What is a Spring?

In an essay on springs written for the 2003 Florida Springs Conference, longtime Florida author and journalist Al Burt said: "Springs have a way of getting into your mind and staying there." (Read the full essay, which was reprinted in the *Tallahassee Democrat*, here.)

A spring is a place where groundwater flows naturally onto the land surface or into a body of surface water. Florida has one of the largest concentrations of freshwater springs on Earth. Over thirty of these are found within Lake County. These springs provide natural, recreational, and economic resources for residents and visitors. Those that are the most popular are Alexander and Silver Glen Spring.

Today we are faced with the challenge of protecting our springs from disappearing. Unfortunately, some already have, such as Kissengen Spring in Polk County, which ceased flowing over 50 years ago. Many of Florida's springs are in trouble due to nutrients entering the aquifer from fertilizers and organic wastes.

In 2000, the Florida Springs Task Force reported[1]:

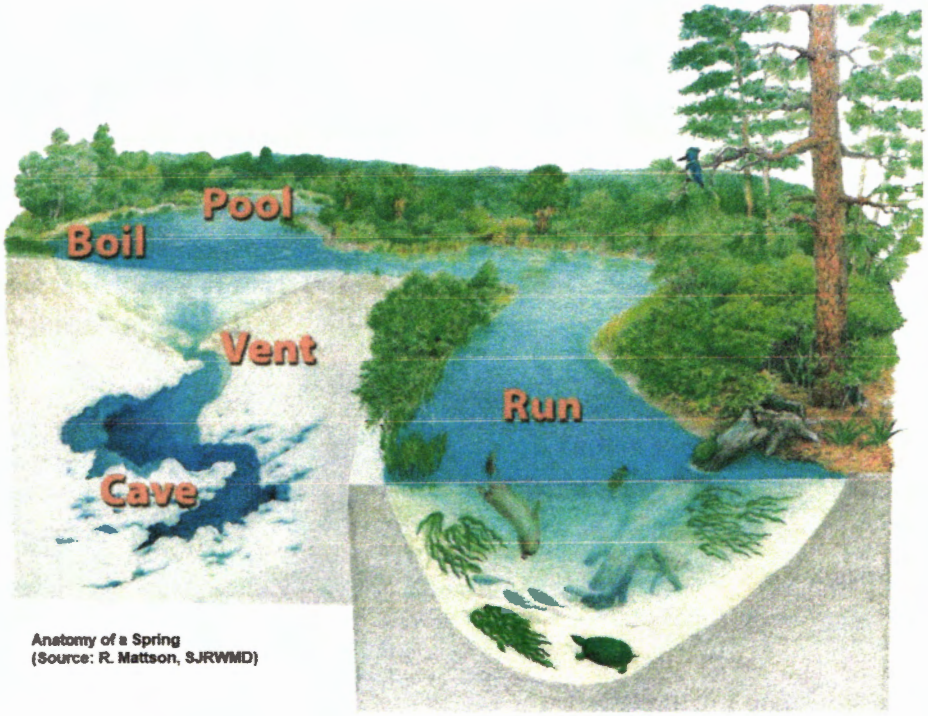
> *Elevated nitrates are a common and growing problem in Florida springs. A steady rise in nitrate levels has been observed in most Florida springs over the past thirty years or so. Nitrate, an essential plant nutrient, was once a very minor constituent of Florida spring water. Typical nitrate concentrations were less than 0.2 milligrams per liter (mg/l). Today many Florida springs discharge water that has more than 1.0 mg/l of nitrate. Springs with recharge basins that have been left in a fairly natural state have maintained low nitrate levels. The Ocala National Forest boasts several such pristine springs. . . . [An increase in Nitrates can be] catastrophic for biological systems.*

Most of our springs discharge water from the Floridan aquifer, the same aquifer that we depend on for our drinking water. This water is provided by rain falling in the springshed; percolating slowly through the soil and recharging the deep limestone the aquifer. This is the same aquifer that supplies water for residential and commercial lawns and landscaping, agriculture and industry. The excessive withdrawal of groundwater to satisfy a myriad of human needs and wants has resulted in a significant drop in the level of the aquifer within Central Florida, and consequently a decline in water volume from area springs.
As our population increases, we consume more water and produce more wastes. The impacts of human activities include declines in groundwater levels and quality, reduction in spring flow, and harm to native wetlands plants and animals.

