



Cumberland Piedmont Network Water Quality Report; Third Serial

Carl Sandburg Home National Historic Site



ON THE COVER

Side Lake, September 4, 2001

Photograph by: Joe Meiman

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Carl Sandburg Home National Historic Site

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Introduction

This is the third report on water quality of Carl Sandburg Home National Historic Site (CARL) generated by the Cumberland-Piedmont Network (CUPN) Water Quality Monitoring Program (contact the CUPN office for details on program design). The first report, submitted to the park in February 2005, presented the initial results of the water quality inventory, beginning in December 2002. The second report included these data along with those collected during fiscal year 2005. This report includes those early findings as well as data gathered in fiscal year 2007 and displays the results in graphic form (accompanied with a brief interpretation), and concludes with a water quality summary and recommendations. Water quality is measured four times per year (quarterly) on alternate years at four sites; Mountain Reservoir, Front Lake, Trout Spring, and Side Lake. Based upon program requirements and findings of the water quality inventory, a set of parameters were chosen for long-term monitoring; including the field measures of water temperature, specific conductance, pH, dissolved oxygen and discharge. Samples were also collected for laboratory analysis for bacteria (*Escherichia coli*) and acid neutralizing capacity. An additional sample was collected from one site per round as a quality assurance – quality control provision.

