Kimberly Marshall
ENV 6932

Exam 4

Question 1: Please identify the state and local agencies that are responsible for protecting the water quality and water quantity for each of the three spring systems you selected and detail their responsibilities.

Springs	Some Responsible State Agencies	Description of Responsibilities	Some Responsible Local Agencies	Description of Responsibilities
DeLeon Springs *(Information from Jones, 2010)*	• SJRWMD • FDEP • FWC • Others	• Establish nutrient criteria for water bodies in Florida in conjunction with the EPA • Monitor the health of the vegetation and wildlife	• St. John's Riverkeeper • Conservancy of Southwest Florida • Others	• Collect information on the spring's health • Educate the public about the spring's health • Monitor the health of the vegetation and wildlife
Volusia Blue Springs *(Information from Hall, 2010)*	• SJRWMD • FDEP • FWC • Others	• Establish an MFL program based on manatees • Study the nutrient quality of the water • Develop and implement a basin management action plan • Monitor the health of the vegetation and wildlife	• There used to exist a Blue Spring working group but the budget for this group was later cut • Gov. for the city of Deland, De Bary, Deltona, Lake Helen, along with Orange City and Volusia County • Volusia County Water Resources and Utilities • Others	• Establish an MFL program based on manatees • Educate the public about the quality and health of the spring. • Monitor the health of the vegetation and wildlife • Monitor the drinking water for consumption
Ichetucknee *(Information from Zavoyski, 2010)*	• Suwannee River Water Management District • FWC • FDEP • Others	• Establish nutrient criteria for water bodies in Florida in conjunction with the EPA • Monitor the health of the vegetation and wildlife	• Ichetucknee Springs Water Quality Working Group • Office of Ecosystem Management • FDCA • Others	• Collect information on the springs • Educate the public about spring health and the health of Ichetucknee • Monitor the health of the vegetation and wildlife

Kimberly Marshall
ENV 6932

Exam 4

Question 2: Please prepare a list of the stakeholder groups who are interested in being involved in restoration and protection for each of the three springs.

Springs	Stakeholders
DeLeon Springs *(Information from Jones, 2010)*	• Friends of DeLeon Springs State Park – assists with raising money, teaching, events, staffing • St Johns River Water Management District • Florida Fish and Wildlife – the spring is part of the Great Florida Birding trail • Florida Department of Environmental Protection • Anyone who uses water from this spring • Anyone concerned about springs protection • Anyone who visits this spring
Volusia Blue Springs *(Information from Hall, 2010)*	• cites of Deland, De Bary, Deltona, Lake Helen, along with Orange City and Volusia County • St Johns River Water Management District, • Florida Department of Environmental Protection • Fish & Wildlife Conservation Commission, • State of Florida Parks System, • Anyone concerned about springs protection • Anyone who uses water from this spring • Anyone who visits this spring
Ichetucknee *(Information from Zavoyski, 2010)*	• Ichetucknee Springs Working Group. • Tourist Development Council, • Suwannee River Water Management District, • North Central Florida Regional Planning Council, • Santa Fe Soil & Water Conservation District, • Department of Environmental Protection, • Department of Agriculture & Consumer Services, • Florida Department of Health, • Fish & Wildlife Conservation Commission, • University of Florida, • Save Our Suwannee, • Sierra Club, • Florida Defenders of the Environment, • Karst Environmental Services, • Wetland Solutions Inc., • S & S Food • Anyone concerned about springs protection • Anyone who uses water from this spring • Anyone who visits this spring

Kimberly Marshall
ENV 6932

Exam 4

Question 3: Compare and contrast the springsheds for your three springs. How large are they? What are the dominant land uses? Have they changed over the past 50 years? Please include maps if available.

