carry out agency responsibilities related to management, protection, and development of Florida's natural resources. Although efforts have been made to make the information accurate and useful, the FDEP/FGS assumes no responsibility for errors in the information and does not guarantee that the data are free from errors or inaccuracies. Similarly FDEP/FGS assumes no responsibility for the consequences of inappropriate uses or interpretations of the data. As such, these digital data are distributed on "as is" basis and the user assumes all risk as to their quality, the results obtained from their use, and the performance of the data. FDEP/FGS bears no responsibility to inform users of any subsequent changes made to this data. Anyone using this data is advised that precision implied by the data may far exceed actual precision. Comments on this data are invited and FDEP/FGS would appreciate that documented errors be brought to staff attention. The development of these data sets represents a major investment of staff time and effort. As a professional responsibility, we expect that the FDEP/FGS will receive proper creditwhen these data sets are utilized. Further, since part of this data was developed and collected with U.S. Government or State of Florida funding, no proprietary rights may be attached to it in whole or in part, nor may it be sold to the U.S. Government or the Florida State Government as part of any procurement of products or services.

Springsheds and Springs

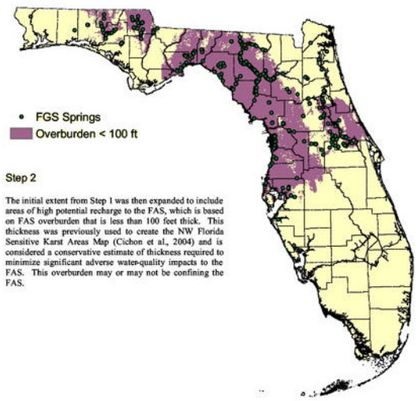


- FGS Springs
- Springsheds

Step 1

All available springsheds and all known spring locations were combined

Overburden on Limestone

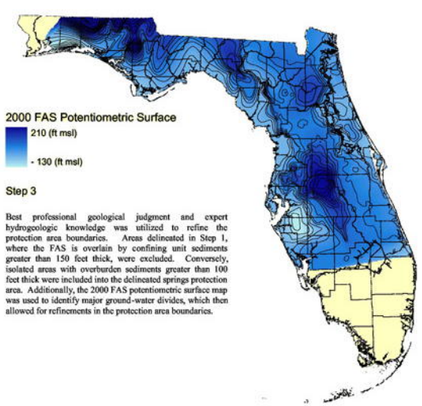


- FGS Springs
- Overburden < 100 ft

Step 2

The initial extent from Step 1 was then expanded to include areas of high potential recharge to the FAS, which is based on FAS overburden that is less than 100 feet thick. This thickness was previously used to create the NW Florida Sensitive Karst Areas Map (Cichon et al., 2004) and is considered a conservative estimate of thickness required to minimize significant adverse water-quality impacts to the FAS. This overburden may or may not be confining the FAS.

Professional Interpretation

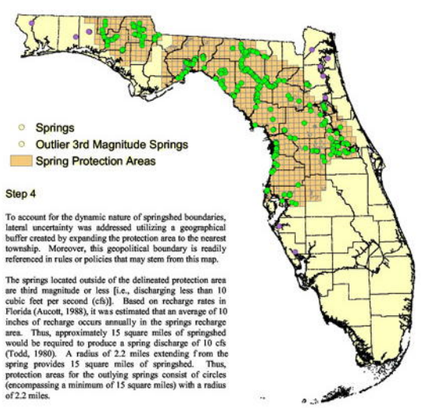


2000 FAS Potentiometric Surface
210 (ft msl)
- 130 (ft msl)

Step 3

Best professional geological judgment and expert hydrogeologic knowledge was utilized to refine the protection area boundaries. Areas delineated in Step 1, where the FAS is overlain by confining unit sediments greater than 150 feet thick, were excluded. Conversely, isolated areas with overburden sediments greater than 100 feet thick were included into the delineated springs protection area. Additionally, the 2000 FAS potentiometric surface map was used to identify major ground-water divides, which then allowed for refinements in the protection area boundaries.

Township Buffer



- Springs
- Outlier 3rd Magnitude Springs
- Spring Protection Areas

Step 4

To account for the dynamic nature of springshed boundaries, lateral uncertainty was addressed utilizing a geographical buffer created by expanding the protection area to the nearest township. Moreover, this geopolitical boundary is readily referenced in rules or policies that may stem from this map.

The springs located outside of the delineated protection area are third magnitude or less [i.e., discharging less than 10 cubic feet per second (cfs)]. Based on recharge rates in Florida (Aucott, 1988), it was estimated that an average of 10 inches of recharge occurs annually in the springs recharge area. Thus, approximately 15 square miles of springshed would be required to produce a spring discharge of 10 cfs (Todd, 1980). A radius of 2.2 miles extending from the spring provides 15 square miles of springshed. Thus, protection areas for the outlying springs consist of circles (encompassing a minimum of 15 square miles) with a radius of 2.2 miles.