Sampling Sites

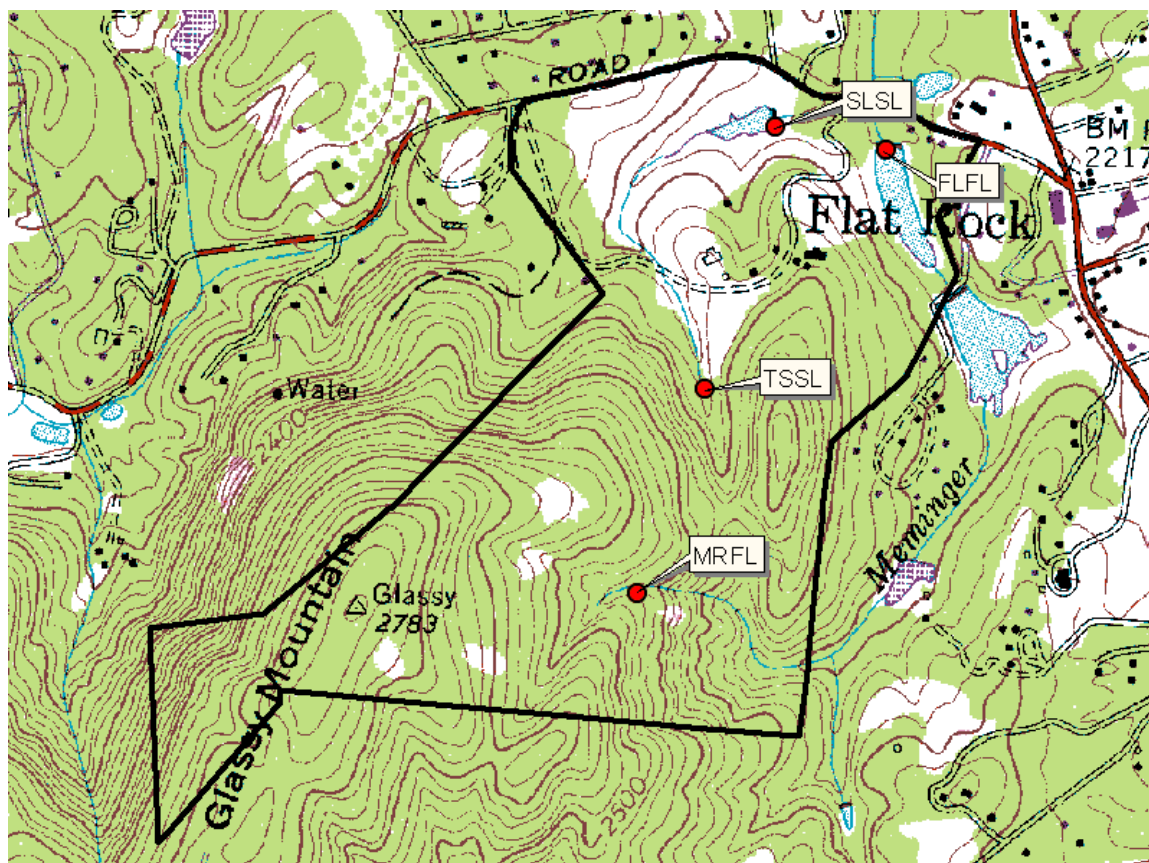


Figure 1. Map of water quality sampling sites at CARL
Description of Sampling Sites

Trout Pond Spring (TSSL)

Located approximately 100 meters upstream of the Trout Pond. This small, perennial spring is the headwater of the Side Lake watershed. The spring was “improved” several years ago by the NPS. The spring was buried under rubble and a spring-box was constructed with an 8,000 gallon underground supply tank that feeds the barn operation via a buried pipe.

Side Lake (SLSL)

Located on the northern edge of the park, this man-made lake is the extreme downstream end of the Side Lake watershed. The lake is fed in part by waters of Trout Pond Spring and an unnamed non-park tributary.

Mountain Reservoir (MRFL)

Located in the southern uplands of the park, this small pond is fed by a small stream originating from small springs in undeveloped woodlands both in and adjacent to the park. This site represents the headwaters of the Front Lake watershed.

Front Lake (FLFL)

Located on the northeastern edge of the park, this man-made lake is the extreme downstream end of the Front Lake watershed. The lake is fed in part by the waters of the Mountain Reservoir which flows as Meminger Creek through the Ravenswood community before entering Front Lake.

Stream Designated Uses

Each water body sampled within the CUPN has either been assigned a designated use by the state, or, by using the same ranking criteria, by this author. The USEPA, besides mandating these rankings, also directed the states to develop water quality standards for each designated use. We can use these water quality standards as a minimum to track water quality trends in CUPN parks. By adapting the state standards, we can also track park water quality trends within the states, regions, or watersheds. New NPS nationwide GPRA goals are now tied to state water quality standards and designated uses. For more information on North Carolina water quality standards, please see:

North Carolina: Subchapter 2B – Surface Water and Wetland Standards, 15A NCAC 02B .0100 - .0510.

Table 1. The table below shows that none of the park’s four sites are officially listed – a state is not required to list designated uses for all waters. The author, using the same criteria used by the state process, “listed” designated uses for each site for purposes of water quality comparison.

<i>Park</i>	<i>Code</i>	<i>Site</i>	<i>State</i>	<i>Designated Use</i>
CARL	TSSL	Trout Pond Spring	NC	HQW (High Quality Waters)
CARL	SLSL	Side Lake	NC	Class WS-II (Water Supply)
CARL	MRFL	Mountain Reservoir	NC	HQW (High Quality Waters)
CARL	FLFL	Front Lake	NC	Class WS-II (Water Supply)

Results

Quarterly sampling commenced in December 2002 and continued until September 2003. After a one-year hiatus four more rounds were collected between November 2004 and August 2005. After another one year pause quarterly samples were taken between November 2006 and August 2007. This annual “off and on” sampling routine follows a set rotation. A total of 12 sampling events have been completed through this program.

Water quality results are displayed in time series graphs showing all data for each site for a given parameter. As the Water Quality Program continues, trends will emerge from these time series graphs – some are beginning to show at this time.

Water quality results are displayed in time series graphs showing all data for each site for a given parameter. The data gaps are caused by the planned one-year pause in sampling. The datasets for ANC (acid neutralizing capacity) and *Escherichia coli* are abbreviated as they represent new protocols which are not directly comparable with old methods.

If state standards exist for a particular parameter they will be displayed. In addition, in a cursory attempt to show an element of data error, each plot is assigned error bars, representing the minimum potential error associated with the measurement.

