Physiochemical Effects of the Wekiva River on the St. Johns River, Central Florida

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Introduction

The St. Johns River is a 6th order river which flows north from its headwaters in Indian River County a distance of 310 miles to its outlet with the Atlantic Ocean in Duval County. It is a slow moving meandering river which widens into several lakes throughout its flow and has an average elevation change of less than 1 inch per mile. The St. Johns River is considered to be a blackwater river (Clewell, 1991). Blackwater rivers are characterized by tea-colored water caused by high concentrations of Dissolved Organic Matter (Meyer, 1990). The Wekiva River is a calcareous river fed by Wekiwa Spring and Rock Spring. It joins the St. Johns River as a single channel where the boundaries of Seminole, Lake, and Volusia Counties meet (Figure 1). The surrounding river bank is forested with wetland species including cypress (*Taxodium sp.*) and red maple (*Acer rubrum*) transitioning to upland oak communities through cabbage palm (*Sabal palmetto*).

This confluence of water provides an opportunity to observe the effect on water chemistry when a spring fed river joins a blackwater river. Physiochemical properties of water were measured at eight stations. Six of these stations were located in the St. Johns River upstream from its confluence with the Wekiva River. One station was placed in the Wekiva River upstream from its confluence with the St. Johns River and one station was placed in the St. Johns River downstream from the confluence with the Wekiva River. Stations were located in this manner to determine how physiochemical properties of the St. Johns River are affected by water inflowing from the Wekiva River. Specific attention was given to water color, total alkalinity, ammonium, and dissolved oxygen. Sampling was conducted on 15 November, 2006.

Figure 1. St. Johns and Wekiva River confluence.

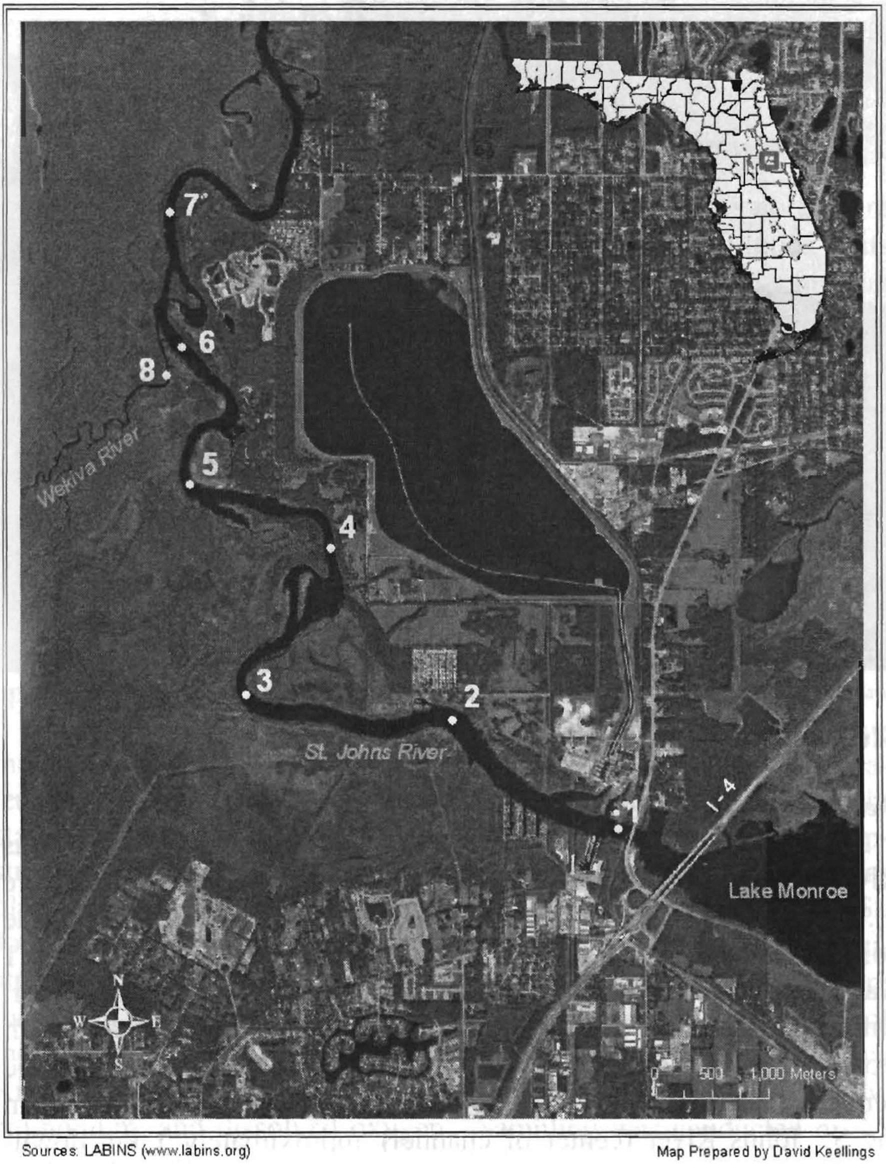
Source: Author Photograph.

