Please pick one Florida spring that we have discussed in this class. Provide a map that shows the general location of your spring.

A location map is attached.

Assume you are an environmental advocate. Please provide a thoughtful description of why this specific spring is important and worthy of restoration and protection?

The survival and health of Blue Spring is intimately tied to the well being of the Floridan aquifer, the surrounding community and environment. The impacts of anthropogenic nutrient inputs and unbalanced withdrawal from the Floridan aquifer threaten the well being of Blue Spring, one of the most visited and largest artesian springs in Florida. Restoration and protection of Blue Spring should be a priority since it is an important manatee habitat, a highly productive yet threatened ecosystem and a major tourist and recreational attraction.

An important reason to protect Blue Spring is its unique value as a manatee refuge. The West Indian manatee and the spring run are protected by the U.S. Endangered Species Act. The warm waters of the spring which averages approximately 23°C year round are the only refuge on the Florida East Coast for the large herbivore mammal during winters (Wetland Solutions 2006). Manatees have a low metabolic rate and low thermal buffering capacity to survive in cold waters. The manatee population would drop off steeply with lower flows since cold water would intrude into their winter home and the vegetation they consume would decrease. Currently, due to recent regulation of thermal impacts of industrial water discharge to the St. Johns River, the manatee population of Blue Spring has surged back. The winter month manatee population was measured at an average count below 50 in the 1980s and recently the population has surpassed 250. This should place more emphasis for protecting these mammals' habitats.

In addition to the manatee, Blue Spring supports a complex and diverse web of organisms in a highly productive ecosystem. If the established trophic levels which have evolved over hundreds of years are affected by changes to flow, temperature and nutrient inputs, it could threaten the habitat of many organisms. These include fish, mollusks, amphibians, birds and mammals. When the spring flow is reduced and the ecosystem is disturbed, the habitat for one species is destroyed which means that another species will overtake the habitat and the springs are ecosystem quality decreases. Filamentous algae are particularly becoming a nuisance in Blue Spring and are displacing a once diverse ecosystem of submerged aquatic vegetation which supported operculate snails, mullet, turtles, mosquito fish and may other species.

The Blue Spring State Park hosts over 300,000 visitors a year for a wide variety of activities including wildlife viewing including manatees, swimming, fishing, education, canoeing, kayaking, bird watching, snorkeling, scuba diving, water skiing and use of personal water craft (Wetland Solutions 2006). These activities directly and indirectly impact the local economy. The average daily amount of money spent at the park was recently calculated to be $19 per person and the total annual average spending rate of $10 million which supports about $2.4 million in wages and 174 local jobs (Wetland Solutions 2006).

Blue Spring is a first magnitude spring and the largest in the area. Blue Spring has a long-term mean flow over 1932 to 2006 of 157 cubic feet per second (101 MGD) which is the minimum flow set by the St. Johns River Water Management District. For perspective, a 101 MGD water supply could support a metropolitan area of over 500,000 people (assuming a water usage rate of 200 gallons/person/day) which is the approximately the population of Volusia County. A spring's velocity is very important to the ecosystem since it imparts energy into the ecosystem. High velocity spring runs have sandier, coarser sediments which are more supportive of SAV, remove detritus material more efficiently, discourage filamentous algae and other lower-quality organisms and have more efficient ecosystem trophic movement of energy. A decrease in spring flow also increases the thermal instability of the stream and deteriorates the ecological quality of the stream run. If the flow in Blue Spring decreases, it also means the Floridan Aquifer is being overdrawn. Overdrawing the Floridan aquifer will impact the water supply of the surrounding area by potential saltwater intrusion and damage the local population which depend on the aquifer for drinking water and other uses.