Version: February 9, 2005

Appendix H. Implementation Table – All Strategies

Participants Referenced in the Implementation Table

The Florida Department of Environmental Protection is responsible for coordinating agencies and administering programs for the Florida Springs Initiative (FSI). Several additional agencies, governments, and others participate in springs protection strategies either on their own or as part of the FSI.

ARC	Acquisition and Restoration Council (advises Florida Forever)
CSO	Citizen Support Organizations for State Parks
Contractor	Government Funded Contractors
County Park	County Parks with Springs
DCA	Florida Department of Community Affairs
DEP	Florida Department of Environmental Protection
DOH	Department of Health, County Health Departments
DOT	Florida Department of Transportation
Extension	County Extension Offices
FCT	Florida Communities Trust
DACS	Florida Division of Agriculture and Consumer Services
FGS	Florida Geological Survey
Florida Forever	State Land Acquisition Program
FNAI	Florida Natural Areas Inventory
FNPS	Florida Native Plant Society
FSTF	Florida Springs Task Force
FWC	Florida Fish and Wildlife Conservation Commission
Legislature	Florida Legislature
Local Gov't	City and County Governments
NGO	Non-government Organizations or Non-profit Groups
NRCS	Natural Resources Conservation Service
NSS	National Speleological Society
NWR	National Wildlife Refuges
Private	Private Industry, Landowners, etc.
Private Park	Private Parks with Springs
RPC	Regional Planning Councils
School	Public and Private Schools (elementary, middle, high)
State Park	State Parks with Springs
TAC	Nutrient Technical Advisory Committee
University	Public and Private Universities
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
Utility	Water Utilities
WMD	Water Management Districts

Implementation Table – All Action Steps

Action Number	Action Description	Status	Participants
1. Education & Outreach Strategies			
1.1. Education			
Goal: Educate homeowners and associated groups			
1.1.1	Educate homeowners and associated groups (homeowners associations, consumers, landscape and lawn care companies, garden clubs) on fertilizer best management practices, including slow-release, no fertilizer, and other alternatives for residential lawns and gardens.	Ongoing	DEP, FYN, NGO
1.1.2	*Develop a user-friendly version of the booklet, *What You Need to Know About Fertilizing and Watering Your Lawn and Landscape to Protect Florida's Springs*, to meet the needs of homeowner use.	New Action	DEP, FYN
1.1.3	*Fund the DEP Spring Ambassador Program to educate homeowners (including large landowners) in springsheds about threats to the springs and what they can do to protect springs.	Ongoing	DEP
1.1.4	*Coordinate with the Florida Yards and Neighborhoods program to design effective strategies to reach homeowners with springs information, including providing resources and support for existing programs, and providing resources to Spring Ambassadors.	New Action	DEP, FYN, WMD
Goal: Educate the public about springs protection			
1.1.5	Conduct an aggressive public education program on the benefits of water conservation.	Ongoing	DEP, WMD, Utility, Private, NGO
1.1.6	Fund the production of a high-quality, made-for-television video to educate Floridians about the values, function, and protection needs of springs. Produce an updated version every five years.	Achieved – Needs Update	DEP, Private
1.1.7	Compile and publish an update to the 1977 Florida Geological Survey's *Geological Bulletin No. 31 Revised, Springs of Florida*.	Achieved – Needs Update	DEP, FGS
1.1.8	Provide and publicize user-friendly, online information about springs and the issues that threaten them.	Achieved – Needs Update	DEP, NGO
1.1.9	*Provide user-friendly stand-alone graphs based on available data to illustrate discharge and water quality trends and make them available online.	New Action	DEP, FGS
1.1.10	Generate periodic "Springs Condition Index" depicting relative water quality trends (current and future).	Ongoing	DEP
1.1.11	*Develop materials that interpret and explain TMDLs and MFLs in a way that can be	New Action	DEP

Action Number	Action Description	Status	Participants
	readily understood by the public.		
1.1.12	Conduct a Florida Springs Conference at three-year intervals.	Ongoing	DEP, NGO
1.1.13	Erect signs within springsheds with the name of the springshed on it to raise awareness of the geographic location of these springsheds.	Ongoing	DEP, DOT
1.1.14	*Develop media kits to create opportunities for interviews and appearances by spring specialists, should include PSAs and Press Releases.	New Action	DEP
1.1.15	*Develop a distribution plan to provide central access to springs resource educational materials.	New Action	DEP
Goal: Educate students about springs.			
1.1.16	*Conduct environmental science literacy programs (such as enrichment programs and service learning projects) as part of the statewide Learning in Florida's Environment Program (LIFE) coordinated by the DEP Office of Environmental Education.	Ongoing	DEP, State Park, School, Extension
1.1.17	Develop and conduct field trips and classroom presentations.	Ongoing	DEP, FGS, State Park, School, Extension, NGO
1.1.18	*Develop a Florida Springs Curriculum.	Ongoing	DEP, NGO
Goal: Educate visitors about threats to and protection strategies for public springs.			
1.1.19	*Install outdoor exhibits at springs parks.	Ongoing	DEP, State Park, County Park, Private Park
1.1.20	*Conduct springshed interpretive programs for visitors to state parks.	Area of Need	State Park, County Park, Private Park
Goal: Inform local government			
1.1.21	Develop a booklet that provides land use planning guidance to local governments and enables them to identify and plan for the protection of springsheds.	Achieved – Needs Update	DCA
1.1.22	*Develop tools to keep local government officials and inter and intra government agencies periodically informed of FSI programs.	New Action	DEP
1.1.23	Conduct workshops on springs protection strategies for local government elected officials and staff in each county with springs and/or in a springshed.	Ongoing	DEP, WMD, Utility, Local Gov't
1.1.24	*Fund and implement a reporting procedure for current springs information to provide springs specialists with access to research results, monitoring projects, protection successes, threats, new regulations, recently acquired lands, etc.	New Action	DEP

