ENV 6932: Spring Systems Exam 5 – Campbell

FINAL EXAM

1: For the Final Exam I will be analyzing Wakulla Springs. Wakulla Springs is located near Tallahassee, Florida.

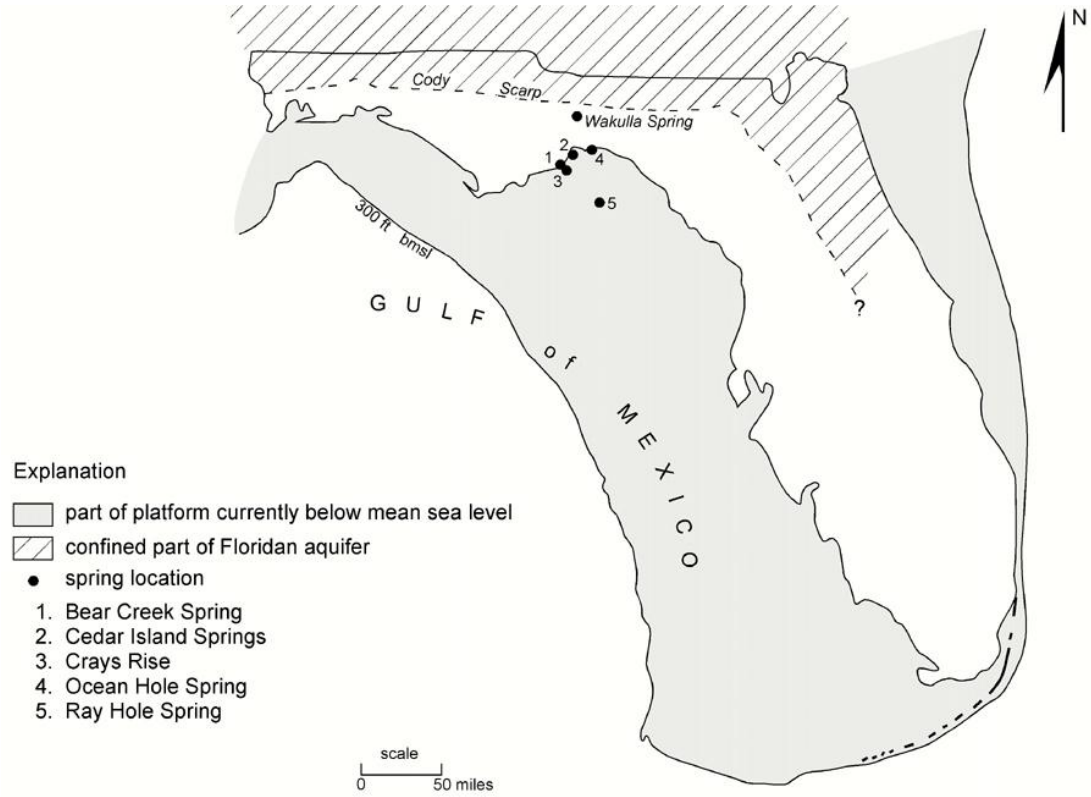

Image 1: Map of Florida Showing Wakulla Springs. (Kincaid, 1999)