As the clear cool water flows from a spring, it generally forms a shimmering pool. The spring may have multiple vents or sand boils in the pool or run adding to the flow. From the pool the spring run forms and the water begins it trek to the sea.

Water flowing from our springs supplies lakes, rivers and streams and provides habitat for fish and wildlife, including unique species invertebrates found nowhere else in the world.

With the population explosion in Lake County there has been an increase in water use and extensive land use changes. Many individuals, organizations, and agencies are concerned with the increased demands upon and threats to our water resources. As a result, Lake County and various agencies have initiated programs to monitor and assess our surface and ground water resources, including springs. The spring's portion of this monitoring program includes the regular collection of water samples and flow measurements from area springs. The larger and less-remote springs are sampled on a regular schedule while those springs located in remote or difficult areas to reach are visited as often as resources allow. The data collected is pooled with results from other agencies to increase our understanding of the hydrogeologic, climatic, and human factors that affect water resources.



Anatomy of a Spring
(Source: R. Mattson, SJRWMD)

Springs Protection

In the year 2000, the Florida Springs Task Force determined that the mounting challenges of accommodating Florida's rapid population growth demand effective tactics to protect our world-renowned springs. The Task Force proposed strategies and action steps for protecting the uniqueness and quality of our spring systems in its publication *Florida's Springs, Strategies for Protection & Restoration*[1]. Strategies were organized into five functional groups: Outreach, Information, Management, Regulation, and Funding.

Geologic Characteristics

The St. Johns River Water Management District (SJRWMD) has prepared an excellent summary explaining how springs are formed and their general characteristics. This information is summarized below and can be found on the SJRWMD's website.

Spring Magnitude or Flow

Most of the springs in Lake County have a relatively low flow. Spring flow is classified by magnitude (from 1 to 8) on the basis of flow volume, or discharge of water. A first magnitude spring has the highest rate of flow.[2]

Spring flow is not constant, changing with rainfall, pumping and hydrogeology. A spring classified as a certain magnitude at one time may not continue to flow at that rate at other times. For this reason, the magnitude of a spring is based on a weighted median value of all discharge measurements for the period of record. Spring flow can even be reversed, should the receiving water resource have a higher water level than the source that supplies the spring.

"Historical Spring Magnitude" is 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. It is recognized that historically, many springs in Florida have kept one magnitude category, even though the discharge may have changed considerably from when it was first assigned a magnitude. For this reason, a historical category is acceptable in the Florida Springs Classification System. For example, suppose the discharge of a particular spring was measured in 1946 and at that time, it was classified as a first-magnitude spring. No other measurement is taken until 2001, when three discharge measurements were taken. The median value for the two annual medians reveals that the spring should be re-classified to a second-magnitude spring in 2001. Despite the reduction in flow, the spring would still be considered a historical first-magnitude spring.

Magnitude	Units
1	≥ 100 cfs (≥ 64.6 mgd)
2	≥ 10 to100 cfs (≥ 6.46 to 64.6 mgd)
3	≥ 1 to 10 cfs (≥ 0.646 to 6.46 mgd)
4	≥ 100 gpm to 1 cfs (≥ 100 to 448gpm)
5	≥ 10 to 100 gpm
6	≥ 1 to 10 gpm
7	≥ 1 pint/min to 1 gpm
8	< 1 pint/min

cfs = cubic feet per second
mgd = million gallons per day
gpm = gallons per minute
pint/min = pints per minute

Depending on the amount of discharge, the units of measurement may change. Larger springs are generally measured in millions of gallons per day (mgd) or cubic feet per second (cfs). Smaller spring may be measured in gallons per minute (gpm) or in even smaller quantities.

The location of a discharge measurement is critical. Whenever possible, a discharge measurement should be restricted to a single vent or seep. However, this is often impractical. For example, the only place to take a measurement may be in a spring run downstream where multiple springs have discharged into the run. For this reason, whenever a discharge measurement or water sample is taken, the springs (vents or seeps) included in the measurement need to be reported along with the exact location (section) of the discharge measurement. In the case of submerged springs that discharge directly into a lake or stream like Apopka or Island Springs, the flow measurement has to be taken underwater using SCUBA equipment. Spot measurements are taken across the measurement section with a rotating cup flow meter, a newer Doppler flow device or other accepted methods. These measurements are then combined with the area of the section measured to determine the overall flow.