Action Number	Action Description	Status	Participants
1.2. Spring Basin Working Groups			
Goal: Form and support working groups to protect major springs and spring groups.			
1.2.1	Fund coordination of spring basin working groups and dedicate DEP staff time to this effort.	Ongoing	DEP
1.2.2	Provide technical assistance and training in support of the formation and facilitation of working groups.	Ongoing	DEP
1.2.3	*Provide formal opportunities for working groups to share information and success stories, such as a session or round table discussion at the Springs Conference or other events.	New Action	DEP
2. Research & Monitoring Strategies			
2.1. Research			
Goal: Improve understanding of hydrogeology and flow of springs.			
2.1.1	Delineate springsheds for all of Florida's first magnitude and other selected springs through mapping (cave diving exploration), dye studies, and other means and include the fluctuation in boundaries due to natural and anthropogenic variations in recharge.	Ongoing	FGS, WMD, USGS
2.1.2	Conduct hydrogeologic investigations to determine the relationships between ground water levels and spring flows.	Ongoing	FGS, WMD, USGS, University
2.1.3	*Assess spring runs to identify factors (siltation, damming, trash, etc.) that may impair spring flows and access.	New Action	DEP, WMD, Private
2.1.4	*Statistically analyze the existing water level and flow data to detect the presence of trends.	New Action	DEP, WMD, University, USGS
2.1.5	*Identify and develop data sets to determine historic flow and ground water level baselines.	New Action	FGS, USGS, WMD, University
2.1.6	*Identify improved methods of gaging flow, especially with estavelles.	New Action	USGS, University
2.1.7	*Identify relationships between spring flow and protected, rare, endemic, and managed species in spring systems.	New Action	DEP, WMD, University
2.1.8.	*Identify the relationship between spring flow and non-consumptive uses (including recreation and aesthetics).	New Action	WMD, University
2.1.9.	*Identify the geological characteristics and human factors affecting and controlling the mixing of surface water and ground water and the mixing of differing ground water sources to determine impacts on spring water quality and quantity.	New Action	FGS, DEP, WMD, USGS, University
Goal: Conduct water quality research			
2.1.10	Design an analyte list for each spring based on information generated by the survey of	Achieved –	DEP, FGS, WMD

Action Number	Action Description	Status	Participants
	land uses within the springshed.	Needs Update	
2.1.11	*Identify anthropogenic compounds present in springs systems.	New Action	DEP, FGS, USGS, WMD, University
2.1.12	*Facilitate research into the effects of anthropogenic compounds (including pesticides, pharmaceuticals, endocrine disrupters, etc.) on spring systems.	New Action	DEP, USGS, University
2.1.13	*Develop mapping criteria that identify specific land use activities that impact springshed water quality and quantity.	New Action	DEP, USGS, WMD, FGS, University
2.1.14	Characterize how land use affects water quality in relationship to aquifer vulnerability.	Ongoing	FGS
2.1.15	Identify and investigate water quality problems detected through monitoring, which may vary considerably from spring to spring, based on each individual case.	Ongoing	DEP, USGS, WMD
2.1.16	Identify indicator species best suited to determining potential water quality problems.	Ongoing	DEP, FWC, University, USGS
2.1.17	*Identify relationships between water quality and protected, rare, endemic, and managed species in spring systems.	New Action	DEP, FWC, University
2.1.18	*Determine relationship between water chemistry and system ecology.	Ongoing	DEP, FWC, University
2.1.19	*Identify the relationship between spring water quality and non-consumptive uses (including recreation and aesthetics).	New Action	DEP, WMD, University
Goal: Improve understanding of springs ecology			
2.1.20	*Develop methodologies for assessing the condition of biotic systems in spring systems, and enhance to include assessment of restoration efforts.	New Action	DEP, WMD, FWC
2.1.21	*Obtain data describing the specific environmental needs of cave dependent species.	New Action	DEP, FWC
2.1.22	Identify protected, rare, endemic, and managed species and the springs systems they inhabit.	Area of Need	Contractor, DEP, FWC
2.1.23	Identify threats to the spring-related habitats of the species identified above and develop and implement strategies to address the threats.	Area of Need	DEP, FWC
2.1.24.	*Characterize dependence of plants and animals on water quality and quantity.	New Action	FWC
Goal: Evaluate best management practices and engineering designs and provide for modification as necessary to improve springs protection.			
2.1.25.	Evaluate wastewater treatment technologies (onsite and centralized) to determine the level of contaminant reduction in discharge and the impacts on springs.	Ongoing	DEP, DOH, Private
2.1.26	*Scientifically evaluate the use and effectiveness of agriculture BMPs within springsheds.	New Action	DEP, DACS
2.1.27	*Scientifically evaluate the use and effectiveness of Silviculture BMPs within	New Action	DEP