Methods and Materials

Field Data

Seven sample stations were evenly located on the St. Johns River in the center of the channel approximately 1 km apart (Figure 2). Six of these stations (stations 1-6) were located upstream of the confluence of the St. Johns River with the Wekiva River. Station 1 was located in Lake Monroe near its outlet into the St. Johns River. One station (station 8) was located approximately 0.5 km upstream from the junction of the Wekiva River with the St. Johns River in the center of the Wekiva channel. One station (station 7) was located in the St. Johns River (center of channel) approximately 1 km downstream from its junction with the Wekiva River. At each of these stations water samples were collected from 1 m depths using a bilge pump and plastic tubing to obtain uncompromised samples. Water

Figure 2. Map of location and sampling stations.



temperature and specific conductivity was taken at each station and a 20 cm diameter Secchi Disc was utilized to determine the extent of light penetration (Welch, 1948). Sampling took place on 15 November, 2006 between 11:30 am and 1:00 pm.

Water Chemistry Analyses

The water samples were then analyzed in the lab at 3:00 pm on 15 November, 2006. The water samples were tested for total alkalinity using Standard Methods and a Corning pH meter model 125 (APHA, 1992). Water color and turbidity was tested using Standard Methods and a Hach Turbidimeter model 16800 (APHA, 1981). Ammonium, nitrate, and nitrite concentrations were tested using a Hach test kit model NI-8. Tannin and orthophosphate concentrations were determined using Standard Methods and a Milton Ray Spectronic 20+ model LR45227 spectrophotometer (APHA, 1981). Dissolved oxygen was tested using the modified Winkler Method (APHA, 1981). Free carbon dioxide was determined using Standard Methods (APHA, 1975). Water samples were also analyzed for pH using a Corning pH meter model 125.

Results

Table 1 shows all physiochemical parameters which were tested for at each sampling station on the St. Johns and Wekiva Rivers. Having examined these data it was found that no parameters other than water color, total alkalinity, ammonium, and dissolved oxygen exhibited significant variation between sampling stations on either the St. Johns or Wekiva Rivers. As a result only those parameters which exhibited variation were focused on as a part of this study.

Water color was found to be high (>50 Pt-Co) throughout the sampling area of the St. Johns River upstream from its junction with the Wekiva River. Water color was found to be low (<50 Pt-Co) at the Wekiva River sampling station (Table 2). Water color was lower at sampling station 7 (located on the St. Johns River downstream from its junction with the Wekiva River) than any other sampling station on the St. Johns River (Figure 3).

Total alkalinity values were found to be relatively constant at the sampling stations on the St. Johns River upstream from its junction with the Wekiva River (Figure 4). Total alkalinity in the Wekiva

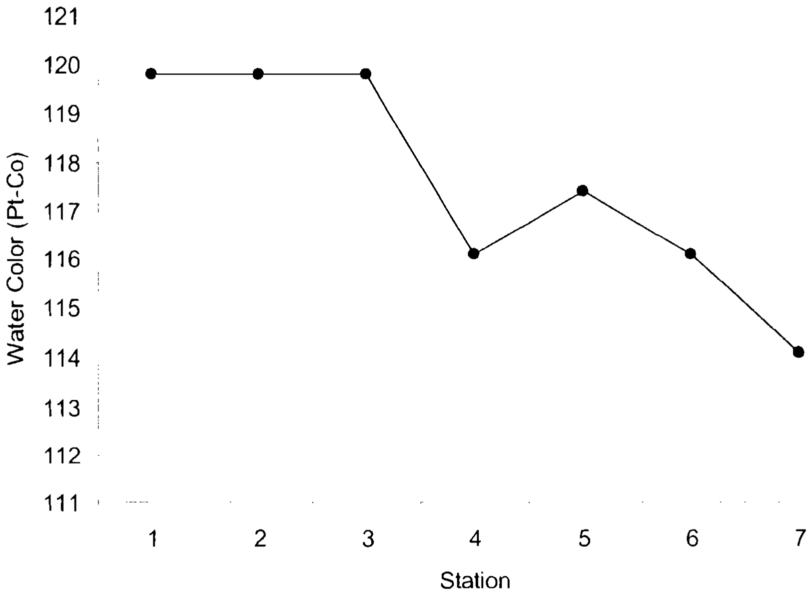
Table 1. Sampling data per station for the St. Johns and Wekiva Rivers, Central Florida, 15 November 2006.