Water Types

In some cases, the ground water exiting from multiple vents in the same spring may originate from different zones in the Floridan aquifer. One vent may exhibit a different water chemistry than another vent. That is, some vents may produce water indicative of ancient sea water while others may produce water indicating a nearby surface source. These differences are sometimes referred to as water types. Water type can be determined from the chemical content of a sample; however, determining the physical origin of water that emerges from a spring is difficult.

Age of Groundwater

The average age of ground water flowing from a spring can be estimated by analyzing radioactive-isotopes found in the water. This measurement only provides an average age of the water as there may be mixing of multiple underground sources. "Younger" water may indicate that the source of the water is close to the spring.

Spring Recharge Basin or Springshed

A spring recharge basin, or springshed, consists of "those areas within ground- and surface-water basins that contribute to the discharge of the spring" (DeHan, 2002; Copeland, 2003). The spring recharge basin consists of all areas where water can be shown to contribute to the ground-water flow system that discharges from the spring of interest. Because karst systems frequently include sinking streams that transmit surface water directly to the aquifer, the recharge basin may include surface-water drainage basins that bring water into the spring drainage from outside of the ground-water basin. This concept is important because contaminated surface water may be introduced to the springshed from sources well outside of the ground-water basin by streams that originate outside the basin.[2]

Factors affecting quality and quantity of spring water include the distribution of karst features within a springshed, thickness of confining units, soil characteristics, topography, potentiometric surfaces, land use, as well as others. The amount of water and the nature and concentrations of chemical constituents that discharge from a spring are functions of the geology, hydrology, and land uses within the ground- and surface-water drainage basins that collect water for discharge from the spring.

The boundaries of a spring recharge basin can vary with time. That is, the boundary represents of a "snapshot" in time, rather than a permanent delineation. This is a result of a changing potentiometric surface, or ground water level, in the Floridan aquifer. (The potentiometric surface is a measurement of the level that water will rise to in a well drilled into an aquifer.) Note that a spring recharge basin is not defined by chemical or other physical characteristics of spring discharge.

A generalized springshed map has been produced by the St Johns River Water Management District to describe the recharge area contributing to springs within the Wekiva River System. This area includes much of east and southeast Lake County, including parts of Mt Dora, Eustis, and Mt Plymouth-Sorrento. Even portions of Clermont and the Green Swamp are located within this springshed.

Aquifer Vulnerability Maps

Water quality in springs reflects that of the aquifer that supplies them. All aquifer systems in Florida are vulnerable to contamination. This is not only attributable to Florida's hydrogeologic setting but also to human modifications of the natural system. The Florida Geological Survey (FGS) has developed a methodology using geographic information systems to analyze the factors that indicate the relative vulnerability of both the surficial and Floridan aquifers and to predict the vulnerability of major aquifer systems to contamination. The FGS has produced an Wekiva Aquifer Vulnerability Assessment (WAVA)[4] for the Wekiva Study Area located in portions of Lake, Orange and Seminole Counties. The WAVA

vulnerability report can be used to develop measures designed to protect the Floridan Aquifer System, which provides flow to most of our springs. It can also be applied to a variety of environmental management, protection and conservation activities, including:

- Wellhead protection
- Source-water protection
- Recharge protection
- Vulnerability indices
- Contaminant-specific maps
- Land conservation acquisition
- Total maximum daily loads (TMDLs)
- Surface-water/ground-water interactions
- Water-quality management tool
- Resource planning strategies and policies
- Prioritization of areas of critical concern
- Design of monitoring plans
- Best Management Practices

References:

1. Florida Springs Task Force. (2000). *Florida's Springs, Strategies for Protection & Restoration*.
2. Florida Geological Survey. (2004). Springs of Florida. FGS Bulletin No. 66.
3. Florida Springs Nomenclature Committee (FSNC), Florida Geological Survey. (2003). *Florida Spring Classification System and Spring Glossary*.
4. Florida Geological Survey. (2005). *Wekiva Area Vulnerability Assessment, FGS Report of Investigation 104*.