Action Number	Action Description	Status	Participants
	springsheds to ensure ground water protection, with special emphasis on the application of fertilizer and pesticides.		
2.1.28.	*Scientifically evaluate the use and effectiveness of Golf Course BMPs within springsheds to ensure surface water and ground water protection.	New Action	DEP
2.1.29.	*Scientifically evaluate the use and effectiveness of municipal and domestic (septic), wastewater management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.	New Action	DEP, DOH
2.1.30.	*Scientifically evaluate the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.	New Action	DEP, WMD, Local Gov't
2.2. Monitoring			
Goal: Monitor spring flow			
2.2.1.	Establish stream flow gaging stations at a network of springs selected to represent most of the springs in the State.	Achieved – Needs Update	USGS
2.2.2.	Establish a network of monitoring wells to provide baseline data to determine if water levels are declining.	Ongoing	WMD, FGS, USGS
2.2.3.	Request assistance from spring owners and managers in reporting observations and changes of water quality and quantity.	Ongoing	DEP, Private, WMD
2.2.4.	Conduct long-term thermal and flow monitoring of all spring systems used as thermal refuges by protected and endemic species.	Ongoing	WMDs, FWC, USGS
Goal: Monitor water quality			
2.2.5.	Develop a water quality monitoring plan for all clear water first magnitude and other selected springs that are sampled.	Ongoing	WMD, FGS, USGS
2.2.6	*Monitor anthropogenic compounds in springs systems.	New Action	DEP, WMD, USGS
2.2.7.	Collect spring flow data whenever water quality sampling is performed, where practical.	Ongoing	FGS
Goal: Conduct biological monitoring in spring systems.			
2.2.8.	*Repeat biological inventories of springs and spring runs on a periodic basis to create a baseline from which to compare future data.	Ongoing	DEP, WMD
2.2.9.	Conduct bio-assessments and monitor indicator species at first magnitude and other selected springs.	Ongoing	DEP, WMD,
2.2.10.	Coordinate with cave divers to receive observation reports on submerged cave species. Post the reports on the DEP website.	Ongoing	DEP, Cave Divers
Goal: Integrate monitoring of spring flow, water quality, and biological systems to help in understanding the relationship between water			

Action Number	Action Description	Status	Participants
quality and quantity in spring systems and their associated ecosystems.			
2.2.11.	Identify metric(s) from integrated monitoring data to report on spring condition.	Area of Need	DEP, WMDs, USGS
2.2.12.	*Develop and utilize uniform, consistent methods for data collection across agencies	Ongoing	DEP, WMDs
Goal: Monitor best management practices and engineering designs to collect data on their performance.			
2.2.13.	*Monitor new wastewater treatment technologies to determine the level of contaminant reduction in the discharge and the impacts on springs.	New Action	DEP, University, DOH
2.2.14.	*Monitor the use and effectiveness of municipal and domestic (septic) wastewater management practices for biosolids and levels of treatment for existing facilities within springsheds to ensure surface water and ground water protection.	New Action	DEP, DOH
2.2.15.	*Monitor the use and effectiveness of stormwater management practices within springsheds to ensure surface water and ground water protection.	New Action	DEP, DCA
2.2.16.	*Monitor the use and effectiveness of agriculture BMPs within springsheds.	New Action	WMD, DEP, University
2.2.17	*Monitor the use and effectiveness of silviculture BMPs within springsheds to ensure ground water protection, especially concerning application of fertilizer and pesticides.	New Action	WMD, DEP, University
2.2.18.	*Monitor the use and effectiveness of golf course BMPs within springsheds to ensure surface water and ground water protection.	New Action	University, DEP, WMD
2.3. Research & Monitoring Support			
Goal: Support Research and Monitoring Projects			
2.3.1.	Provide support to scientists, engineers, and policymakers for the development of proposals to address important research and monitoring questions.	Ongoing	DEP, FGS, WMD, USGS
2.3.2.	Provide recurring funding to support research and monitoring projects.	Ongoing	FGS, WMD, USGS
2.3.3.	*Establish a grant program for graduate student research and monitoring.	New Action	University, FGS, USGS, WMD
Goal: Ensure the prompt dissemination of research data and reports.			
2.3.4.	*Disseminate data and reports for public and scientific access.	New Action	DEP, WMD, USGS
2.3.5.	Provide springs water quality, discharge, and biological data in a timely manner through an internet accessible centralized database.	Ongoing	DEP
2.3.6.	Provide periodic reports on the status of monitored springs and include recommendations on monitoring needs.	Area of Need	DEP
Goal: Support projects that explore and map cave systems to help understand the hydrogeology of Florida karst systems.			
2.3.7.	Facilitate qualified cave exploration and access to restricted springs and improve coordination between the cave diving community and the scientific community.	Ongoing	NSS/CDS