	Station							
Parameter	1	2	3	4	5	6	7	8
Secchi Disc (m)	0.77	0.84	0.73	0.75	0.71	0.74	0.74	bottom
Water Temp. (C)	21.8	21	21.2	21.4	21.2	20.9	20.8	18.9
Turbidity (NTU)	3.9	2.4	2.4	2.4	2.8	2.8	2.6	1.2
Tannin (ppm)	6.54	6.4	6.4	6.27	6.4	6.27	6.27	1.85
Water Color (Pt-Co)	119.8	119.8	119.8	116.1	117.4	116.1	114.1	20.2
Dissolved Oxygen (mg/L)	5.6	5.3	5.8	5.3	6.0	5.8	5.1	8.2
pH	6.5	6.85	6.83	6.84	6.9	7.0	6.93	7.03
Carbon Dioxide (mg/L)	3	6	7	7	8	8	8	9
Total- Alk (mg/L $CaCO_3$)	70	80	79	81	81	81	85	145
Sp Cond (µmhos/cm)	1085	1082	1085	1081	1080	1080	1066	855
Ammonium (NH_4) (ppm)	0.91	0.91	0.78	1.04	1.04	1.04	7.8	1.3
NO_2-N (ppm)	0	0	0	4.4	0	0	0	0
NO_3-N (ppm)	0	0	0	0	0	0	0	0
OPO_4 (ppm)	0	0	0	0	0	0	0	0

River was found to be high at 145 mg/L $CaCO_3$ (Table 2). The total alkalinity of the St. Johns River at sampling station 7 (downstream from the Wekiva River junction) is the highest of all sampling stations on the St. Johns River (Figure 4).

The ammonium concentration was found to be relatively con-

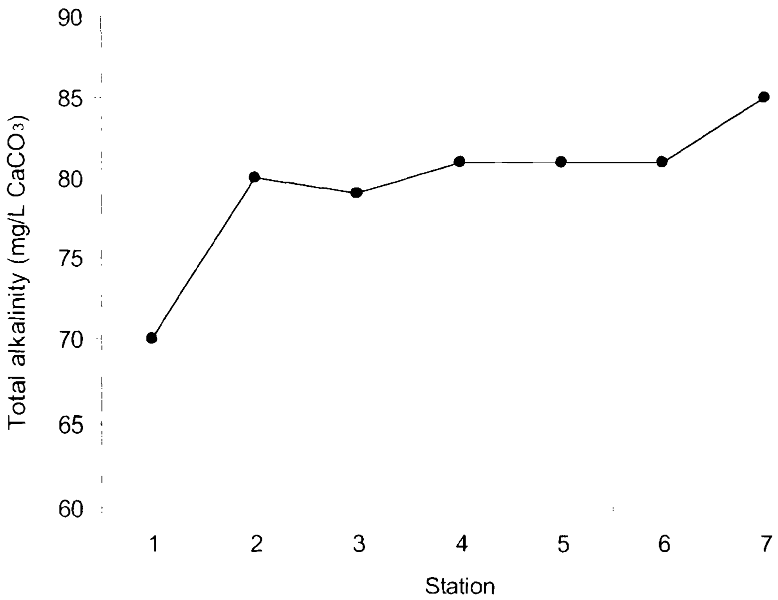
Figure 3. Water color per station in the St. Johns River, central Florida, 15 November 2006.



stant at sampling stations on the St. Johns River upstream from its junction with the Wekiva River (Figure 5). The ammonium concentration at the Wekiva River sampling station is of a similar magnitude to stations 1 through 6 on the St. Johns River (Table 2). The ammonium concentration at station 7 on the St. Johns River (downstream from the Wekiva River junction) is the highest of all sampling stations on the St. Johns River (Figure 5).