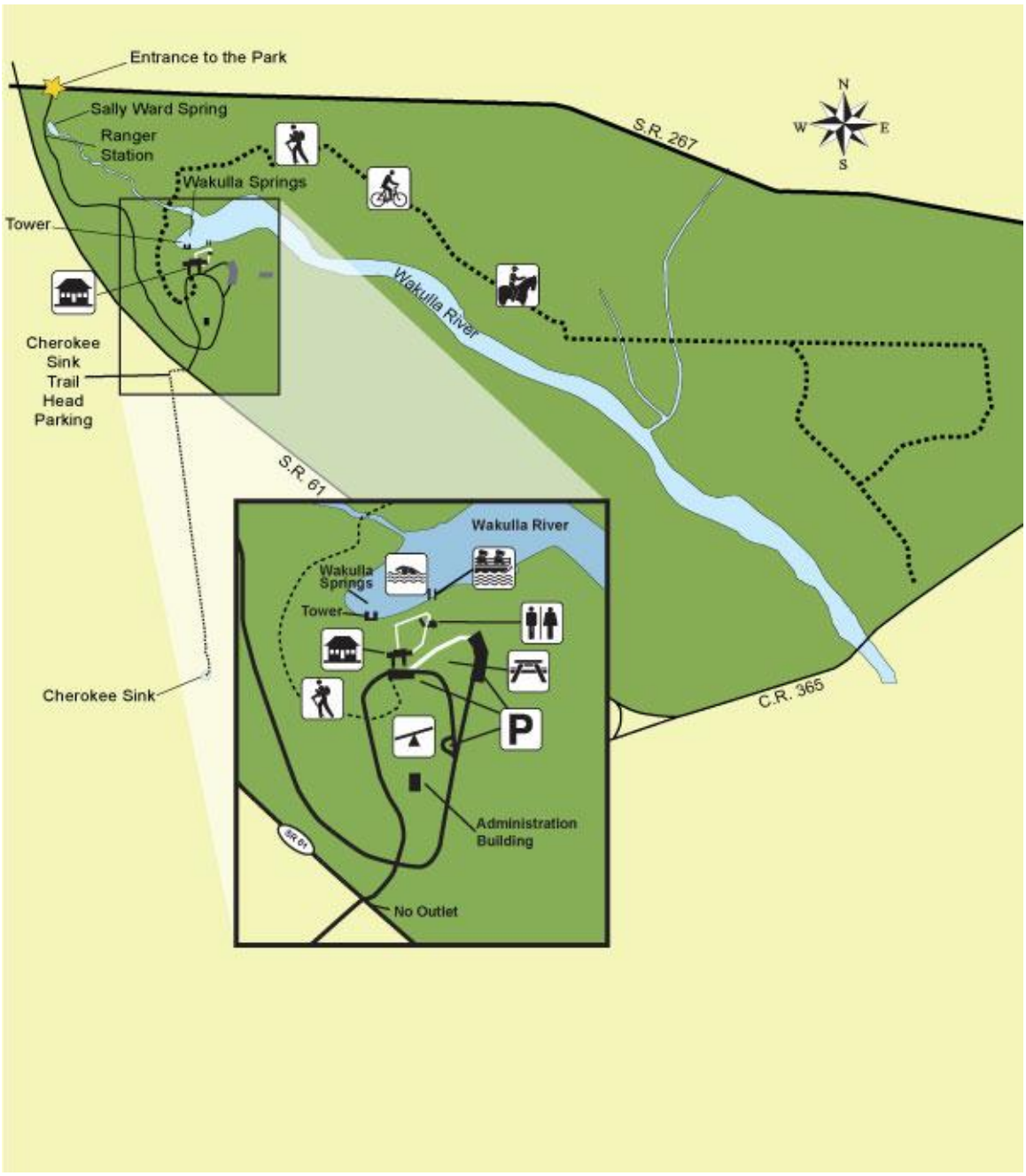

Image 2: Wakulla Springs State Park (floridastateparks.org, 2012)

Image 3: Wakulla Aerial (1000friendsofforida.org, 2012)

