February 28, 2015

SOUTH FORK OF THE EDISTO RIVER AND POND BRANCH MONITORING RESULTS (FEBRUARY 2014 TO JANUARY 2015)

By
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Abstract

In February, 2014, a team of volunteers began monitoring water quality at two locations on the South Fork of the Edisto River in Aiken County, SC. In July, 2014, the team added a location on Pond Branch, a tributary to the Edisto. This report presents data obtained through January 2015. The monitoring program assesses the water quality at the three locations with the intent of detecting impacts from agricultural development near Aiken State Natural Area and Keadle Bridge (where Spring Branch/Windsor Road crosses the river). Monitoring includes measuring chemical and physical properties of the water. During the first year of monitoring, sampling results show good water quality at all three sampling points. Dissolved oxygen content was high, the pH was in the range expected for a slightly tannic stream, chemical pollutants were low or absent, and settleable solids were present at trace levels. Occasional turbidity has been observed but no clear pattern is evident.

Introduction

The South Fork of the Edisto River drainage basin covers approximately 800 square miles in Saluda, Edgefield, Aiken, Barnwell, Bamberg, and Orangeburg counties (Figure 1.) Most of the watershed is rural and farming is the major land use category. The river supplies water to local farmers and is used for recreational purposes, such as fishing and boating. In January of 2014, public attention focused on the river when South Carolina Department of Health and Environmental Control (SC DHEC) approved an agricultural request from Walther Farms to remove 805 million gallons of surface water per month (later reduced to 400 million gallons/month). Local citizens, both farmers and recreational users, became concerned that the approved withdrawals would adversely affect their use of the river, particularly during times of low rainfall. To address citizens' concerns, SC DHEC held an informational meeting in Aiken, during which they explained that SC state law did not allow them to deny the request. From the discussion, it seemed that little information was available to assess the impact of the water withdrawal. No information was provided on the river monitoring on the South Fork of the Edisto River in the vicinity of the planned withdrawals, except for a few references to the river gauge downstream at Denmark, SC.

Concerned members of the Augusta-Aiken Audubon chapter formed a volunteer group to monitor the water quality above and below the Walther Farms water withdrawal site (see Figure 2). Several months later, a third sampling point was added on Pond Branch, a tributary of the S. Edisto River, prompted by the proposed construction of a poultry farm in the vicinity. Monitoring at the three sites includes both chemical and physical measurements performed monthly. Monitoring allows assessment of current water quality and provides baseline data to gauge the effects of future development.

Monitoring on the South Fork of the Edisto River

Figure 2 shows the locations of the three monitoring sites used in this study. The sites are located on or near the South Fork of the Edisto River in Aiken County near the town of Windsor, SC. The upstream sampling point (SER-1) is within the Aiken State Natural Area. The downstream sampling point (SER-2) is located at the boat landing adjacent to Keadle Bridge. The Pond Branch sampling point (PB-1) is located where Pond Branch crosses Oak Ridge Club Road. See Appendix A for the site names, map coordinates, photographs of each site, and description of the habitat.

For 2014-15, SC DHEC has two active monitoring sites on the South Fork of the Edisto River in the region of interest (Ref. 1). Coincidently, these are quite close to the sites used in this study. SC DHEC has a base site at the bridge on Secondary Road S-02-53, which is a short distance upstream from our site at the Aiken State Natural Area canoe landing. This location has been monitored since at least 2010. For 2014, SC DHEC had a random site where S-02-212 crosses the river, which is the same location as our Keadle Bridge site. These sites are monitored monthly or bimonthly using a standard suite of analyses that includes those that we are performing. In October 2014, the United States Geologic Survey (USGS) placed a water level monitoring gauge on the bridge. Several monitoring sites listed in the 2012 SC DHEC watershed water quality assessment of the Edisto River Basin (Ref. 2) are now inactive, although none of them were in the area of interest for this study. Most of those sites are upstream by several miles and the next site downstream lies 8 miles from the area of interest for this report. SC DHEC has additional sites on tributaries, but these do not aid in monitoring changes in the river.