Comparing Figure 6 with Table 2, the dissolved oxygen concentration was determined to be higher in the Wekiva River (station 8) than at any other station on the St. Johns River. There was little variation in dissolved oxygen concentrations at all stations on the St. Johns River (Figure 6). Tannin and turbidity levels were found to be lower in the Wekiva River (station 8) than in the St. Johns River and there was little variation in both tannin and turbidity levels at all sta-

Figure 4. Total alkalinity per station in the St. Johns River, central Florida, 15 November 2006.



tions (stations 1-7) on the St. Johns River (Table 1).

Discussion

The minimum average flow of the St. Johns River is established to be 2050 cubic feet per second (cfs) (SJRWMD, 2006). The minimum average flow of the Wekiva River is established to be 240 cfs (SJRWMD, 2006). Despite the far lesser discharge of the Wekiva River it is still of a magnitude capable of effecting some aspects of the St. Johns River water chemistry.

The St. Johns River is highly colored which is consistent with it being considered a blackwater ecosystem (Clewell, 1991). The Wekiva River is sourced to a spring which indicates low water color values. The combining of these two different water types has the effect of lowering the water color in the larger, more colored, St. Johns River

Figure 5. Ammonium per station in the St. Johns River, central Florida, 15 November 2006.

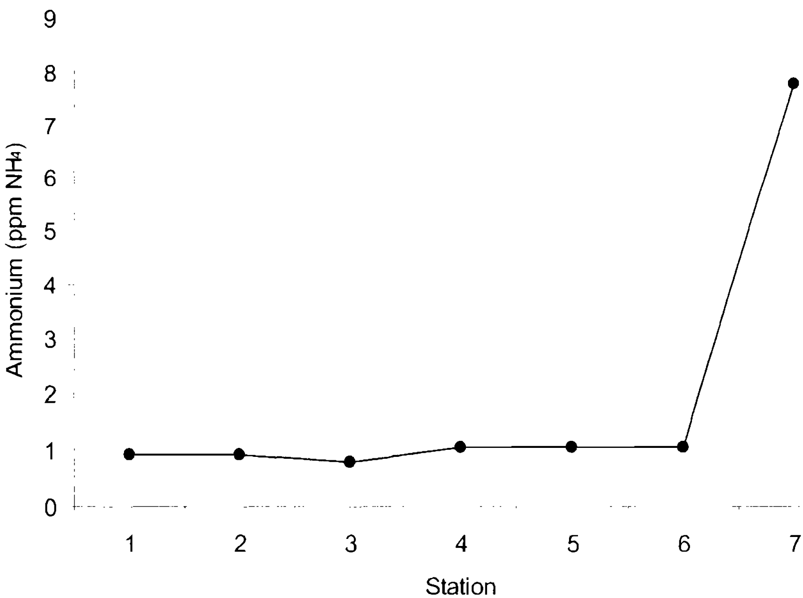
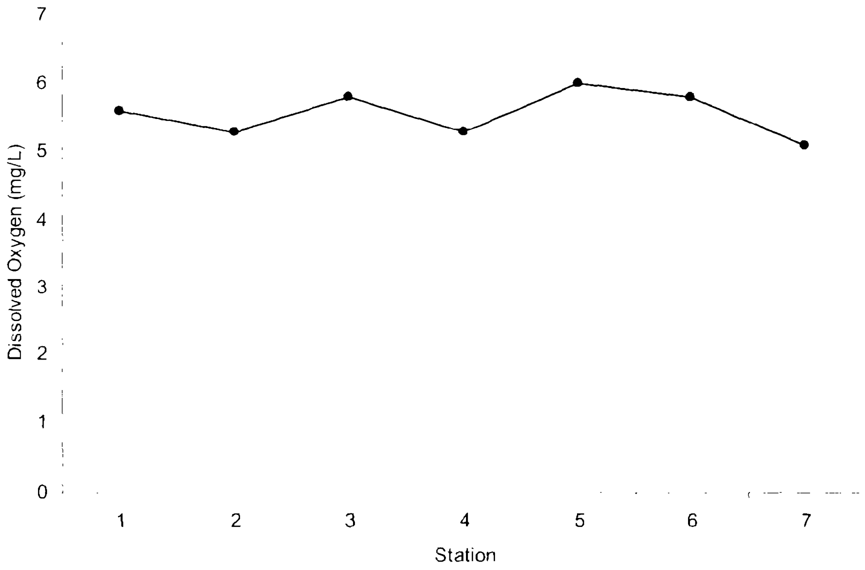


Table 2. Water sampling data for Wekiva River station, central Florida, 15 November 2006.