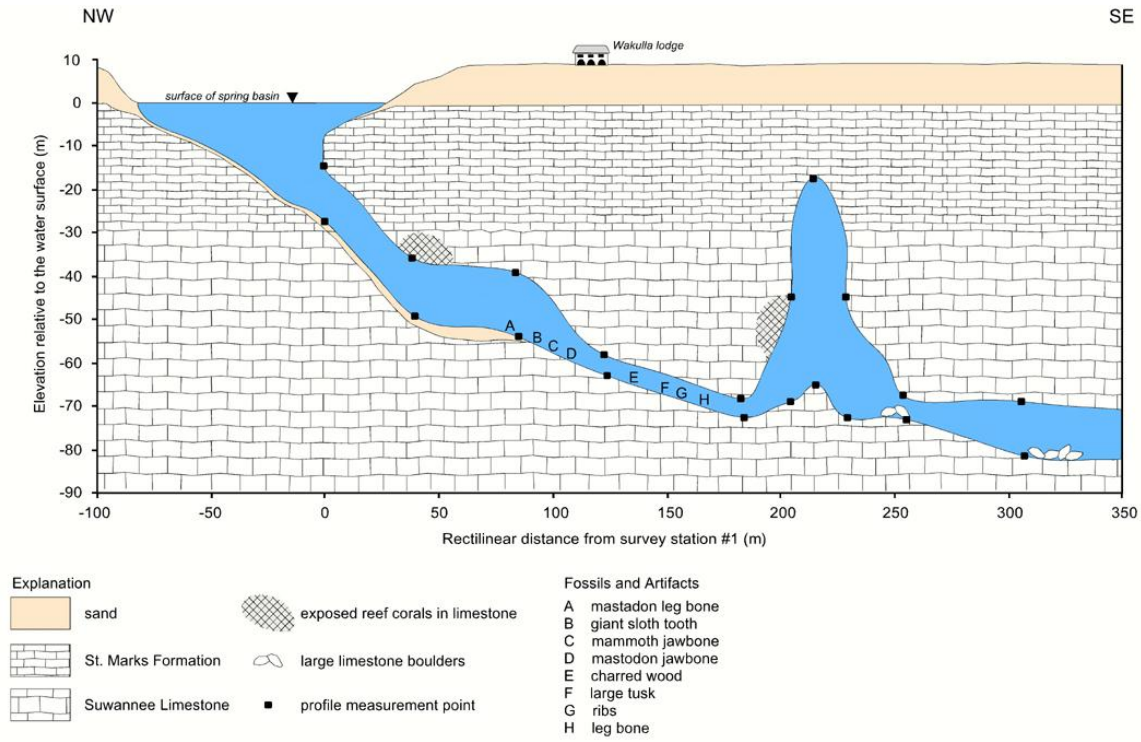

Image 4: Wakulla Cave Cross-Section (Kincaid, 1999)

2. Why Wakulla Spring is important and worthy of restoration:

Wakulla Springs is located in Wakulla County in Wakulla Springs State Park about 20 miles south of Tallahassee. (Scott et al, 2004) Wakulla Springs is billed as the worlds largest and deepest freshwater spring. (wakullasprings.org, 2012). As one of the largest springs in the world Wakulla has naturally been a draw for humans seeking recreation and involvement with awe inspiring natural systems. Over the years Wakulla springs has been developed into a recreational and wildlife viewing area. The current park includes a lodge and restaurant. Glass-bottom boats provide tours and swimming is allowed in the southeast quadrant of the spring pool. (Scott et al, 2004) Wakulla is unique since a single individual owned it for 50 years prior to the State of Florida taking ownership and creating the Wakulla Springs State park. The Spring is protected from boat traffic by a fence that was erected by the previous owner Mr, Edward Ball.

Due to the magnificence of Wakulla Springs it has been the focus of many studies over the years and is has a wealth of information available for study. That being said it also means that the degradation of the spring is more obvious when looking at the data. During the period of data that we have for Wakulla Spring we have observed increasing nitrate, declining water clarity, an increase in invasive plant species, increased algal mat, and a decline in both the aquatic insect and animal populations. (Hand, 2012) The peak of most of the degradation occurred around 1990 at which time efforts where established to attempt to correct the issues witnessed at the spring.

Wakulla Springs like all of Florida's springs are a valuable natural resource that needs to be maintained for future generations. Springs offer a portal into the underground water storage and treatment systems that are the groundwater aquifers. Springs are valuable to the natural flora and fauna, which rely on them to sustain life. Humans have also relied on springs for their livelihood since spring water has long been a source of clean fresh water. Springs are also sources of water with constant temperatures due to the temperature regulation provided by the earth. This last phenomena makes springs natural refuges for species that are sensitive to large temperature variations like manatees and certain fish species.