Over the years a set rotational program such as this should sample extremes of the flow continuum; from flood to drought and the common flows in between. Throughout the southeastern United States a drought persisted during the late summer and autumn of 2007. Streams of the Piedmont and foothills of the Blue Ridge were greatly reduced in flow (some dried out completely) as the drought went from moderate, through severe and into extreme levels. These low flow conditions are reflected in flow conditions and water quality taken during this period.

As a final note to this preamble, special recognition to Shepard McAninch, CUPN Ecologist/Data Manager, who collected and analyzed these samples over the years. Also allow me to acknowledge the excellent support of CARL management and staff in assisting Shepard in the field. Inclusion of fine people like Irene Van Hoff in the monitoring process helps our program immensely. The efforts of CUPN Data Manager, Brenda Wells are greatly appreciated as well. The generation of accurate field measures and careful management of the data are not only critical to this program, but also make reporting an easier task.

Water Temperature

Water temperatures at CARL are considered to be within range to support native aquatic life. The compressed temperature range at Trout Spring (TSSL) is a function of longer retention times of groundwater recharging the spring. This attenuation is seen to a less extent at Mountain Reservoir (MRFL). North Carolina designated use standards for both HQW and WS-II waters state that temperature cannot exceed natural conditions by more than 2.8°C , nor above 29°C . Side Lake reached this limit and Front Lake was very close – the latter is more shaded than the former. These high temperatures are a direct result of the prolonged drought and high temperatures of the summer of 2007.