Parameter	Value
Water Color (Pt-Co)	20.2
Total Alkalinity (mg/L CaCO3)	145
Ammonium (ppm NH4)	1.3
Dissolved Oxygen (mg/L)	8.2

by dilution with the smaller, less colored, Wekiva River (Figure 3). The effect on water color sampled at the station after the junction of the two rivers was of a similar magnitude to the ratio of their flow.

Figure 6. Dissolved oxygen per station in the St. Johns River, central Florida, 15 November 2006.



Total alkalinity was found to be high in the spring fed Wekiva River as one might expect due to the alkaline limestone watershed (Goldman and Horne, 1994). Total alkalinity was relatively low in the St. Johns River. Again, the combining of these two different water types has the effect of raising the total alkalinity in the larger, less totally alkaline, St. Johns River by dilution with the smaller, more totally alkaline, Wekiva River (Figure 4).

Ammonium concentration was found to be relatively constant in the upstream St. Johns River samples (stations 1-6) and in the Wekiva River (station 8). However, ammonium concentration was of a highly increased level in the St. Johns River downstream from the Wekiva River (Figure 5). This increase may be due to agricultural run off from the surrounding area but I find this unlikely as no such similarly elevated levels of ammonium were sampled at any other station along the rivers. The increase at this specific point after the combination of water from the St. Johns River and the Wekiva River may be due to the process of alkalitrophy. The mixing of the high total alkalinity Wekiva River with the St. Johns River may cause sudden high levels of biologic production associated with the influx of large levels of calcium (Wetzel, 2001).

The higher level of dissolved oxygen in the Wekiva River (Table 2) can be attributed to the clear oligotrophic conditions, allowing deeper light penetration and increased photosynthetic rates, and the lower temperature in the Wekiva water (Table 1) which allows greater volumes of oxygen to dissolve (Wetzel, 2001). This higher level of oxygen entering the St. Johns River from the Wekiva River may also be responsible for the sudden increase in ammonium concentration present at station 7 on the St. Johns River (Figure 5). The higher oxygenated water inflowing from the Wekiva River may cause an increase in decomposition as well as respiratory activity in organisms, particularly benthic invertebrates, in this section of the St. Johns River leading to subsequently higher ammonium concentrations (Wetzel, 2001).

Conclusion

The results of water tests conducted at all 8 stations show that the inflowing water from the Wekiva river is having an effect on the physiochemical properties of the water in the St. Johns River. Water color in the St. Johns River is reduced by the inflow of lowly colored water from the Wekiva River despite its lesser volume of water flow. Total alkalinity is increased in the St. Johns River due to the inflow of high total alkalinity water from the limestone spring fed Wekiva River. The ammonium concentration in the Wekiva River is of the same magnitude as that of all sampling stations on the St. Johns River upstream from its junction with the Wekiva River. However, ammonium concentration is greatly increased after the junction of the two rivers. This sudden increase in ammonium concentration may be a result of agricultural run off from the surrounding terrestrial habitat or the effect of chemical properties in the water joining the St. Johns River from the Wekiva River.

Alternatively, the high total alkalinity water of the Wekiva River may be causing alkalitrophy and subsequently high levels of biologic production in the St. Johns River leading to an increase in ammonium concentration. The higher levels of dissolved oxygen entering the St. Johns River from the Wekiva River may also lead to increased levels of biologic respiration of organisms in the St. Johns River and would also subsequently increase ammonium concentration. Both inflow of high total alkalinity and elevated dissolved oxygen may have a combined effect in raising ammonium concentration in the St. Johns River. However, further testing of the water at and around the junction of these rivers is required before the exact cause of increased ammonium levels can be stated definitively. Further sampling efforts may include benthic invertebrate population comparisons with other areas of the St. Johns River to give an indication of potentially high biologic productivity at the confluence. Manipulative experiments could also be conducted in a lab environment to test if variation of dissolved oxygen or total alkalinity levels in an invertebrate tank affect ammonium concentrations. Seasonality may also play a large part in ammonium production due to variations in both water temperature and productivity at different times of the year. Therefore sampling efforts should encompass these seasonal differences.

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