In early 2014, Aiken County Council member Kathy Rawls requested the Stormwater Division of the Aiken County Engineering Department to sample the South Fork of the Edisto River. The sample results provided a baseline reading of the water quality in the vicinity of the Walther farm prior to any impact that might occur. Sampling occurred on June 6, 2014, and the *Aiken Standard* (Ref.3) reported the activity. Two of these sites are located at or near the same three points as in this study. The Stormwater Division effort includes only one sampling event. The date of sampling, requested analyses, and results were not reported by the newspaper, but are contained in the laboratory report (Ref. 4). The analyses are similar to those performed in this study with the addition of alkalinity and coliform bacteria.

Procedures

The Edisto River monitoring effort forms part of the Georgia Adopt-A-Stream program. The volunteers received GAAS training, including annual retraining, and follow GAAS sampling and data collection protocols. These are accessible through the GAAS website (Ref. 5) or through their publications (Ref. 6). At least two GAAS-trained and qualified monitors participated in each monitoring event. The results from sampling the South Fork of the Edisto River are entered in the GAAS database and are available on-line (Ref.5). The team's identification number is AAS-G-1087 and its name is "AAAS Stream Stompers". Appendix B contains details of the equipment and methods. The only significant change from GAAS procedures is the use of a transparency tube in place of the Secchi disk.

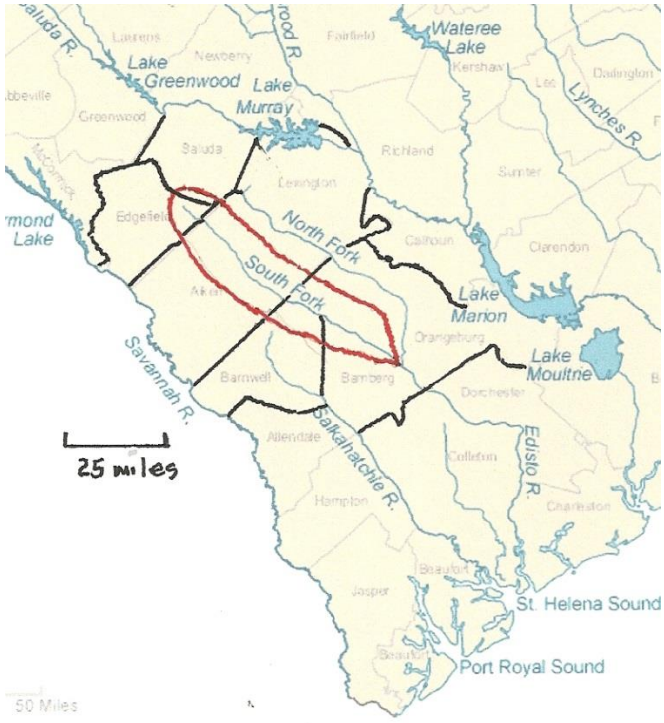

FIGURE 1. The drainage basin for the South Fork of the Edisto River is outlined in red.

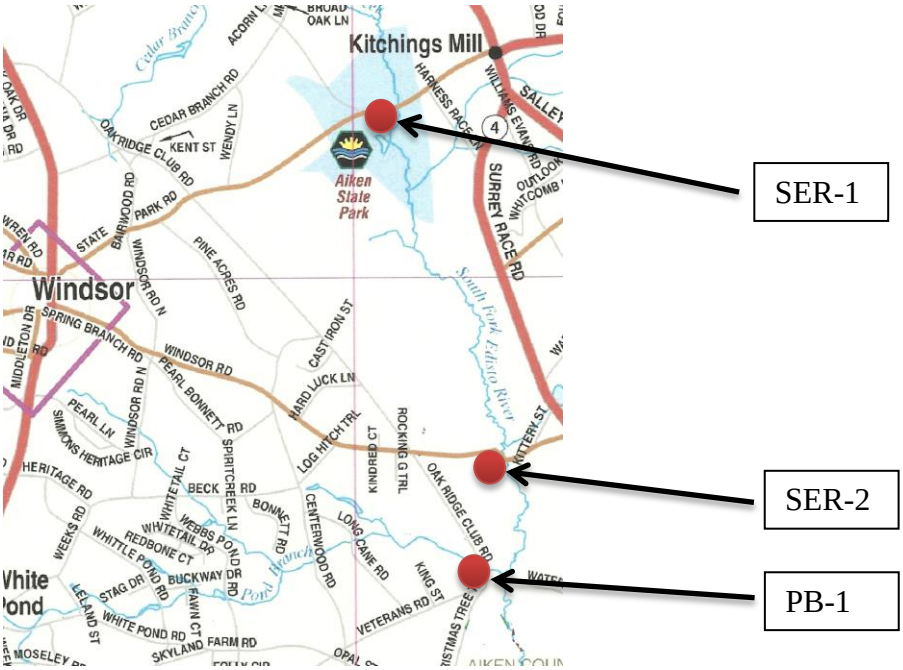

FIGURE 2. Map of the Windsor area showing the locations of the sampling points on the South Fork of the Edisto River and Pond Branch. SER-1 is located in Aiken State Natural Area, SER-2 is located at Keadle Bridge, and PB-1 is located where Pond Branch crosses Oak Ridge Club Road.