Springs	Size of Springshed	Dominant land use	Changes over the last 50 years
DeLeon Springs *(Information from Jones, 2010)*	~10.8 square miles (See Fig. 1)	Mainly rural Open water and wetlands account for the majority of land space Agriculture has increased substantially	Forestland was the dominate type of landscape in 1974, with very little agriculture usage. However, in 2004, agriculture usage has risen to nearly 27% of land use and the amount of forested land decreased by 50%.
Volusia Blue Springs *(Information from Hall, 2010)*	130 square miles (See Fig. 2)	Urbanization accounts for the majority of land use	No significant changes in land use in the last ten years. However, in the last fifty years, land use has shifted from rural and agricultural to urbanization-dominated.
Ichetucknee *(Information from Zavoyski, 2010, and ISRP, 2012)*	960 km^2 = ~371 square miles (See Fig. 3)	As of 1995, the dominant uses are forest and agriculture	In 1977, forested land made up 60% of the springshed, agriculture made up 26% and urban was 3.4%. Since that point, agriculture has held consistent, but urbanization has increased while forested land has declined.

Kimberly Marshall
ENV 6932

Exam 4

Figure 1. Map of DeLeon Springs Springshed (Source = Jones, 2010).

Kimberly Marshall
ENV 6932

Exam 4

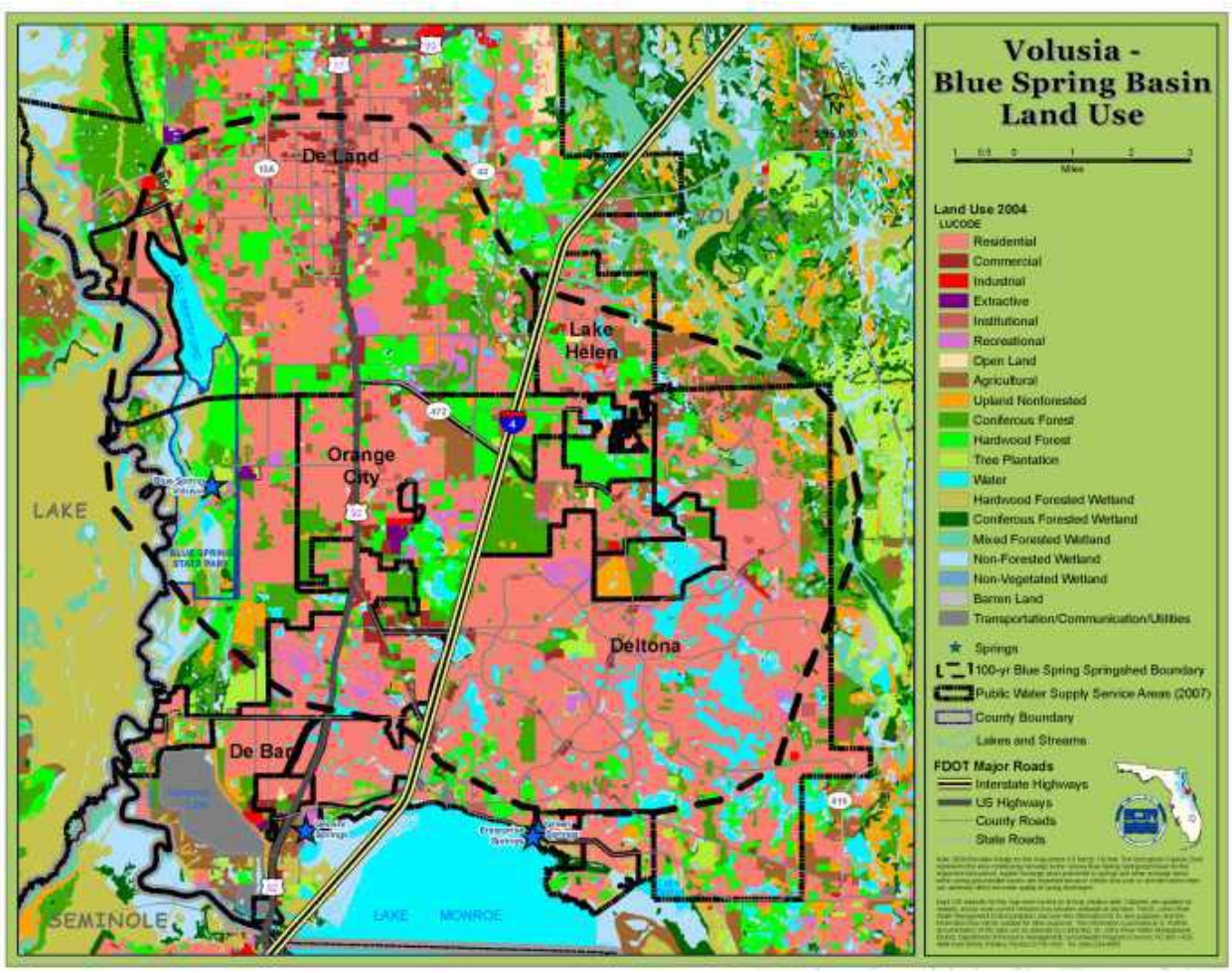

Figure 2. Map of Volusia Blue Springs Springshed and Land Use (Source = Hall, 2010).