The nutrient inputs, particularly nitrogen, are increasing in Blue Spring and causing heavy algal growth and declining fish and aquatic populations. Recently, nitrate concentrations have consistently averaged about 0.64 mg/L, above regulatory standard of 0.35 mg/L for springs and above the 0.05 mg/L background level for the aquifer. Although this measurement is almost average among Florida's impacted springs, it is high since the springshed is typically located in a largely confined area. Unlike many springs in the area, the dominant land use in the springshed is urban (59%), followed by forested land (25%), wetland/water (10%), and agriculture (4%). Public water use in Volusia County has doubled from 30.2 MGD to 58.55 MGD from 1980 to 2005. The springshed cover covers approximately 130 square miles and includes the cities of Deltona, Orange City and Deland which are all located in Volusia County (Shoemaker, *et. al. 2004*). The typical nutrient inputs into the Floridan aquifer from urban sources include residential and commercial lawn and golf course fertilizers and wastewater effluent. Hydraulic residence time has been measured up and maybe surpassing 100 years, which means that that it may take decades for the spring health to recover. This assumes that nutrient inputs into the aquifer are transported with the water. It may take a longer time for nitrogen to recover.

Restoring, monitoring and protecting Blue Spring is important since it is a window into the health of the Floridan Aquifer and St. Johns River. Blue Spring itself is a unique resource for the local economy, the manatee population, recreationists and wildlife enthusiasts. Simple actions such as characterizing the water withdrawals with water meters, reducing lawn/golf course fertilizing or enforceable best management practices could be taken with regulatory enforcement. A regulatory framework exists for taking action. Blue Spring is designated a Florida Outstanding Water Resource offering special protection preventing the DEP to issue permits which would degrade ambient water quality by direct or significantly degrade quality by indirect discharge. Blue Spring is also classified as a Class III fresh water by the Florida DEP. Class III regulatory standards include analysis of biological integrity (macroinvertebrates shall not be reduced to less than 75% of established background levels), conductivity and nutrients (cannot cause an imbalance in the ecosystem). Additionally, Blue Spring has a Minimum Flow Level (MFL) which recommends a flow of 137 cfs until 2014 and incrementally increases to 157 cfs by 2024. Under these regulatory frameworks, the St. Johns River Water Management District, DEP and other local authorities can take steps to protect Blue Spring.

Prepare a spring restoration assessment plan (*i.e.,* a monitoring plan) for your spring/springshed that I sufficient to document changes in its health from its current condition to a desired future restored condition. Please include a map showing sampling locations, a list of sampled parameters, and a schedule for sampling, analysis, and reporting.

The purpose of this Blue Spring monitoring regime is to assess the restoration and recover of the spring and springshed. The collected data are to be evaluation tools in assessing improvements in the spring system's productivity and restoration of the spring to pre-industrial conditions. A bi-annual report will document the progress of the restoration efforts. The monitoring plan includes the following categories:

- Springshed Monitoring
    - Aquifer water levels
    - Springshed delineation
    - Land use monitoring
    - Water use survey
    - Nutrient inputs
- Spring and River Monitoring
    - Flow and velocity
    - Staff gauge
    - Water chemistry
    - Biology
    - Human use

Reporting

The data compiled through this monitoring program will be assessed on a continuous basis and compiled every two years. The report will be available to the public and reviewed by the Florida Department of Environmental Protection. The bi-annual report will include the following:

- springshed maps of the potentiometric surface, land use, aerial photography, well locations and septic tanks;
- tabular summaries of the spring and springshed data during the reporting period;
- trend graphs of the analytical data;
- an evaluation of the trends in analytical concentrations;
- an assessment of the monitoring program effectiveness;
- recommended changes to the monitoring plan; and
- an assessment of the spring restoration efforts.