Results and Discussion

Table II lists test results for February 2014 to January 2015. A year of sampling results show consistently good water quality at all three sampling points. Dissolved oxygen levels (5.6 to 9.9 mg/L) will support most aquatic life forms; the pH was consistently in the range 5.5 to 6.5; chemical pollutants (e.g., nitrate, ammonia, and phosphate) were low or absent; settleable solids were low (≤0.1 mL/L); and conductivity was low (<30 mS/cm). Transparency was normally very good (>120 cm), although on three occasions it dropped to 106-113 cm.

Dissolved Oxygen

As seen in Table II, dissolved oxygen concentrations in the stream varied between 5.6 and 9.9 mg/L. The two river sampling points (SER-1 and SER-2) averaged 7.5 mg/L and 7.4 mg/L. We previously (Ref. 8) reported consistently lower values downsteam (SER-2), but additional data indicates the concentrations at the two sites is comparable. To put this range in perspective, Georgia state standards require an average concentration of 5 mg/L with a minimum of 4 mg/L to provide adequate oxygen for most aquatic life forms (Ref. 5). Thus, no problem is apparent in the dissolved oxygen levels in the Edisto River where we sampled.

Much of the month-to-month variation in DO results from changes in water temperature. Figure 3 shows the same data recalculated as "% of saturation" based on the saturation limit of pure water at the temperatures of the samples (Ref. 6). As shown in the graph, the dissolved oxygen concentration is very similar at the two sampling points. When expressed in mg/L, the oxygen concentration varies ±30%, whereas, when expressed at % of saturation, it varies by only ±15%.

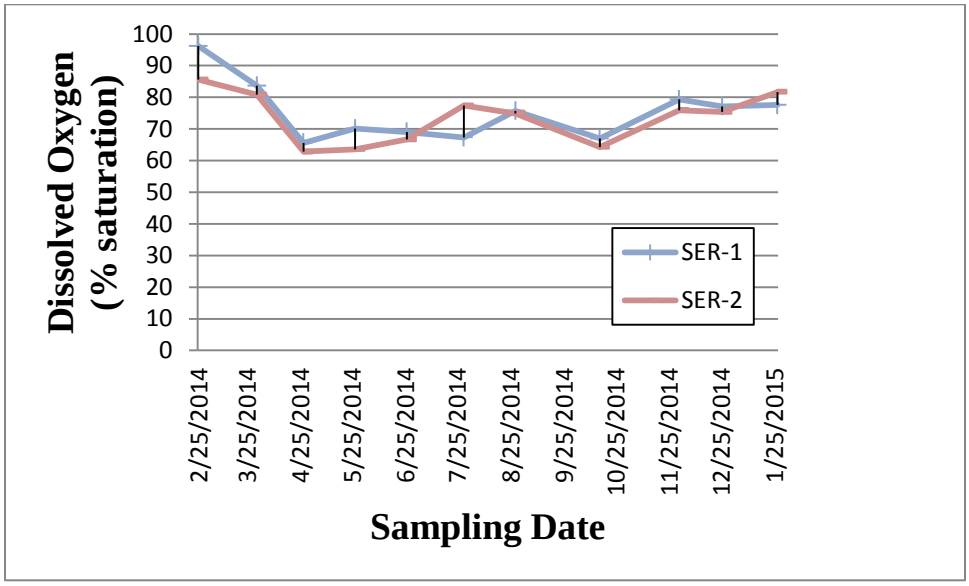

FIGURE 3. Dissolved oxygen (as % of saturated) results for two sampling locations.

pH

The pH showed little variation with a range of 5.5 to 6.5. This pH range is relatively high for a slow moving, blackwater river. The tannic nature of such rivers can produce pH values as low at 3.5. A pH of 5.5 to 6.5 is closer to the range for fast-moving mountain streams (pH 6.0 to 8.0). The reason for the low acidity is not known, but there appears to be no significant difference in pH between the three sampling points.