Kimberly Marshall
ENV 6932

Exam 4

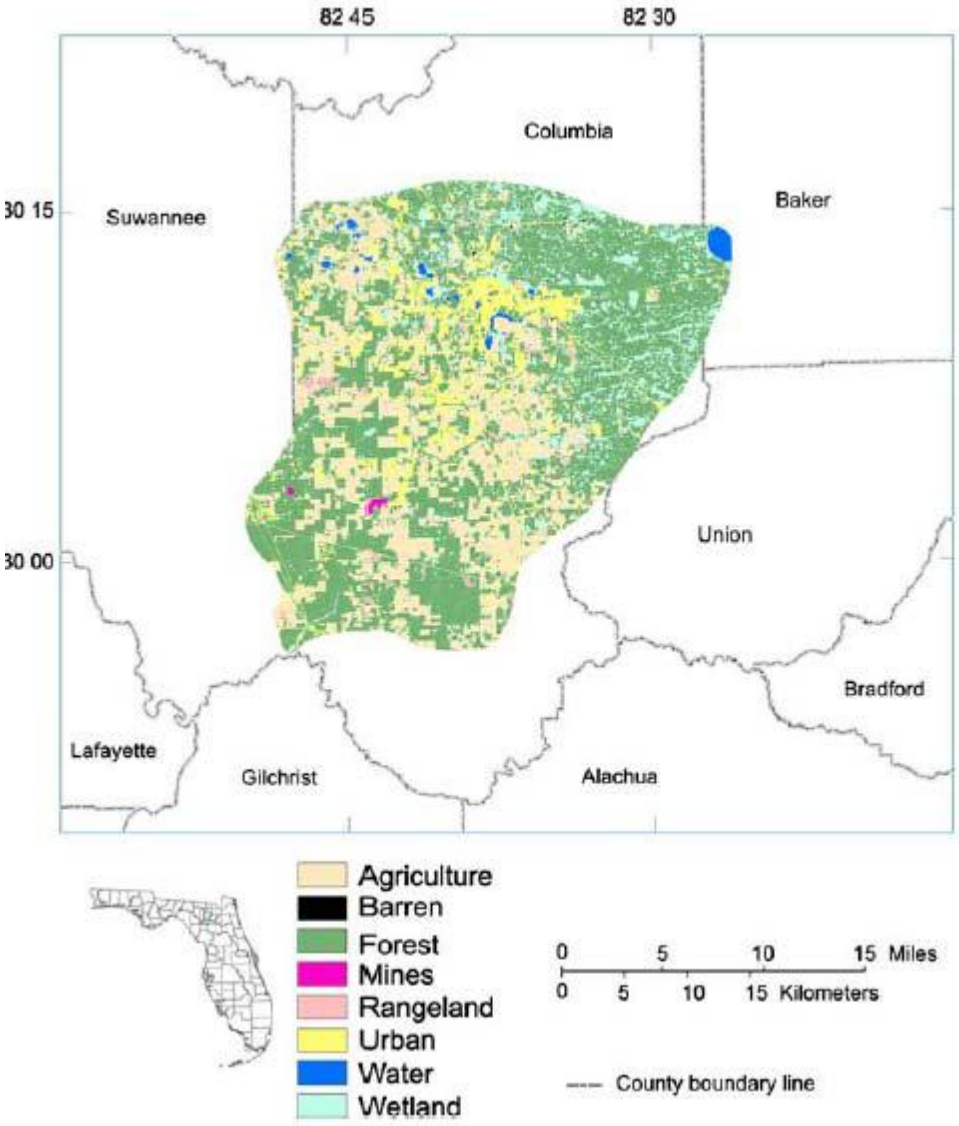

Figure 3. Map of DeLeon Springs Springshed and Land Use (Source = Zavoyski, 2010).

Kimberly Marshall
ENV 6932

Exam 4

Question 4: What is the current average nitrate concentration and recent flows in your three selected springs (citing your sources and/or assumptions)? What were the historic pre-development flows and nitrate levels for each spring? Estimate the historic and current nitrate load in each spring (concentration x flow) in tons of N per year.

	Historical Flow rate (cfs)	Historical Nitrate** (mg/L)	Historical Load (tonsN/yr)	Current Flow Rate (cfs)	Current Nitrate** (mg/L)	Current Load (tonsN/yr)
DeLeon Springs (**nitrate + nitrite used) *(Information from Jones, 2010)*	~ 32 (1985)	~0.7 (1985)	22.05	~28 (2005)	~ 1.0	27.56
Volusia Blue Springs *(Information from Hall, 2010)*	~ 165 (1950)	0.1 (1975)	16.24	157 (2005)	1.00 (2005)	154.54
Ichetucknee *(Information from Zavoyski, 2010, and ISRP, 2012)*	~360 (1946)	0.22 (1946)	77.96	~289 (2010)	~0.80 (90s – present)	227.58

Historical and current flow rates and nitrate levels were determined from graphs provided for DeLeon Springs by Jones, 2010, for Volusia Blue Spring by Hall, 2010, and Ichetucknee Springs by Zavoyski, 2010. Using these numbers, the current nitrate load in DeLeon is 28 T/year, Volusia Blue Springs is 155 T/year and Ichetucknee is 228 T/year.

Kimberly Marshall
ENV 6932

Exam 4

Question 5: Estimate the percent contribution of each of the following land uses to the current nitrate loads at your three springs: atmospheric sources, agricultural sources, and urban/industrial sources (cite references and/or assumptions).

			Atmospheric deposition			Urban		Agriculture			
	Land size (sq mi)	Nitrate Load (T/yr)	% not usage	% permeability	% contribution	% land surface		% land surface	Permeability Coefficient		
DL	10.8	27.56	0.5	0.9	10%	9.50%	17%	27%	1.5	41%	73%
VB	130	154.54	0.5	0.6	14%	50%	77%	3.50%	1.5	5%	8%
IS	371	227.58	0.5	0.33	15%	20%	30%	24%	1.5	36%	54%

To determine the percentage contribution of atmospheric deposition, urban use and agriculture to the nitrate load, I had to make several assumptions. First, regarding atmospheric deposition, I looked through the literature to find an average atmospheric deposition rate (wet deposition) for Florida (in this case ~ 2kg/ha/year (Cohen *et al.,* 2007). Assuming this accounts for the majority of deposition, I applied this value to the springshed area of each spring.