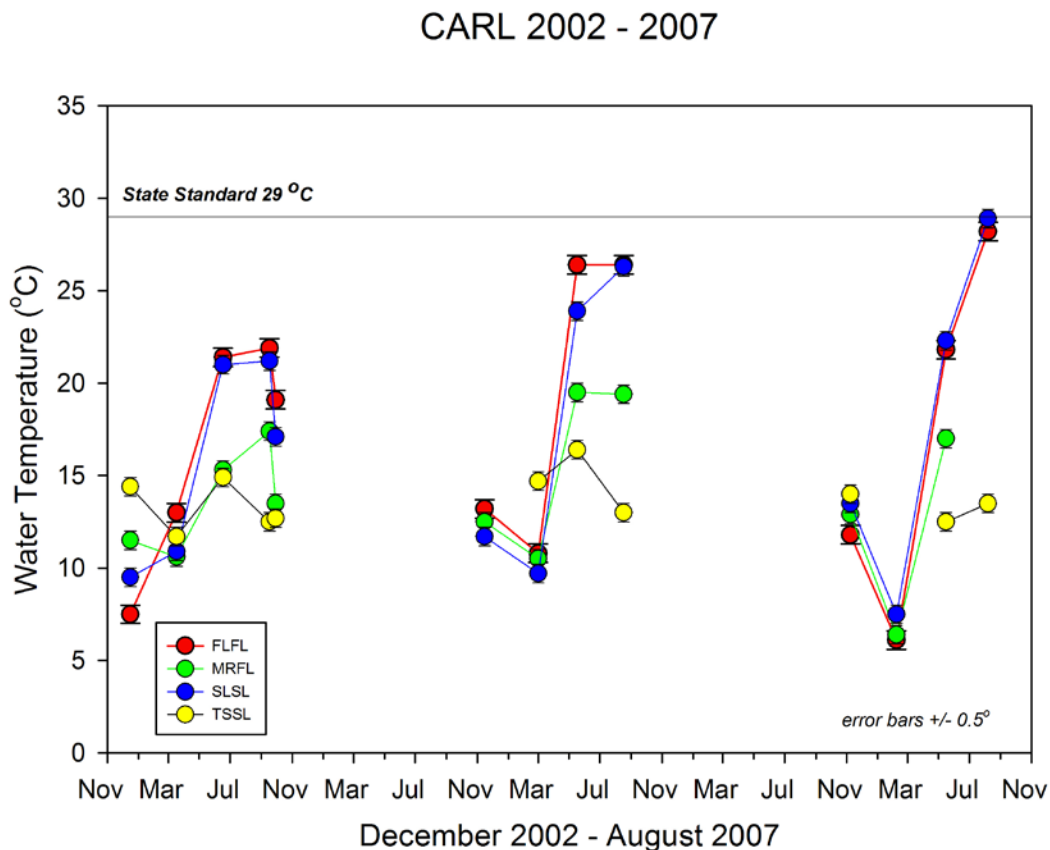


Figure 2. Water Temperature at CARL

Specific Conductance

The distribution of specific conductance (SpC) at CARL, like anywhere, is a function of the amount of dissolved ions in the water. The very low SPC values at TSSL and MRFL represent the emergence of groundwater (springs) flowing through relatively insoluble rock. There is not much of an opportunity to dissolve mineral species into the water. The higher SpC values at MRFL in May 2005 is somewhat a mystery. Its QA-QC duplicate was out of range (>10% tolerance) and not supported by other parameters. The most probable explanation is sensor or operator error. As the streams flow down to their lakes, Side (SLSL) and Front (FLFL), they pick up a moderate amount of dissolved ions and their SpC increases. The larger and more developed watershed of FLFL is reflected by consistently higher SpC values. There is no state standard for SpC.