Nitrate/Ammonia/Phosphate

Chemical pollutants (nitrate, ammonia, and phosphate) were not detected above levels of concern. Nitrate values above our detection limit were found in four samples (Table II), but these values (0.05 mgN/L) are not considered a cause for concern. The City of Aiken maximum contaminant level goal (MCLG) for nitrate in drinking water is <10 mg N/L (Ref.7). The river water at both sampling points was safely within this limit. Nitrate contamination can occur from excessive use of agricultural fertilizers.

Ammonia concentrations were below detection limit (≤ 0.3 mg N/L) at all times at all sampling points. The presence of ammonia can be due to fertilizers, animal waste, or improperly treated sewage. Phosphate was never detected in the river (detection limit equaled 0.2 mg PO4/L). Levels of phosphate above 0.3 mg/L can stimulate plant growth sufficiently to surpass natural eutrophication rates and lead to oxygen depletion.

Settleable Solids

The river did not contain significant amounts of settleable solids as measured by Imhoff cones. Settleable solids were measured at the lowest quantifiable amount (0.1 mL/L) in June, but were less than that (recorded as "trace, <0.1 mL/L) in other months. A recent rain event two days before sampling may have caused the quantifiable reading in June.

Water Transparency

Transparency of the river water at both sampling points exceeded the 120-cm length of the transparency tube on three occassions. The transparency decreased to 108 cm (April, Keadle Bridge), 106 cm (May, Keadle Bridge), and 113 cm (December, Aiken State Natural Area). The decreases were temporary and returned to >120 cm at the next sampling event. The reason for the occasional loss of transparency is unknown, but is likely due to runoff from heavy rain somewhere upstream within the drainage basin. Further investigation of this finding is recommended. Transparency measurements following rain should be attempted to determine if a correlation exists. Continued monthly monitoring is also recommended to ascertain the seasonal changes in the transparency.

Conductivity

Conductivity proved quite low, indicating very low concentrations of dissolved ions. Certain forms of pollution, or salt water intrusion (near the coast), can cause very high conductivity (>500 µS/cm). Measured conductivity ranged between 6 and 29 µS/cm, which is quite low.

Site Cleanup Event

The Keadle Bridge sampling site is a gathering point for fishing and loitering on the river. These gatherings result in considerable garbage and trash accumulation at the boat landing. Although two trash barrels located at the site offer a place to deposit waste, the barrels were found to be full and overflowing during the first four sampling events. Therefore, the authors organized a cleanup of the site on June 5, 2014. The Silver Bluff Audubon Center and Sanctuary generously provided a pick-up truck and six volunteers from the Augusta-Aiken Audubon Society provided the manpower. Figure 3 shows pictures before and after the clean-up at the site.

(a) (b)

FIGURE 3. Keadle Bridge boat landing before (a) and after (b) trash and garbage removal on June 5, 2014. The cleanup crew in (b) are Larry Eldridge, Doug Walker, George Reeves, Marylyn McLeod, Don McLeod, and Alice Walker (not shown; photographer).

Summary

With one exception, the results from the first year of sampling indicate good water quality in the south fork of the Edisto River. The one exception, water transparency, showed the water quality decrease believed due to heavy rain runoff. Additional transparency monitoring following rain events is recommended. These data provide a baseline to monitor for changes in the river's water quality as development and changes in water usage occur in the vicinity of the two sampling points.

At present we intend to continue monitoring through the fall of 2015 when we will begin to exhaust our chemical reagent supply. Monitoring will continue into 2016 if we can obtain funding. We are planning to monitor for *E. coli* bacteria if we can obtain funding to purchase the necessary equipment. A grant proposal has been submitted to SC Audubon to fund this effort and a decision is pending.

Acknowledgements

We appreciate the encouragement and funding for our monitoring program that we received from Audubon South Carolina. We thank Ruth Mead (Phinizy Center for Water Sciences) for training the team members in Physical/Chemical Monitoring. We also appreciate the Georgia Adopt-A-Stream program for providing procedures and a web site where we can post our results.

References

1. David Chestnut, Bureau of Water, SCDHEC, *State of South Carolina Monitoring Strategy for Calendar Year 2014*, Technical Report No. 1126-13, January 2014.