Next, I considered the amount of karst and substrate composition for each spring to judge the permeability of the nitrate into the groundwater. For DeLeon springs, according to Jones (2010) the springshed is primarily sandy soils sitting right on the karst limestone, meaning very high permeability (in this case, I attributed this to be 90%). For Volusia Blue springs, Hall (2010) showed in her paper that 60% of the springshed was “excessively permeable” based on the land composition. For Ichetucknee springs, the springshed is sitting on the Cody Escarpment with the northern section well confined above the aquifer, and the southern portion (which appears to be approximately 33% (from the map provided by Zavoyski, 2010)) very permeable. Then I made the assumption that approximately half of the load from the atmosphere ends up being absorbed or converted to nitrogen gas by denitrification before even having the potential to reach the water. Given these assumptions, I could determine how much of the load is from atmospheric deposition and convert this value to a percentage based on the load values I determined in the previous question.

For the urban and agriculture use, I found out how much of the land making up each of these three springsheds was attributed to urban or agriculture usage based on information provided by the class papers. For Ichetucknee, the most recent comprehensive data was provided from 1995 so I estimated the current value by calculating a delta from the 1977 data to the 1995 data and using a straight-line growth assumption to determine the 2012 data. From there, I decided that, based on Cohen *et al.*’s analysis (2007), agriculture nitrate should be weighed slightly higher than urban because research has shown that nitrate from fertilizers appears to be less likely than organic-based nitrates (from urban septic tanks etc) to be denitrified. Therefore, I felt that the nitrate load from agriculture applications should be weighted by a factor (in this case, I chose 1.5). Given the data from the atmospheric deposition, I was able to then

Exam 4

calculate the remaining percentages for agriculture and urban contribution to complete the estimation.

Question 6: Estimate the percent contribution of each of the following to the observed changes in flows at your three springs: changes in rainfall, changes in land use, agricultural water uses, urban water uses, industrial/commercial water uses (please cite sources and/or assumptions).

	Rainfall	Land Use (structural aspects in spring)	Agriculture		Urban		Industrial/ Commercial	
	%C	%C	%Δ	%C	%Δ	%C	%Δ	%C
DeLeon Springs	15%	60%	20%	52%	8%	21%	1%	2%
Blue Spring in Volusia County	15%	1%	3.5 %	4%	50%	54%	25%	26%
Ichetucknee Springs	15%	1%	5%	20%	8.5%	32%	8.5%	32%

%Δ = Percentage change in land use
%C = estimated contribution to the decrease in flow

In order to estimate the percentage contribution to the flow rates, I first considered the contribution from rainfall decreases. All three class papers indicated that the springs were being affected by rainfall decreases. However, as the Suwannee River Water Management District reported in 2012 regarding Ichetucknee springs, even though rainfall decreased, the discharge rate from the spring had a steeper decline, indicating that something else was responsible for the decrease. Without any better data, I made the assumption that rainfall decreasing would cause 15% of the decrease for the flow levels in each of the springs.

Given that, the next thing I considered was land use, which in this case I interpreted as changes to the structure of the spring itself. For Blue Spring and Ichetucknee, I couldn't find much evidence of major structural changes to the springs to cause a reasonable decline in flow rate, so I attributed only a 1% contribution for land use to both springs regarding flow decrease. However, for DeLeon springs, since they have put in a weir in the spring to dam the water, this obviously very heavily impacts the flow rate coming out of the spring so I assumed the contribution of land structures towards the decreasing flow rate was much higher for DeLeon at 60%.

Finally, I looked up information from the class papers to determine the changes in land use for agriculture, urban, and commercial activities. DeLeon had this information provided in the paper in its entirety. For Blue Springs, I estimated the changes based on the fact that I knew that urban activities have increased substantially while

agriculture use has remained fairly consistent. The Ichetucknee data from Zavoyski (2010) was also provided except for commercial and industrial applications, but I estimated that those activities would have increased as much as the urban activities. In this way, I was able to use coefficients to evenly attribute the contribution to each of the three activities based on their percentage change from the historical.

Question 7: Please describe any structural modifications that affect the health of your three springs and describe any impairment that are caused by those modifications.