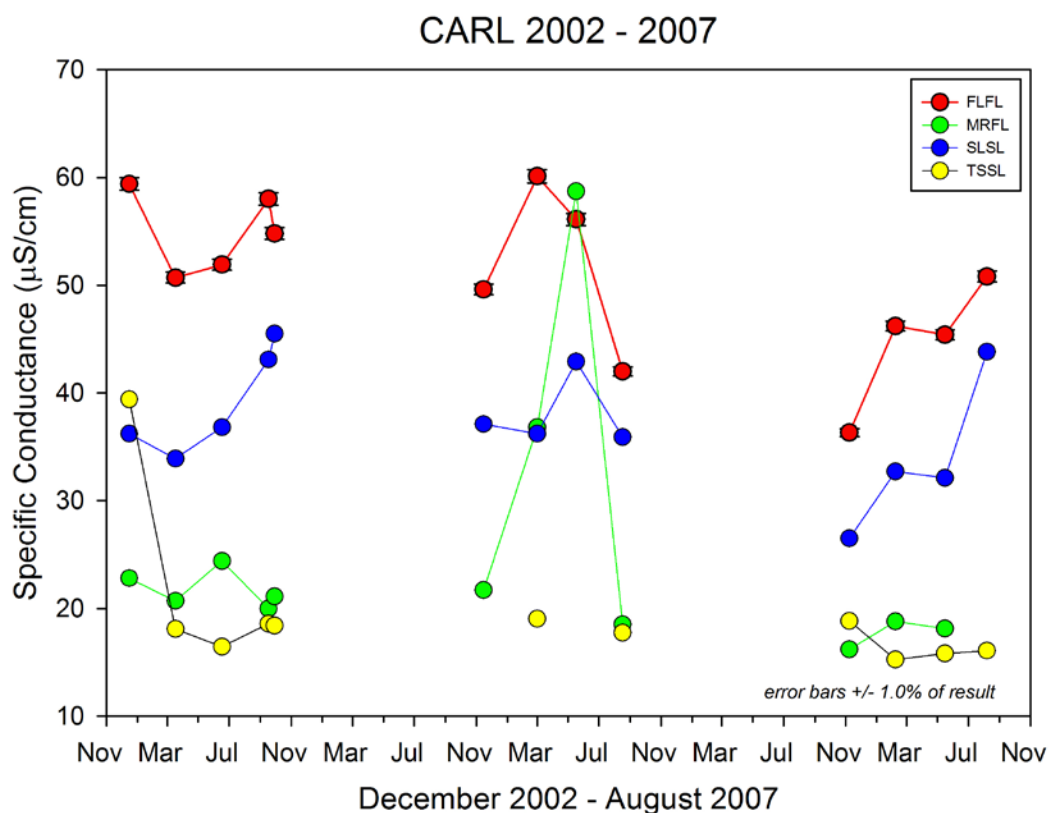


Figure 3. Specific Conductance at CARL

pH

Waters of CARL are slightly to moderately acidic. The sites higher within a particular watershed are more acidic than lower sites. This may be an effect of contributing basin size – that is, sites like TSSL and MRFL are at their headwaters and as they emerge from the granitic bedrock are naturally acidic and have little or no contact with buffering agents. The less acidic waters of FLFL and SLSL, as will be seen in the forthcoming ANC graph, is due to a higher load bicarbonates, which buffer the effects of the acids. State standard for freshwater pH is between 6.0 and 9.0 SU. We can see that both spring sites are below the lower state pH range. As these springs are recharged in a buffering-limited environment, this low pH is most likely natural. Both lake sites, and especially Side Lake, dropped below the 6.0 limit in 2005. It appears that these low values were short-lived as they were not seen in FY 2007. This gradual increase in pH during the drought has been observed in other naturally low-pH waters of the CUPN.

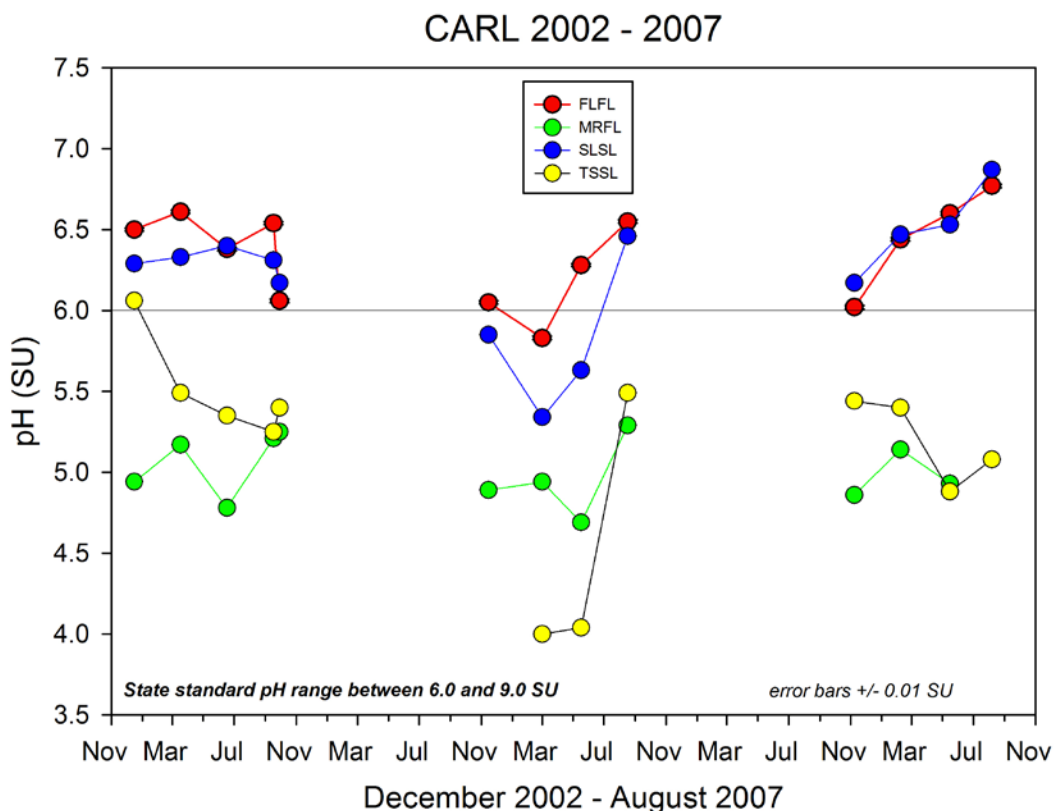


Figure 4. pH levels at CARL

Dissolved Oxygen

Dissolved oxygen, in all samples, was above the state limit of 5.0 mg/l. There were a few readings at MRFL and one at FLFL that approach this limit. These low readings all occurred during the warmer summer months when water cannot dissolve as much oxygen as when it is cold. In general, DO levels, while still above state standards, were slightly lower in FY 2007 as a consequence of the long, hot drought.