Action Number	Action Description	Status	Participants
3. Land Use Planning & Management Strategies			
3.1 Land Use Planning			
Goal: Local governments will adopt springshed protection programs as part of local comprehensive plans and land development regulations.			
3.1.1.	Identify the most vulnerable areas of springsheds and assist local governments in creating zones of special consideration for land use planning or regulation.	Ongoing	FGS, DCA, Contractors, Local Gov't
3.1.2.	Develop criteria for state agencies to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments that potentially impact springs.	Ongoing	DCA
3.1.3.	Develop criteria for local governments to use when evaluating suitability of a site for proposed land use changes during review of comprehensive plan amendments and local land use actions that potentially impact springs.	Ongoing	DCA, Local Gov't
3.1.4.	Develop and implement comprehensive plan policies, ordinances, and LDRs to protect springsheds and karst features with probable direct connections to the aquifer.	Ongoing	DCA, Local Gov't, FSTF
3.1.5.	Develop goals and objectives in the intergovernmental coordination elements of comprehensive plans to cooperatively create approaches and measures needed to protect and restore ground water and springs.	Area of Need	DCA, DEP
3.1.6.	Identify and inform local governments of land uses that are known to adversely affect spring water quality.	Area of Need	DEP, DCA
Goal: Implement enhanced springs protection measures at the regional level.			
3.1.7.	Revise Regional Planning Council Strategic Regional Policy Plans to recognize the aquifer(s) as a natural resource of regional significance in springs areas.	Area of Need	RPC
3.1.8.	Consider legislative action to identify the aquifer(s) as a natural resource of regional significance in all Strategic Regional Policy Plans in spring areas and provide enhanced protection for these resources under that process.	Area of Need	DEP, FSTF, Legislature
Goal: Modify the Development of Regional Impact Review Process to address multi-jurisdictional impacts to springs and springsheds.			
3.1.9.	Modify DRI review criteria to address impacts to ground water resources.	Area of Need	DCA, DEP, DOT, DACS, FWC

Action Number	Action Description	Status	Participants
3.1.10.	Continue to develop, evaluate, and revise best development practices and BMPs for application in springsheds.	Ongoing – Area of Need	DEP
3.1.11.	Reviewing agencies should recommend that local governments include requirements to implement ground water protection BMPs in all DRI development orders in springs areas.	Area of Need	DCA, DEP, DOT, DACS, FWC
3.1.12.	Propose legislation to prohibit state agencies from issuing permits for activities in springs areas that are inconsistent with the applicable local government comprehensive plan and land development regulations.	Area of Need	DEP, Legislature
3.2. Wastewater Management			
Goal: Encourage use of efficient nitrogen removal technologies			
3.2.1.	Within springs areas, permit only nitrogen-reducing performance based Onsite Sewage Treatment and Disposal Systems for new construction, modifications, or to replace failing systems.	Ongoing – Area of Need	DEP, DOH, DCA
3.2.2.	Identify and provide incentives that will encourage the use of more efficient nitrogen and nutrient removal technologies.	Area of Need	DEP, DOH
3.2.3.	Promote legislation that would make approval of DRIs and large-scale developments within a springshed contingent upon the construction of a centralized, advanced wastewater treatment plant (AWTP).	Area of Need	DEP, Legislature
Goal: Upgrade existing wastewater facilities to state of the practice or similar			
3.2.4.	Amend existing statutes or ordinances to require OSTDS inspection and maintenance every five years or when property is sold, and upgrade to current standards as needed.	Area of Need	DOH, Local Gov't, FSTF, Legislature
3.2.5.	*Require local governments within springs areas to upgrade existing wastewater treatment facilities to Advanced Wastewater Treatment Plant (AWTP) and require new wastewater treatment facilities in the springs areas to operate at an AWTP standard and provide water reuse within the springshed.	New Action	DEP, Local Gov't, DOH
Goal: Evaluate and manage nutrient contributions			
3.2.6.	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	Interagency Coordination
3.2.7.	A nutrient management plan should be incorporated in permits that regulate wastewater treatment facilities in springs areas.	Area of Need	DEP, FSTF