Regarding existing structures that could affect the health of the spring, there was little that I could come up with based on the class papers I read along with additional information for Ichetucknee and Volusia Blue Springs. However, for DeLeon springs, a notable structure that exists is the dam that was put in place to create an area for swimming (Jones, 2010). Concrete walls and a weir have been erected around the spring pool to create the swimming area. Water can spill over the weir to the spring run below, but this structure has certainly reduced the overall discharge rate of the spring.

Kimberly Marshall
ENV 6932

Exam 4

Question 8: Compare and contrast recreational uses in your three springs. Approximately how many people visit each spring per year? Please assess the importance of and effects of recreational impacts in the three springs.

Springs	**Recreational Usage**	**Visitors/year**	**Importance**
DeLeon Springs (**nitrate + nitrite used) *(Information from Jones, 2010)*	Swimming, snorkeling, scuba diving, wildlife viewing, hiking, fishing, canoeing and kayaking, boating and boat tours.	> 250,000 people 67% of attendance during April - Sept	Produces the second highest $ of eight priority springs in SJRWMD. High impact on vegetation/spring health
Volusia Blue Springs *(Information from Hall, 2010)*	Swimming, wildlifing/birding snorkeling, scuba diving, tubing, kayaking/canoeing, boat tour, fishing, hiking, manatee-viewing, camping	~ 337,356 (2001-2002)	Provides about $10million annual High impact on vegetation/spring health
Ichetucknee *(Information from Zavoyski, 2010)*	Swimming, kayaking, canoeing, tubing, diving, wildlifing, birding,	200,000	Provides about $22 million to the local economy on an annual basis. High impact on vegetation/spring health

All of the springs are used for swimming and diving and wildlifing and kayaking etc. Volusia Blue is known for its manatee population and therefore manatee viewing is an important activity during the winter time. Ichetucknee is known primarily for the tubing that takes place during the summer months and which attracts many tourists. DeLeon has a prominent swimming pool around the spring vent and used to have a mill set up in the spring. All of these individual characteristics create different reasons for visitors attending the parks. Each of the springs, therefore, is important for its community but the effects of the recreational activities cause damage to the spring.

Kimberly Marshall
ENV 6932

Exam 4

At DeLeon springs, the swimming enclosure has probably affected discharge and flow rates of the spring run, which in turn affect the vegetation and nutrient quality in the spring. Each of the springs receives enough traffic to cause changes in the turbidity of the spring floor which can also affect the wildlife. Moreover, the human activities in these springs cause an increase in trash build up and nutrient increases that cause algal growth to overtake plant vegetation in the spring runs. Overall, the traffic received at these springs is important economically for the communities that are supported by them, but it still comes up with consequences to the spring health and should be carefully monitored and mitigated.

References:

Cohen M.I. *et al.,* 2007. "Sources, Transport and Transformations of Nitrate-N in the Florida Environment." St. John's Water Management District. SPECIAL PUBLICATION SJ2007-SP10.

Hall, J. 2010. "Volusia Blue spring protection and restoration plan." University of Florida, Gainesville, Fl. ENV6932 – Florida Spring Ecosystems.

"Hydrologic Database, Statistical Analysis, and Adjusted Historical Flow Development of Select Surface Water Stations on the Lower Santa Fe and Ichetucknee Rivers." 2012. Suwannee River Water Management District. <http://www.srwmd.state.fl.us/DocumentCenter/View/7169>

"Ichetucknee Springs Restoration Plan" (ISRP). 2012. H.T. Odum Florida Springs Institute (prepared for the Ichetucknee Springs Working Group). <http://floridaspringsinstitute.org/newly-completed-ichetucknee-springs-and-river>

Jones, K. 2010. "De Leon springs protection and restoration plan." University of Florida, Gainesville, Fl. ENV6932 – Florida Spring Ecosystems.

Zavoyski, B. 2010. "Ichetucknee springs protection and restoration plan." University of Florida, Gainesville, Fl. ENV6932 – Florida Spring Ecosystems.