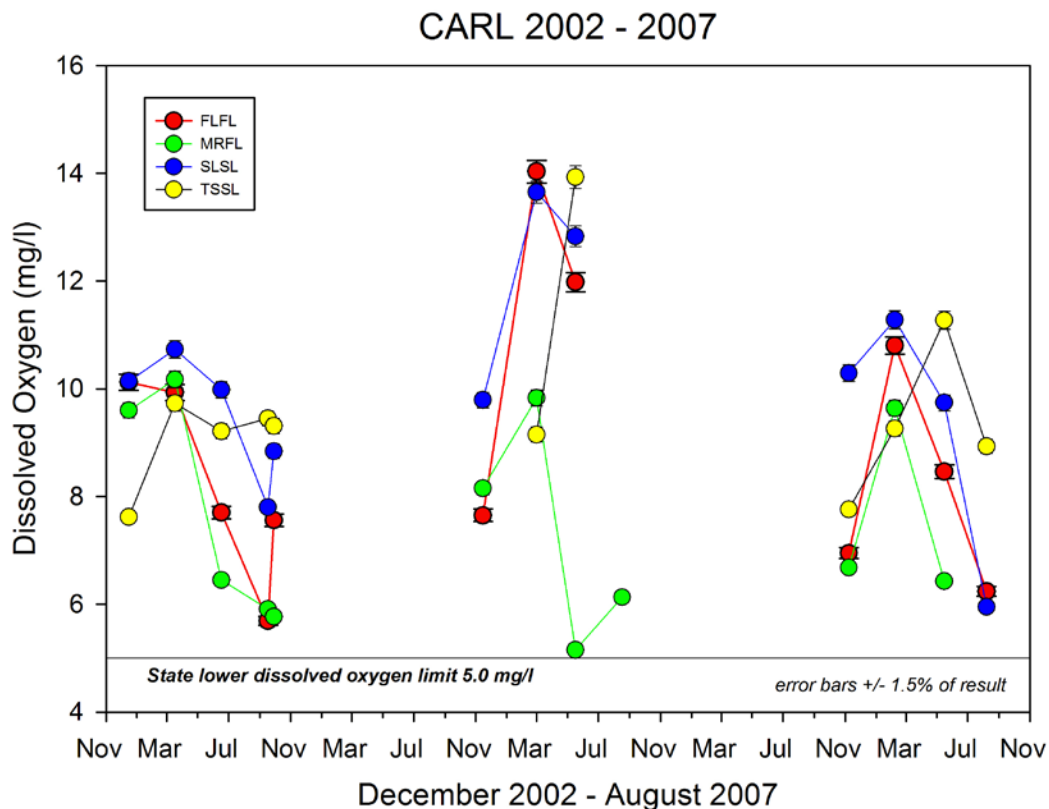


Figure 5. Dissolved Oxygen levels at CARL

Acid Neutralizing Capacity

This graph shows only the four sampling rounds of FY 2007. During protocol review a better method was adopted for ANC analysis. Old data are not included in this graph as their accuracy is doubtful. Acid neutralizing capacity (ANC) of CARL waters is fairly low to very low, indicating a lack of contact with carbonate strata or other sources of the bicarbonate ion. As the streams flow to the lakes a small amount of bicarbonates are acquired and the ANC increases. Low ANC levels make waters more susceptible to acid precipitation as there are limited amounts of bicarbonates available to counter additional acids. This is a primary reason to believe the low pH of CARL waters is natural. It is not known why the November 2007 ANC value at Front Lake (FLFL) was four to five times higher than normal. There is no state standard for ANC.