One of the most awe-inspiring aspects of springs is the water clarity and underwater visibility. People are typically amazed by the ability to view fish and other aquatic life sometimes hundreds of feet below the surface. This is evident from the number of springs, which have been home to glass-bottom boat rides. Wakulla Spring is one of the Florida Springs, which still operates a glass bottomed boat tour. However visibility has greatly decreased over time resulting in a reduction in the amount of tour boats that run in a given year. (Hand, 2012) This reduction greatly affects the ability of patrons to experience the natural beauty of the spring. It is also anticipated that the visibility has a negative affect on the flora and fauna since light penetration needed for photosynthesis is reduced thereby decreasing gross primary production of the spring system.

Most importantly springs are windows into the aquifers that supply most of the drinking water we use. If springs are unhealthy the aquifer is unhealthy.

Reductions in spring flow indicate a lowering of the piezometric surface due to over pumping. Additionally increases in nutrients and pollutants in the spring indicate that there are sources of contamination in the springshed and that the quality of the aquifer water is being compromised.

Springs are one of Florida's most valuable and spectacular natural wonders. Wakulla Spring is one of the most spectacular springs in the world. All springs should be the focus of protection efforts and Wakulla Springs should be protected at the highest level. The loss of a natural spring is a devastating natural disaster that has unparalleled environmental, social and economic costs.