Action Number	Action Description	Status	Participants
3.2.8.	State parks with springs shall have the best available wastewater treatment technology for nutrient removal or connect to an offsite AWTP.	Ongoing	DEP, State Parks
3.3 Landscape BMPs			
Goal: Encourage efficient and limited application of fertilizer and pesticides in springs areas.			
3.3.1.	Encourage efficient and limited application of fertilizer on public properties in springs areas and create landscaping conditions and other BMPS where the reduction of fertilizer is appropriate.	Ongoing	DOT, County Park, Private Park, Local Gov't, Contractor
3.3.2.	*Encourage efficient and limited application of pesticides on public properties in springs areas. Create landscaping conditions and other BMPS where the reduction of pesticides is appropriate.	New Action	DOT, County Park, Private Park, Local Gov't, Contractor
3.3.3.	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	Interagency Coordination
Goal: Minimize fertilizer and pesticide dependent areas in landscape design.			
3.3.4.	Require the retention of large areas of native vegetation and/or installation of Florida friendly vegetation in common areas within springs areas.	Area of Need	Local Gov't
3.3.5.	Develop model deed restrictions that incorporate Florida friendly landscaping principles.	Area of Need	DCA, Local Gov't, FYN
3.4 Agriculture BMPs			
Goal: Reduce nutrient loading from agricultural sources in springs areas.			
3.4.1.	*Scientifically evaluate agriculture BMPs and use the findings to modify Agriculture BMPs to ensure ground water protection in springs areas.	New Action	DEP
3.4.2.	Promote effective incentive-based programs as the preferred method for reducing nutrient loading in springs areas.	Ongoing – Area of Need	DEP, DACS, USDA-NRCS, WMD
3.4.3.	Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	DACS, Interagency Coordination
3.4.4.	Form partnerships of farmers, private organizations, environmental groups, state and federal agencies, and local governments to provide policy and technical guidance for the planning process, and to guide the long-term implementation of an action plan.	Ongoing	DEP, DACS, NGO, Private
Goal: Protect sinkholes and other sensitive karst features on agricultural lands in springs areas.			
3.4.5.	Establish a 100-foot naturally vegetated buffer around sinkholes and other karst features that are directly connected to the aquifer.	Ongoing	NRCS, DACS
3.4.6.	*Encourage and assist private landowners to remove waste from sinkholes and other karst features in springs areas.	Ongoing	DEP, Local Gov't, NGO, Private

Action Number	Action Description	Status	Participants
3.4.7.	Avoid the use of pesticides and fertilizers above known spring cave systems.	Area of Need	Private
3.5 Silviculture BMPs			
Goal: Implement silviculture BMPs			
3.5.1.	At a minimum, all forestry operations in springs areas should adopt the practices outlined in the DACS manual, *Best Management Practices for Silviculture* 2003.	Ongoing	DACS
3.5.2.	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	New Action	DACS, Interagency Coordination
Goal: Evaluate and improve silviculture BMPs			
3.5.3.	Scientifically evaluate silviculture BMPs for ground water protection, especially concerning application of fertilizer and pesticides in springs areas	Area of Need	DACS, Private
3.5.4.	Modify BMPs as necessary (based on scientific evidence) to achieve surface and ground water protection.	Area of Need	DACS, Private
3.6 Stormwater Management			
Goal: Implement enhanced stormwater management practices.			
3.6.1.	Develop and adopt a sensitive karst procedure, or equivalent, for the design and construction of stormwater management systems in karst areas.	Area of Need	DEP, WMD, RPC, Local Gov't
3.6.2.	Establish a validation procedure for the Sensitive Karst Areas Criteria (FAC Chapter 40C-41.063(7)) to determine its effectiveness at protecting ground water. Adjust the Karst Criteria, based on the results of the validation process.	Area of Need	DEP, WMD
3.6.3.	Apply the validated Sensitive Karst Areas Criteria for stormwater treatment (subsection 40C-41.063(7) FAC) in all springsheds of the state as referenced in the springs area map, including stream-to-sink (swallet) basins and sinkholes.	Area of Need	DEP, WMD
3.6.4.	Require pre-treatment design (for example, swales, berms, ponds, or dry basins) to retain runoff that currently discharges directly into karst features such as sinkholes and springs.	Ongoing	DCA, Local Gov't
3.6.5.	Scientifically evaluate stormwater treatment facilities and systems' maintenance practices to ensure they protect surface water and ground water resources in springs areas.	Area of Need	DEP, WMD, RPC, Local Gov't
3.6.6.	Promote use of native vegetation to assist in stormwater treatment.	Area of Need	DEP
3.6.7	*Nutrient reduction plans specific to the springshed should be developed for nutrient impacted springs.	Ongoing	Interagency Coordination
3.6.8.	*Inspect existing stormwater management systems, retrofit and repair systems that are substandard, and perform maintenance to assure that flood control and water quality benefits are achieved.	New Action	DOT, County