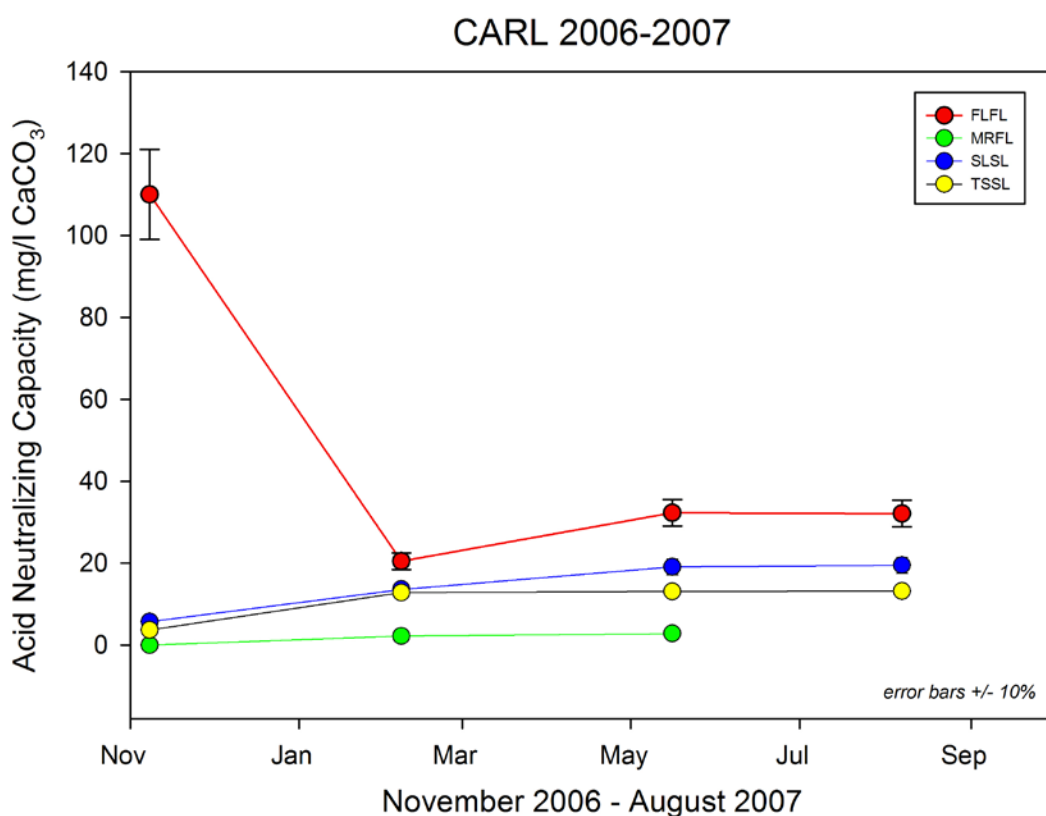


Figure 6. Acid Neutralizing Capacity at CARL

Bacteria

Similar to the truncated ANC graph, the record of bacteria presented below is limited. During protocol review it was determined that the fecal coliform tests originally done were both highly variable and not as representative as an indicator bacteria as *Escherichia coli* (*E. coli*). While the park does not promote recreational contact with its waters we have included this measure to monitor what should be a natural bacteria level.

The North Carolina standard for WS-II and HQW for fecal coliform is a geometric mean of 200 colonies/100 ml of not less than 5 samples taken within a 30 day period. As the program does not conduct high-frequency sampling we must look for a single sample standard. The USEPA recommends a single sample *E. coli* standard for limited contact waters as 576 CFU (colony forming units) per 100 ml.

In general, coliform bacteria levels at CARL are among the lowest within the CUPN. Similar to dissolved ions, the upper-basin sites (the springs) were lower in bacteria, as additional microbes were added to the streams as they made their ways to the lakes. The higher levels at Front Lake (FLFL) is derived from the Memminger Creek portion outside the park or from domestic animal waste proximal to Front Lake within the park.