2. South Carolina Department of Health and Environmental Control.2012.Watershed Water Quality Assessment: Edisto River Basin. Technical Report No. 103J-12. Bureau of Water, Columbia, S.C.

3. *The Aiken Standard*, Vol.148, No. 171, June 20, 2014, p. 3A.

4. Shealy Environmental Services, Inc., *Report of Analysis: Aiken County Engineering Department, Project: Windsor Stormwater, Lot Number PF13060*, dated June 24, 2014. Report provided by Kathy Rawls.

5. Georgia Adopt-A-Stream website and database can be found at:
www.georgiaadopastream.org/ or htpp//aesl.ces.uga.edu/aascd/home.html

6. Georgia Adopt-A-Stream, Department of Natural Resources, Environmental Protection Division, 2 MLK, Jr Drive, SW, Suite 1462E, Atlanta, GA 30334, *Biological and Chemical Stream Monitoring*, 2006.

7. City of Aiken, *Annual Drinking Water Quality Report*, System Number 0210001, 2013.

8. Alice Walker, Doug Walker, and John Demko, "South Fork of the Edisto River Monitoring Results (February 2014 to June 2014), July 3, 2014 (available from the Silver Bluff Audubon Center and Sanctuary, 4542 Silver Bluff Road, Jackson, SC 27831).

9. Lucas Odom, "Report of Analysis, Lot # PF12060", Shealy Environmental Services, Inc., dated June 24, 2014. (Report analyses performed for the Aiken county Engineering Department, Project Name: Windsor Stormwater.)

Table II. Results of Chemical Monitoring

	Air Temperature (ºC)			Water Temperature (ºC)			Dissolved Oxygen (mg/L)			pH		
Location	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1
Date												
2/25/14	19	24		14	13		9.9	9.0		6.0	6.0	
3/31/14	20.5	21		13.5	12.5		8.7	8.6		6.0	6.0	
4/27/14	28	26		18	17.5		6.2	6.0		6.0	6.0	
5/27/14	28	30		23	21.5		6.0	5.6		6.5	6.5	
6/26/14	28	26		24	24		5.8	5.6		6.5	6.5	
7/29/14	24.5	24	36[§]	24.5	24	24[§]	5.6	6.5	6.6[§]	6.5	6.5	6.0[§]
8/28/14	25	23	25	22	21.5	19	6.6	6.6	7.3	6.0	6.0	6.0
10/16/14	20	19	21	19	19.5	17.5	6.2	5.9	7.2	6.0	6.0	5.5
12/1/14	17	12	14	7.5	7.0	10	9.5	9.2	9.4	6.0	5.5	5.5
12/26/14	12/5	13.5	15	9.5	9.5	11	8.8	8.6	9.2	5.5	5.5	5.5
1/27/15	8	7	9	7	7	10	9.4	9.9	9.0	6.5	6.5	6.0

	Nitrate Ion (mg N/L)			Ammonia (mg N/L)			Phosphate (mg PO4/L)		
Location	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1	SER-1	HC-2	PB-1
Date									
2/25/14	0	0		0	0		0	0	
3/31/14	0	0		0	0		0	0	
4/27/14	0	0		0	0		0	0	
5/27/14	0	0		0	0		0	0	
6/26/14	0	0.05		0	0		0	0	
7/29/14	0	0	0[§]	0	0	0[§]	0	0	0[§]
8/28/14	0.05	0	0	0	0	0	0	0	0
10/16/14	0	0	0	0	0	0	0	0	0
12/1/14	0	0	0	0	0	0	0	0	0
12/26/14	0	0	0	0	0	0	0	0	0
1/27/15	0.05	0.05	0	0	0	0	0	0	0