Action Number	Action Description	Status	Participants
3.7 Sinkhole Protection			
Goal: Identify Vulnerable Sinkholes			
3.7.1	*Identify and prioritize sinkhole connectivity and impact to the aquifer.	New Action	DEP, FGS
3.7.2.	Encourage and assist private landowners with sinkhole cleanup and protection. After sinkholes are cleaned they should be protected from future dumping.	Ongoing	DEP, Local Gov't, NGO, Private
3.8. Golf Course BMPs			
Goal: Encourage the use of Golf Course BMPs			
3.8.1.	Work with state agencies to develop and adopt rules for required BMPs for golf course design, operation, and maintenance. Include a resource management plan, an Integrated Pest Management Plan, and a ground water-monitoring plan for the operation of golf courses in Florida.	Ongoing	DEP, Private
3.8.2.	*Scientifically evaluate golf course BMPs to ensure surface water and ground water protection in springs areas.	New Action	DEP
3.8.3.	*Require golf courses in springs areas to use reuse water from AWTPs when available.	New Action	DEP
3.9. Land Acquisition			
Goal: Protect springs, springsheds, and karst features through land acquisition.			
3.9.1.	Identify and acquire the most vulnerable portions of springsheds and give these lands priority ranking in land acquisition programs.	Ongoing	DEP, WMD, FCT, Florida Forever
3.9.2.	Give priority to the acquisition of springs that cannot be adequately protected and managed by the current owner or are at risk of being developed.	Ongoing	ARC
3.9.3.	Continue to focus the efforts of state land acquisition programs on spring systems with manatee use.	Ongoing	DEP, WMD
3.9.4.	Ensure that springs acquired through environmental lands programs are managed by agencies experienced in the sensitive stewardship and use of springs.	Area of Need	DEP, Florida Forever
3.9.5.	When acquisition is not feasible, conservation easements should be sought to protect springs and areas within springsheds.	Ongoing	DEP, WMD, Local Gov't
3.10. Recreation and Land Management			
Goal: Reduce recreation impacts on springs, protected species and springs-related habitat			
3.10.1.	*Develop a comprehensive training program for springs managers including concessionaires.	New Action	DEP, FGS, State Park
3.10.2.	Springs-related recreational activities should be managed to minimize their effect on protected, rare, endemic, and managed species (including manatees).	Ongoing	State Park, NWR, Local Park, Private Park

Action Number	Action Description	Status	Participants
3.10.3	*Control foot and vehicle traffic through the use of steps, fencing, and directional signs.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.4	*Minimize the amount of upland/shoreline clearing of vegetation and only clear in the areas where direct access is allowed.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.5	*Use exhibits, interpretive signs, leaflets, or staff to help educate users about the values of the spring and how to minimize impacts.	New Action	State Park, NWR, Local Park, Private Park, NGO, CSO, USFS
3.10.6	*Use stormwater management and erosion control methods to protect the spring from contamination, sedimentation, and turbidity problems from upland activities. Direct stormwater away from the spring and maintain a buffer between the uplands and the spring and spring run.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.7	*If motorboats are permitted, designate and control the number and locations of specific mooring spaces for boats.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.8	*Provide trash receptacles and routinely empty them to reduce littering.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.9	*Provide a system for human waste disposal.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.10	*Delineate a specific swimming area with buoyed lines to reduce impacts of swimming on submerged vegetation in the spring or spring run.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.11	*Prohibit fossil or artifact collecting by the public.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.12	*Prohibit feeding of wildlife associated with the spring or spring run, including alligators.	Ongoing	State Park, NWR, Local Park, Private Park
3.10.13	*Control the number of divers in the spring at any one time by requiring they receive	Ongoing	State Park, NWR,

Action Number	Action Description	Status	Participants
	permission from the owner to dive.		Local Park, Private Park
3.10.14	*Develop educational programs targeting swimmers, boaters, and SCUBA divers, which focus on the sensitive ecology of spring runs and how to avoid disturbing plants and animals.	Ongoing	State Park, NWR, Local Park, Private Park, NGO, CSO, USFS
3.10.15	*Organize an Adopt-A-Spring effort in cases where a spring owner cannot provide adequate control of public access and use.	New Action	State Park, NWR, Local Park, Private Park, NGO
Goal: Manage springs, protected species and springs-related habitat			
3.10.16.	Management plans for State and Federally owned spring systems should include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.	Ongoing	NWR, State Park, USFS, DEP
3.10.17.	*Encourage development of management plans for private and local government owned springs that include management strategies for the protection of protected, rare, endemic, and managed species (including manatees). Coordinate plans with local governments and WMDs.	New Action	DEP, Local Park, Private Park
3.10.18.	Manage aquatic plant control programs in spring areas used by manatees to ensure adequate winter forage for manatees and prohibit control activities when manatees are present.	Ongoing	DEP, State Park, Local Park, Private Park, USFS, NWR
4. Regulation Strategies			
4.1 Water Quality Regulations			
Goal: Implement and/or Enforce Existing State and Federal Regulations to Protect Spring Water Quality.			
4.1.1	*Identify regulations and evaluate the status of existing regulations to assess implementation, adequacy, whether or not they are working and why, and how to improve them.	New Action	DEP, FSTF
4.1.2.	Implement and enforce existing Federal and State regulations that can be used to protect the quality of ground water that flows to springs.	Area of need	DEP, WMD
4.1.3.	Establish and apply quantifiable ground water and surface water quality standards for nitrate-nitrogen, phosphate, and other contaminants to protect the ecological quality and condition of ground water systems (including aquatic cave species) and surface water systems in springsheds.	Ongoing	DEP, FSTF, TAC
4.1.4.	Amend existing Federal and State regulations (in particular, the impaired water rule) as	Area of Need	DEP, DCA, DOH,