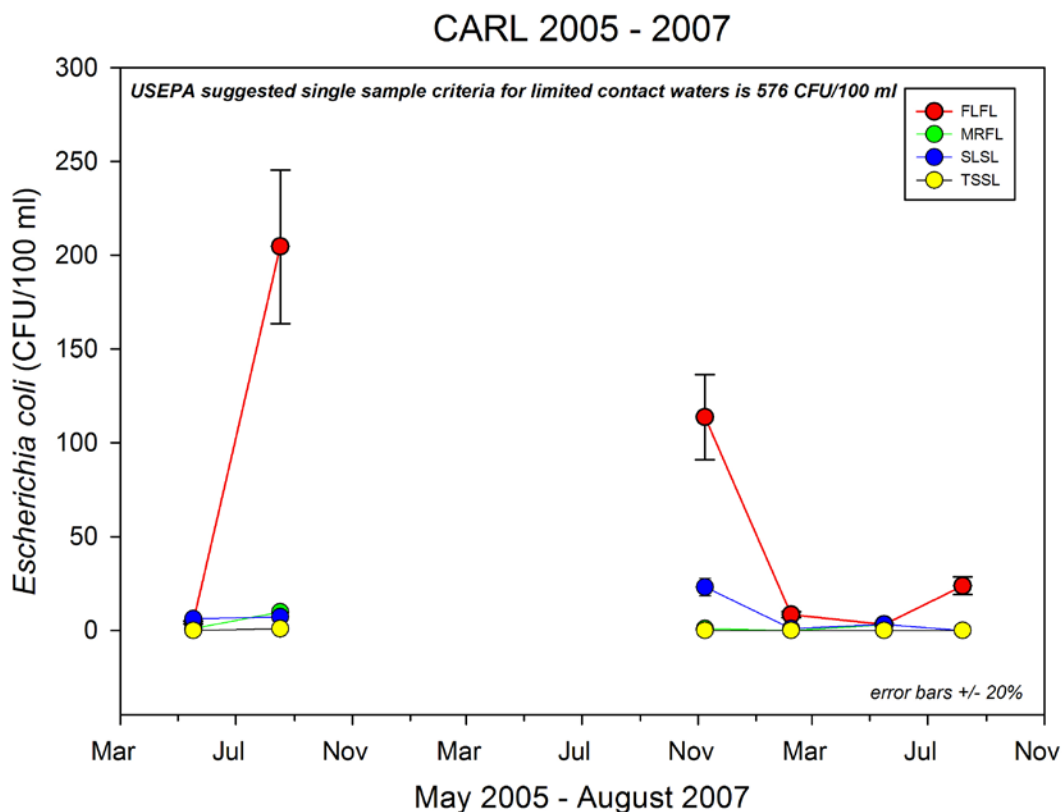


Figure 7. Bacteria levels at CARL

General Water Quality Status

The water quality of the four sites sampled at CARL is very good. It remains the highest quality water found in the CUPN. It is obvious that the pH of Trout Spring and Mountain Reservoir are below the state standard of 6.0 SU. In the most general sense this is a violation of standard for Class WS-II and HQW, thus non-attainment of designated uses under the Clean Water Act. It is my belief that the waters of CARL, due to their headwater position within a granitic watershed are naturally acidic – at or below 6.0 SU. This is supported by low ANC values. North Carolina, as with most states sensible to natural hydrologic conditions has a provision in its statutes for waters which are naturally in violation of standards. *15A NCAC 02B .0205 Natural Characteristics Outside Standards Limits* states “Natural waters may on occasion, or temporarily, have characteristics outside of the normal range established by the standards. Water quality standards will not be considered violated when values outside the normal range are caused by natural conditions.”

The new bacteria protocol, as with data from the old fecal coliform protocol, shows that Front Lake has the highest bacteria levels found at CARL. These levels are not exceptionally high but do warrant future monitoring.

Future Water Quality Monitoring Recommendations

The CUPN is required in accord with the national water quality program to monitor water temperature, specific conductance, pH, and dissolved oxygen. In addition, there is sufficient reason to continue to monitor *Escherichia coli* and ANC. Although these two parameters are generally below state water quality standards (where they exist), long-term data may serve to alert the park to impending water quality issues.