	Settleable Solids (mL/L)			Transparency Tube (cm)*			Conductivity (µS/cm)			River Depth**	
Location	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1	SER-1	SER-2	PB-1	SER-1	SER-2
Date											
2/25/14	Trace	Trace		>120	>120		26	23		9 ft 3 in	NM***
3/31/14	Trace	Trace		>120	>120		24	22		9 ft 2 in	NM
4/27/14	Trace	Trace		>120	108		23	24		8 ft 11 in	NM
5/27/14	Trace	Trace		>120	106		29	27		7 ft 11 in	6 ft 6 in
6/26/14	0.1	0.1		>120	>120		26	24		7 ft 10 in	5 ft 11 in
7/29/14	Trace	0.05	Trace[§]	>120	>120	>120[§]	24	23	6[§]	7 ft 4.5 in	6 ft 9.5 in
8/28/14	Trace	Trace	NM	>120	>120	>120	19	17	6	6 ft 2 in	5 ft 0 in
10/16/14	Trace	Trace	NM	>120	>120	>120	22	20	7	8 ft 2 in	7 ft 3 in
12/1/14	Trace	0	NM	>120	>120	>120	24	24	6	9 ft 1 in	9 ft 2 in
12/26/14	Trace	Trace	NM	113	>120	>120	18	15	8	9 ft 11.5 in	10 ft 0 in
1/27/15	Trace	Trace	Trace	>120	>120	>120	20	22	6	9 ft 2 in	9 ft 0 in.

*Maximum transparent depth measureable in the transparency tube is 120 cm. For a recorded reading of 120 cm, the actual transparent depth may be greater.

** SER-1 measured at the gauge in the Aiken State Natural Area located at the upper canoe launch. SER-2 measured at the gauge attached to Keadle Bridge. Note: the two gauges provide a relative measurement of the height of the river (i.e., a depth of 7 ft. at Aiken State Natural Area does not correspond to a depth of 7 ft. at Keadle Bridge).

***NM = not measured. The gauge at Keadle Bridge was not installed until the May sampling.

[§]Sample taken 7/15/14.

APPENDIX A
South Edisto Monitoring Sites

Sampling Location Used in this Study.

TABLE A1. Sampling Points

Identifier	Aiken State Natural Area	Keadle Bridge	Pond Branch
GPS coordinates	N 33.5528˚ W -81.4826˚	N 33.5199˚ W -81.4103˚	N 33.5014º W -81.3964º
Location	lower boat landing within Aiken State Natural Area	boat landing at the bridge where S-3-53 (Windsor Road) crosses the South Fork of the Edisto River	culvert entrance where Pond Branch passes under Oak Ridge Club Road
Description	dock on the South Fork of the Edisto River at the canoe takeout within Aiken State Natural Area	boat ramp at Keadle Bridge, approximately 8 miles downriver from the sampling point in Aiken State Natural Area	wooded area about 1.5 mi. south of Keadle Bridge and 0.3 mi. northwest of Davis Bridge
Habitat	mixed hardwood/pine lowland	mixed hardwood/pine lowland	mixed hardwood/pine lowland
GAAS site identifier	S-3296	S-3295	S-3408
Site ID for this report	SER-1	SER-2	PB-1

(a) (b) (c)

FIGURE 2. Sampling points on the South Edisto River: (a) downstream canoe take-out at Aiken State Natural Area, (b) Keadle Bridge boat ramp, and (c) Pond Branch.

Sampling Locations used by Aiken County Stormwater Division

As reported by the Aiken Standard (Ref. 2), the Aiken County Stormwater Division took samples from the South Fork of the Edisto River and Pond Branch on June 12, 2014, at the following locations.

1. South Fork of the Edisto River at State Park Road.
2. South Fork of the Edisto River at Windsor Road.
3. Pond Branch at Centerville Road.

The samples were analyzed by Shealy Environmental Services, Inc. (Ref. 9).

Sampling Locations used by SC DHEC.

The SC DHEC has water quality monitoring sites at the following locations on the South Fork of the Edisto River near the area of interest to this report (Ref. 1).

Active Base Sites

E-114 South Fork Edisto River where Road S-02-053 crosses

E-011 South For of the Edisto River where SC Hwy 39 crosses the river, near Springfield, SC

Active Random Sites

RS-14209, South Fork Edisto River where S-02-212 (Windsor Road) crosses the River (Note: this site was active in 2014 but is not being monitored in 2015)

Inactive Sites

E-001 (approximately 1 mile southeast of Johnston, SC)
E-002 (approx. 1 ¼ mile downstream of E-001)
E-021 (where SC Hwy 302 crosses the river)
E-090 (where US Hwy 1 crosses the river)
E-113 (approx. 2 mi. above SC Hwy 302 bridge)

Base sites are monitored bimonthly and are used for multiple years. Random sites are monitored monthly, but only for one year. In addition to the analyses performed in this study, SC DHEC also performs the following.