3. Spring restoration assessment plan – Wakulla Springs

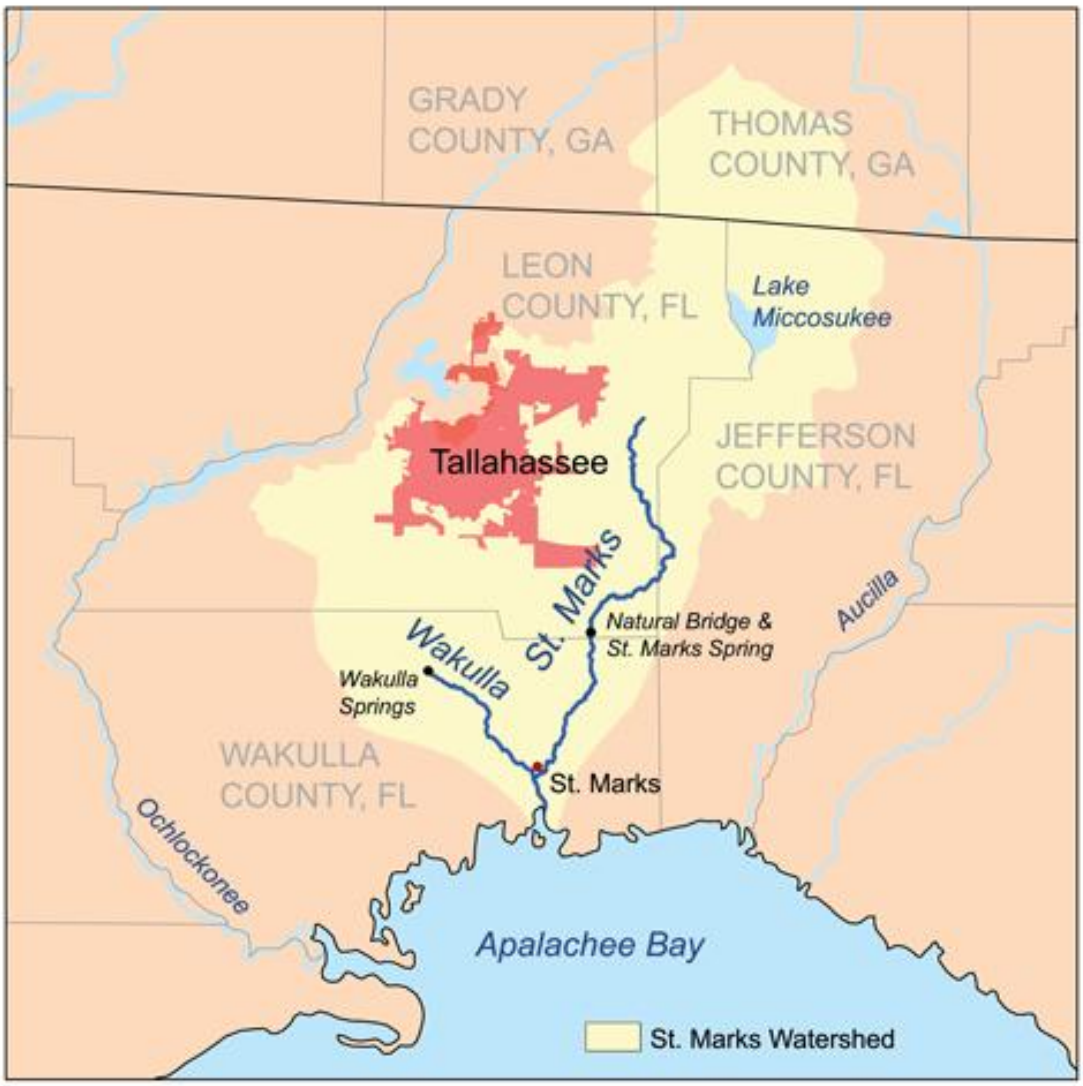

Image 5: Wakulla and St Marks River Map (Musser, 2012)

As discussed in Wakulla Spring - Adaptive Management Strategy developed by The Howard T. Odom Florida Springs Institute in 2011 there are three established restoration goals for Wakulla Spring.

Restoration Goal 1: Reduce Nitrate-Nitrogen
Restoration Goal 2: Reduce Dark Water Days
Restoration Goal 3: Restore Spring Ecology

The goal of this restoration assessment plan will be to build on the established goals and efforts already underway at Wakulla Springs and attempt to set forth a strategy

for assessing the changes in spring health. This restoration assessment plan will look at each of the 3 goals above and discuss the strategies for monitoring each.

Restoration Goal 1: Reduce Nitrate-Nitrogen

The long-term average nitrate+nitrite nitrogen concentration in Wakulla Springs is 76 mg/L with a range of reported values from 0.06 to 9.8 mg/L. (FSI, 2011) Nitrate concentrations have increased over the entire period of record. Historical nitrate concentration for Florida Springs is approximately 0.05 mg/L. Nitrate Nitrogen can be generated from several sources:

Disposal of Municipal Wastewater Effluent
Disposal of Municipal Wastewater Residuals
Onsite Sewage Disposal Systems
Fertilizer application
Rainfall Contributions
Detrimental Changes to Aquatic Plant Communities

In order to asses the increases and decreases in nitrate nitrogen concentrations in Wakulla Spring a sampling schedule should be established that can measure the concentrations at regular reoccurrence intervals. These intervals should be close enough together to establish patterns and monitor reactions to changes in source applications. The recommended sampling schedule should at least be monthly. Monthly samples would allow for the seasonal variations in nitrate loading to the springshed and allow for the data to be used to estimate the distribution of source contributions. It is anticipated that the seasonal increases in fertilizer application rates could be correlated to seasonal nitrate concentrations to assist in estimating what percentage of the nitrate levels are from fertilizer. Additionally, regular monthly samples could allow for recognition of large changes in the springshed such as the construction of large developments.

Sampling locations are of major importance. Since most of the nitrate sources are related to contributions applied to the land within the springshed the nitrate concentrations should be measured as close to the spring boil as possible. This intended to measure Since Wakulla Spring has such a large cave at the spring boil, the opportunity to sample in the cave is a unique opportunity. Sampling locations (SP1-2) are proposed at the mouth of the cave and approximately 100 feet deep into the cave. Data from these two sampling points should indicate the nitrate levels emerging from the aquifer. The plan also includes sample points (SP4-11) spaced at approximately 2000 feet down the spring run. These sample points should be able to indicate the rate of de-nitrification down the spring run. One additional sample point (SP3) is located at the confluence of the Sally Ward Spring Run and the Wakulla Spring run to isolate the contributions of the Sally Ward Spring from the system.