Springshed Monitoring

The purpose of the springshed monitoring program is to characterize the extent and determine the sources of pollution into Blue Springs system. Table 1 is a summary of the proposed program of springshed monitoring:

Table 1 Monitoring Plan Summary – Blue Springshed

Parameters	Sample Location	Frequency	Regulatory Standard
Well Survey	All Known Consumptive Use Permits in Springshed	Bi-annually	N/A
Groundwater Levels	30 Non-Producing Wells in Known Springshed	Bi-monthly	N/A
Springshed Potentiometric Map	Springshed Extent	Bi-monthly	N/A
Aerial Photography and Land Use Mapping	Springshed Extent	Bi-annually	N/A
Flow	Known Entering/Leaving Streams and Swallets in Springshed	Quarterly	N/A
Nitrogen	Known Entering/Leaving Streams and Swallets in Springshed	Quarterly	N/A
Groundwater Well Withdrawals	All Water Uses (Public, Private, Agricultural, Commercial)	Compiled Quarterly	N/A
Nitrogen Effluent Returns	Permitted Land Disposal Sites	Compiled Quarterly	N/A
Flow Effluent Returns	Permitted Land Disposal Sites	Compiled Quarterly	N/A

Fertilizer Sales	All Commercial/ Homeowner Sales	Compiled Annually	N/A
Septic Tank Survey	All in Known Springshed	Bi-annually	N/A
Sinkhole, Swallet and Spring Survey	All in Known Springhed	Once	N/A
Tracer Study	To Be Determined	Once	N/A

Groundwater Levels

Groundwater levels from about 30 wells in the known springshed will be measured to generate a potentiometric surface map. Other well elevation data may be available from the St. Johns River Water Management District. The springshed can be determined by the potentiometric map by drawing a boundary around the hydraulic high point surrounding springshed. The area is estimated to be approximately 130 square miles and cover most of eastern Volusia County but can varies based on precipitation and human withdrawals.

Land and Water Use Monitoring

On a bi-annual basis, the proposed monitoring plan will require a characterization of the water and land use within the springshed. Land use data can be gathered from the Volusia County Property Appraiser, Volusia County Planning Department and St. Johns River Water Management District. Water usage will be monitored via water well surveys and utility records review. Since approximately 60% of the land use in the Blue Spring is designated as urban, then water use data from Volusia Water Resources and Utility Department can be gathered. Additionally, the well permits from the St. Johns Water Management District and County Department of Health can be reviewed for the number of wells, owner information, well use codes and an estimate of withdrawal.

Nutrient Inputs

An estimate of the nutrient inputs into the Blue Spring springshed will be calculated using a variety of data. One will be the land use survey. By determining the acres of land used for crops, cattle or other agricultural uses, the nutrient input from agriculture can be calculated from crop fertilizers and animal waste. Inputs from golf course maintenance will also be estimated this way. Commercial and residential sales records from Department of Agriculture and Consumer Services will also be reviewed to estimate inputs from landscaping. Furthermore, a survey of septic wastewater systems and sludge land application will also be performed to estimate their nutrient inputs.

Surface Water Surveys

The surface water streams that enter and leave the springshed sill be monitored for flows and nutrients quarterly to determine any surface water inputs into the aquifer.

Springs, Sinkhole and Swallet Survey

A database and ground survey of springs, swallets and sinkholes should be conducted in the springshed to characterize areas which have a direct impact on the aquifer. Database research can be accessed from the Florida Geological Survey, Florida DEP and St. Johns Water Management District. The areas in the survey may require targeted evaluation monitoring to determine the magnitude of their influence on Blue Spring.

Tracer Study

The Floridan aquifer contains sometimes a network of conduits which can rapidly convey water and pollution to emergent springs. Tracer studies can be used to identify and characterize the hydraulic conductivity of the portion of the Floridan Aquifer contributing to Blue Spring and identify any conduits. If conduits are identified, this monitoring plan should be modified to actively target those areas in the aquifer with high groundwater velocity.