Salinity
Chlorophyll-a
Hardness (calculated)
Turbidity (in NTU)
5-day BOD
Alkalinity
Total Suspended Solids
Calcium, chromium, copper, lead, nickel, zinc, mercury
E. coli Bacteria

APPENDIX B
Experimental Methods

Physical/Chemical Methods.

Air and water temperatures were measured using alcohol-in-glass general purpose thermometers, 0-50 ºC, purchased from Ben Meadows Co., Janesville, WI (Catalogue #8JB-111052) or similar models.

Dissolved oxygen was measured using a field test kit purchased from the LaMotte Company, Chestertown, MD (Catalogue #5860). The kit uses the Winkler method (Ref. 5) for oxygen concentrations in the range 0-15 ppm. In this method, dissolved oxygen reacts with Mn(II) in base to form Mn(IV), followed by reduction of the Mn(IV) with I^- to form I_3^-. The I_3^- is titrated with sodium thiosulfate in the presence of starch to detect the endpoint (loss of blue color).

Nitrate was measured using a test kit purchased from Hach Company, Loveland, CO (Hach Nitrate Kit, Model N1-14, Catalogue #14161-00). The procedure measures the sum of nitrate and nitrite concentrations in the range 0-10 mg/L. Sample preparation includes first reducing nitrate to nitrite with cadmium metal, followed by reaction with sulfanilic acid to form a diazonium salt, followed by reaction of the diazonium salt with chromatropic acid to form a pink colored compound. The concentration is determined by comparison of the sample color to a color wheel.

Ammonia was measured using a test kit purchased from Hach Company, Loveland, CO (Hach Ammonia Kit, Model N1-SA, Catalogue #24287-00). The test kit measures the sum of ammonium ion and aqueous ammonia concentrations in the range 0 to 2.5 mgN/L (0-3.0 mg NH_3/L). The method is based on the hypochlorite oxidation of ammonia to chloramine, followed by reaction of chloramine with salicylate to form 5-aminosalicylate, followed by the nitroprusside catalyzed reaction of 5-aminosalycilate to indosalicylate. The green indosalicylate concentration is determined by comparison of the sample to a color wheel.

Phosphate ion was measured using a test kit purchased from Hach Company, Loveland, CO (Hach Ortho Phosphate Kit, Model 10-19, Cat. No. 2248-00). The kit measures phosphate concentrations in the range 0-50 mg/L. The test instructions suggest a lower limit of 0.06 mg/L, although the color wheel does not allow eyeball estimates below 0.2 mg/L of phosphate. The method is based on the reaction of phosphate with molybdate in acid to form a phosphomolybdate complex that is reduced using ascorbic acid to a molybdenum blue complex. The concentration is determined by comparison of the blue solution to a color wheel.

Conductivity was measured using a Hanna Instruments Model DiST-5 hand-held conductivity meter with temperature compensation (Catalogue #88230). Calibration using a 1413µS/cm KCl/NaCl standard (Catalogue #23759) occurred prior to use. Both items were purchased from Ben Meadows, Jamesville, WI.

Imhoff cones were used to measure settleable solids. Samples (1.0 L) were allowed to settle for 45 minutes before measuring the volume of the settled solids. The quantification limit was approximately 0.1 mL solids/ L sample. If settled solids were visible but less than 0.1 mL in volume, the result was recorded as "trace".

Water transparency was measured with a 120-cm transparency tube purchased from Ben Meadows. The 1 ¾ inch diameter clear plastic tube has a Secchi pattern at the bottom. The tube is filled to 120-cm with sample, and sample is drained from the bottom until the Secchi pattern becomes visible when looking down the tube. The height of the remaining water column is recorded to the nearest centimeter. In many cases, the Secchi pattern is visible with the tube completely filled (120 cm).

Distribution

1. Barbara Thomas, Audubon South Carolina, Harleyville, SC
2. Norm Brunswig, c/o Audubon South Carolina.
3. Kathy Rawls, Aiken County Council.
4. Tim Rogers, Friends of the Edisto.
5. Paul Koehler, Silver Bluff Audubon Center and Sanctuary, Jackson, SC
6. Seirisse Baker, Georgia Department of Natural Resources, Environmental Protection Division, Atlanta, GA
7. Tabatha Corley, SCDHEC, Region 5, Environmental Quality Control, Aiken, SC
8. Andy Miller, SCDHEC
9. Bill Marshall, DNR
10. Robert Mahoney, State Park Service, Aiken State Natural Area
11. Co-authors