Image 6: Wakulla Springs Sampling Locations (google earth, 12-08-12)

The goal of this sampling layout will be to establish trends in the nitrate levels at the spring and in the spring run. The spacing of the sampling points is intended to indicate the ability of the top part of the spring run to take up nitrogen. Additionally it is intended to allow colorations with mapping efforts of the flora within the spring run to assess the efficiency of varying plant communities down the spring run (see Goal 3).

Restoration Goal 2: Reduce dark water days

Water clarity at Wakulla spring has historically been exceptional. Water in the spring is light blue in color. Water clarity in the spring also varies drastically with rainfall (Scott, 2004) Current water quality trends show that the amount of time that water clarity is at sufficient quality to allow for the use of the glass bottom boats has been decreasing. This degradation has implications on both the ecological health of the spring as well and the human recreational uses of the spring. The goal of the assessment plan for this goal would be to measure the clarity of the water in the spring pool at regular intervals and after rainfall events greater than 0.25 inches in depth. Sample point 1-4 will be utilized for the data collection in this assessment. Additionally, Grab samples should be taken immediately after 0.25 inch rainfall events at known sinkholes that have conduits which connect to Wakulla Spring. The sinkhole samples should be tested for TSS, nutrients, and turbidity. These samples would allow for analysis of the changes (or lack of change) in the water quality from conduit system contributions to the overall flow. Additionally, these samples could be tested for various other pollutants in order to assist in tracing the sources of pollutants in the springshed.

Restoration Goal 3: Restore Spring Ecology

The two worst biological problems at Wakulla Spring are the increases in hydrilla and algal matt. Hydrilla is an invasive plant species that has become a problem for most spring systems throughout Florida. Hydrilla was introduced to Florida in 1959 as an aquarium plant. (efloras.org, 2012) Hydrilla has become established in the first mile of the Wakulla Spring Run and has been found as far as 6 miles down the run. (Hand, 2012) Increased algal mats were first quantified in 2001. (Florida Springs Institute, 2011) The increase in algal mats (as well as the increase in hydrilla) has been attributed to the increase in nitrate in the spring run.

Visual assessments have been used in the past to quantify the relationship of hydrilla, algal mats, and natural plants within the spring run. This assessment plan proposes to establish a regular visual assessment of the springs plant community and develop quantitative aerial mapping strategies to asses the rate of change in the hydrilla, algal mat, and native plant species.

As part of this plan the spring run illustrated in the sampling map will be divided into 10 segments for analysis. Each segment will be 2,000 feet in length (segments are between sample points) Visual assessment and mapping should be performed on a 6 month reoccurrence interval. And the data should be mapped with a GIS system such as ARCGIS for analysis. Through graphical GIS mapping analysis methods each data set can be overlaid and compared for changes in cover and occurrence of flora. Additionally, the graphical data can correlated with 6 month averages of the nitrate concentrations measured at each sample point.

Analysis Summary:

Below is a sample data table for reporting bi-annual data collection.

Dec 2012	Data Summary			
Sample Point	Nitrate concentration (6 month average)	% Change Algal Mat Aerial Cover between SP	% Change Hydrilla Aerial Cover between SP	Dark Water day last 6 months
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Summary:

Many studies have already been performed at Wakulla Spring and plans have been proposed to address the negative affects that have been observed at the spring due to increased development. This restoration assessment plan is intended to provide tools for the assessment of these efforts. FDEP has recently established a draft TMDL for nitrate at Wakulla of 0.35 mg/L. The next step in the process will be to establish a Basin Management Action Plan (BMAP) that will propose methods for reducing the nitrate concentrations. In order to determine if the efforts that are undertaken are successful this assessment plan could be utilized to monitor trends in nutrient loading, and the response of the system. Although the draft TMDL is set at 0.35 mg/L this level is just the start of the recovery of Wakulla Springs at Wakulla Spring, which has a historical nitrate loading of approximately 0.05 mg/L. There is a long road ahead for the recovery of all of Florida's impaired springs, and assessment is essential for determining what actions are helping the spring recover to a healthy state.

Works Cited:

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