Blue Spring Monitoring Plan

The Blue Spring will be monitored for the biological, chemical and physical parameters to assess the progress of springshed restoration activities. Five locations approximately 500 feet apart have been selected in the spring run (BLUE1 through 5). Two locations in the St. Johns River (SJR1-2) have also selected to assess the impacts from the spring on the river. Monitoring of the river may be modified if the collected data shows inconsequential impacts. Analytical sampling should be collected at a uniform depth and location to minimize variation between each sampling event and collect representative spring data.

Table 2 Monitoring Plan Summary – Blue Spring Run

Parameters	Sample Location	Frequency	Regulatory Standard
Biological			
Ecosystem Metabolism	BLUE1-5, SJR1-2	Semiannual	N/A
Manatee Population Counts	BLUE1, BLUE4	Monthly	N/A
Manatee Health Screens	BLUE4	Bi-annually	N/A
Plant/Vegetation Surveys	Spring Run	Semiannual	N/A
Macro invertebrate Productivity (Insect emergence)	Spring Run	Semiannual	N/A
Bacteriological Survey	BLUE2, BLUE4	Semiannual	*Fecal Colifrom: MPN or MF counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period. *Total Coliform: < 1,000 as a monthly average; nor exceed 1,000 in more than 20% of the samples examined during any month; < 2,400 at any time. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period, using either the MPN or MF counts.
Fish Biomass (counts/electro-fishing)	BLUE2, BLUE4	Semiannual	N/A
Herptiles and birds	Spring Run	Semiannual	N/A
Biological Integrity	Spring Run	Semiannual	*The Index for benthic macroinvertebrates shall not be reduced to less than 75% of established background levels as measured using organisms retained by a U. S. Standard No. 30 sieve and collected and composited from a minimum of three Hester-Dendy type artificial substrate samplers of 0.10 to 0.15 m2 area each, incubated for a period of four weeks.
Stream Condition Index	Spring Run	Bi-annually	N/A
Physical			
Velocity/Flow	BLUE1, BLUE 4	Monthly	**137 cfs 4/1/2009 – 3/31/2014 142 cfs 4/1/2014 – 3/31/2019 137 cfs 4/1/2019 – 3/31/2024 157 cfs after 3/31/2024

Weather Station (Temperature, Precipitation, Solar Radiation)	Park Office	Continuous, Compiled Annually	N/A
Spring Run Stages	BLUE1-5, SJR1-2	Daily	N/A
Clarity (Secchi Disk)	BLUE1-5	Monthly	N/A
Bathymetry	Spring Run	Once	N/A
Chemical			
pH	BLUE1-5, SJR1-2	Quarterly	*6 to 8.5 Standard Units
Dissolved Oxygen	BLUE1-5, SJR1-2	Quarterly	*Shall not be less than 5.0. Normal daily and seasonal fluctuations above these levels shall be maintained.
Water Temperature	BLUE1-5, SJR1-2	Quarterly	
Specific Conductance	BLUE1-5, SJR1-2	Quarterly	*Shall not be reduced by more than 10% as compared to the natural background value.
Turbidity	BLUE1-5, SJR1-2	Quarterly	*29 NTUs above natural background conditions
Color	BLUE1-5, SJR1-2	Quarterly	
Biological Oxygen Demand	BLUE1-5, SJR1-2	Quarterly	*Shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.
Chlorophyll-A	BLUE1-5	Quarterly	N/A
Alkalinity	BLUE1-5, SJR1-2	Quarterly	*Shall not be depressed below 20
Nitrate	BLUE1-5, SJR1-2	Quarterly	*The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Chapter 62-302, FAC]. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242, F.A.C. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. ***Nitrate = 0.35 mg/L
Nitrogen	BLUE1-5, SJR1-2	Quarterly	
Phosphorus	BLUE1-5, SJR1-2	Quarterly	
Sodium	BLUE1-5, SJR1-2	Quarterly	N/A
Chloride	BLUE1-5, SJR1-2	Quarterly	N/A
Magnesium	BLUE1-5, SJR1-2	Quarterly	N/A
Hardness	BLUE1-5, SJR1-2	Quarterly	N/A
Sulfate	BLUE1-5, SJR1-2	Quarterly	N/A
Iron	BLUE1-5, SJR1-2	Quarterly	*1.0 mg/L
Human Use			
Visitor Counts	Park Entrance	Daily	N/A
Activity Counts	Spring Run	Monthly	N/A
Visitor Surveys	Park Entrance	Continuously	N/A