Action Number	Action Description	Status	Participants
	appropriate to protect quality of water flowing to and from springs and to expand the scope of regulatory strategies that can be applied to protect springs.		USACE, EPA.
4.1.5.	*Identify impaired springs for TMDL listing and develop and implement TMDLs.	New Action	DEP, WMD
4.1.6.	*Amend Ch 62-520.300(8) (FAC) which states that "...discharge to ground water shall not impair the designated use of contiguous surface waters" to add language that will prevent discharges that will impair ecological quality of known caves, springs, and spring runs.	New Action	DEP
4.1.7.	*Modify rules to establish karst criteria in springsheds for siting of permitted facilities.	Ongoing	DEP
Goal: Implement and Support Local Government Initiatives to Protect Spring Water Quality			
4.1.8.	*Compile and assess regulatory mechanisms that can be used to protect springs.	New Action	Local Gov't
4.1.9.	Amend existing local government regulations to protect the quality of ground water in springsheds.	Ongoing	Local Gov't, DCA
4.1.10	*Establish spring protection zones.	Ongoing	Local Gov't
4.1.11	*Encourage implementation of ordinances so that contaminant producers are not sited in spring protection zones or in springsheds where protection zones are not defined.	Ongoing	Local Gov't
4.1.12	Create ordinances that provide special protection and regulation to springs and springsheds.	Ongoing	Local Gov't, DCA
4.1.13	*Create ordinances that provide special protection and regulation over karst features including sinkholes, known caves and conduits.	Ongoing	Local Gov't, DCA
4.2 Spring Flow Regulations			
Goal: Implement and/or Enforce Existing State and Federal Regulations to Protect Spring Flow.			
4.2.1.	*Review the criteria for significant harm in MFLs to see if they are adequate to protect springs; and if not adequate develop policy guidance based on the review.	New Action	DEP
4.2.2.	*Provide reports on MFLs to springs managers and the public.	New Action	WMD
4.2.3.	Aggressively pursue water conservation requirements in consumptive use permits for all permitted users.	Ongoing – Area of Need	WMD
4.2.4.	In WMD Regional Water Supply Plans, maximize strategies for the development of alternative sources of water.	Ongoing	WMD, DEP
4.2.5.	Consider the use of water reservations, where appropriate, to protect spring flows essential for the "protection of fish and wildlife or the public health and safety" (Ch. 373.223 FS).	Ongoing	DEP, WMD, Legislature.
Goal: Implement and Support Local Government Initiatives			
4.2.6.	Encourage local government to implement water conservation regulations.	Ongoing	WMD, DEP

Action Number	Action Description	Status	Participants
4.2.7.	*Develop and promote model xeriscape and irrigation ordinances.	New Action	FNPS, DEP
4.2.8.	Develop and implement regulations that will result in increased water-use efficiency.	Ongoing	DEP, WMD, Utility, Private, NGO
4.3 Protected Species and Springs-Related Habitat Regulations			
Goal: Ensure Protection of Protected, Rare, Endemic, and Managed Species and their Springs-related Habitats			
4.3.1.	*Seek OFW designation for spring systems with protected, rare, endemic, and managed species, where appropriate.	New Action	DEP, NGO
4.3.2.	Extend Outstanding Florida Waters (OFW) designations to include springs, spring runs, and karst features that are known to have hydrologic connections to OFWs.	Ongoing	DEP
4.3.3.	*Revise the OFW rule such that when known and mapped karst features that connect to surface waters are eligible for OFW designation, the karst features can also be so designated.	New Action	DEP
4.3.4.	*Support and encourage a public records exemption for certain data on caves and springs locations, and protected species, to protect landowners, the public, and offshore springs.	New Action	FGS, FNAI, FSTF, DEP, Legislature
4.3.5.	*Evaluate existing aquatic plant control regulations and programs to ensure that adequate winter forage is available for manatees.	Ongoing	FWC, DEP, USACE, Local Gov't
4.3.6.	*Evaluate regulatory strategies and assess potential application for protection of protected, rare, endemic, and managed species and their springs-related habitat and expand where appropriate.	New Action	DEP, FWC, USFWS, County Park, State Park, Private Park
4.3.7.	*Use biological survey data to develop criteria for springs regulations to ensure natural ecological community functions.	New Action	FWC
4.3.8.	*Petition state and federal agencies to list endemic and cave-adapted animals.	New Action	NGO
5. Funding Strategies			
5.1 Funding for Springs Protection and Restoration Strategies			
Goal: Identify funding sources for FSI programs			
5.1.1.	Create the Springs Protection and Restoration Trust Fund and finance it with a permanent dedicated funding source. The Trust Fund would be administered by DEP and would subsidize springs initiatives.	Area of Need	DEP
5.1.2.	Seek federal funding to augment the Springs Protection and Restoration Trust Fund.	Area of Need	DEP, Local Gov't
5.1.3.	*Documented violations of state rules that impact springs should be required to restore or contribute to the restoration of the impacted springshed.	New Action	DEP
5.1.4.	*Encourage the creation of a Florida Springs Foundation to accept contributions for	New Action	DEP

Action Number	Action Description	Status	Participants
	springs protection and restoration.		
5.1.5.	*Create a mitigation process for new or expanding land use modifications that impact springs.	New Action	DEP, DCA
5.1.6.	*Identify options to augment FSI funding.	Ongoing	DEP

*New action added since the 2000 Springs Report.