Notes:
*Class III Fresh Water Standard (62-302.530, F.A.C.)
**St. Johns River Water Management District Minimum Flow Level
***Proposed FDEP Numeric Nutrient Criteria fro Florida Lakes, Spring Vents and Streams

Biological Monitoring

The spring ecosystem will be evaluated on a semiannual basis. This will include counts and surveys of submerged aquatic plants, bacteria communities, fish counts using electro-fishing or dark water counts, macro invertebrate activity using insect emergent traps, fish biomass, herptiles and birds. Ecosystem monitoring will be conducted to estimate gross primary productivity, net ecosystem production, community respiration, and photosynthetic efficiency. The FDEP's Stream Condition Index will be assessed bi-annually. Manatee counts will be conducted monthly at two spring run locations.

Flow, Velocity and Gauge Staff Recordings
Flow and velocity will be measured on a monthly basis from two locations on the springs.

Weather Station Data
A weather station will be installed to monitor temperature, precipitation, insolation and active radiation. Solar radiation is the primary driving force behind all ecosystems and is included to asses the impact on the daily condition. Solar radiation (insolation) will be less during the winter and on cloudy days and has impacts on the productivity of the springs. Precipitation data will be used to estimate the hydraulic input into the springshed.

Water Transparency
Water clarity is a general indicator of the ecosystem health and the presence of pollution. A Secchi disk is typically used for to measure this. Turbidity and color can also be used. In some springs, water clarity can be unsteady over short periods of time particularly in period of high flood stages (like Fanning Springs).

Bathymetry Mapping
The floor of the spring run will be mapped with LIDAR or by ground survey. The mapping will be used to identify localized areas of turbulent flow which affects plant growth, oxygen diffusion and detritus removal.

pH
This parameter can be an indicator of water age, the presence of organics, the origin of water and the aquifer pathway.

Specific Conductance
This is a measurement of the concentrations of ionic compounds. Increasing conductance is an indicator or saltwater intrusion and pollution.

Dissolved Oxygen concentration/
This parameter is typically very low at the spring boil but increases significantly on the spring run. Dissolved oxygen will also assist in measuring the gross primary productivity of the ecosystem.

Water Temperature
Water temperature should remain relatively constant between monitoring events.

Color
The color of the water is an indicator of dissolved substances.

Alkalinity
Alkalinity is a measurement of the carbonate, bicarbonate and carbon dioxide in the spring water. It is an indicator of the water's ability to neutralize acids. Bicarbonate is the principal source of inorganic carbon in springs.

Total Dissolved Solids:

TDS is a measure of all the solids dissolved in a sample after evaporation of the liquids.

Nitrogen and Phosphorus

These nutrients are readily acquired by the filamentous algae and other nuisance organisms which proliferate in impacted systems. Nitrate, which is very water soluble, is probably the largest contributor to spring pollution and eutrophication to surface waters.

Sodium and Chloride

These parameters are helpful in determining the origin of groundwater and assessing the magnitude of saltwater intrusion into springs.

Calcium and Magnesium (Hardness)

Hardness is an indicator used to measure the dissolution of soap in water. Calcium and magnesium concentrations mainly are a result of the water's interaction with the Floridan aquifer geology.

Visitor Counts, Human Activity Counts and Visitor Surveys

Humans can have a direct impact on the springs ecosystem by trampling vegetation, kicking up sediments and littering. Increasing visitor counts and activities within the spring run (like swimming or wading) is also an indicator of spring health.