



Cumberland Piedmont Network Water Quality Report: Third Serial

Ninety Six National Historic Site



ON THE COVER

Star Fort Lake, September 8, 2001

Photograph by: Joe Meiman

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Ninety Six National Historic Site

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Introduction

This is the third report on water quality of Ninety Six National Historic Site (NISI) 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 January 2004. The second report (January 2007) included those early findings as well as data gathered in fiscal year 2006. This report will include those early findings as well as data gathered in fiscal year 2008 and display these results in graphic form (accompanied with a brief interpretation), and concludes with a water quality summary and recommendations. All data presented in this report were generated by CUPN Ecologist/Data Manager Shepard McAninch.

Water quality is measured four times per year (quarterly) on alternate years at four sites; Star Fort Lake, Tolbert Branch, and the East and West boundary crossings of Henley Creek. 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, and dissolved oxygen. Samples were also collected for analysis for *Escherichia coli* and acid neutralizing capacity (ANC). An additional sample was collected from one site per round as a quality assurance – quality control provision.

Sampling Sites

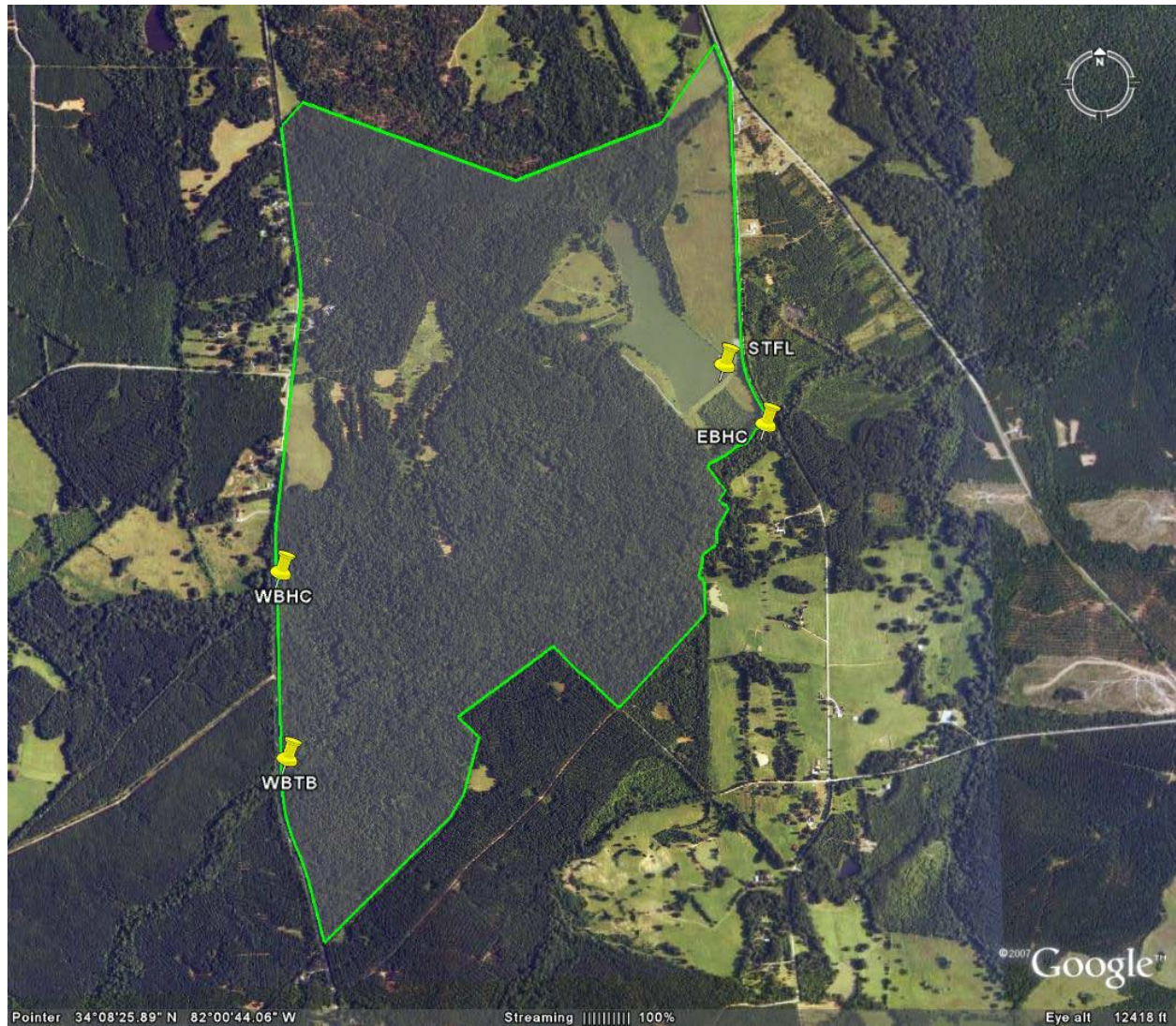


Figure 1. Map of water quality sampling sites at NISI

Description of Sampling Sites

Henley Creek, East Boundary (EBHC)

Located along the southern edge of the park, Ninety Six Creek is the largest stream in the park and sampled as the stream exits the park to the east.

Star Fort Lake (STFL)

This ten-hectare lake is located in the northeastern portion of the park. This site is sampled at the outlet of the lake's discharge pipe.

Tolbert Branch (WBTB)

A tributary of Ninety-Six Creek, Tolbert is sampled as it enters the park at the western boundary.

Henley Creek, West Boundary (WBHC)

A tributary to Ninety-Six Creek is sampled as it enters the park along the western boundary.

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. For more information on South Carolina water quality standards, please see:

South Carolina: Water Classifications and Standards (R.61-68) Classified Waters (R.61-69).

Table 1. The table below shows that only Henley Creek is officially listed. Other water bodies of NISI were "listed" (those sites in red text) by the author using the same criteria used by the state.

<i>Park</i>	<i>Code</i>	<i>Site</i>	<i>State</i>	<i>Designated Use</i>
NISI	WBHC	West Boundary Henley Creek	SC	Freshwater
NISI	EBHC	East Boundary Henley Creek	SC	Freshwater
NISI	WBTB	West Boundary Tolbert Branch	SC	Freshwater
NISI	STFL	Star Fort Lake	SC	Freshwater

Results

Quarterly sampling commenced in April 2004 and continued until January 2005. Regular FY04 sampling schedule was postponed one quarter (and thus extended one quarter into FY05) due to an injury of Shepard McAninch. After a ten-month hiatus four more rounds were collected between October 2005 and July 2006. Following the scheduled biennial pause, sampling began again in October 2007 and ending in July 2008, for a total of 12 sampling rounds

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 between sampling series. As the Water Quality Program continues, trends may emerge from these time series graphs.

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.

It is important that the reader know that much of the Carolina Piedmont has experience drought conditions through 2007 and 2008. Flow conditions for every month except February 2008 were very low.

Water Temperature

Water temperatures of NISI are considered to be within range to support native aquatic life. The quarterly sampling shows a coarse seasonal temperature signature, with the coldest temperatures associated with the January sample and the highest with the July sample. Temperatures at all four sites responded to the cold winter rains of February 2008. The maximum allowable freshwater temperature for a South Carolina stream is 32.2 °C, or more than 2.8 °C above natural conditions.

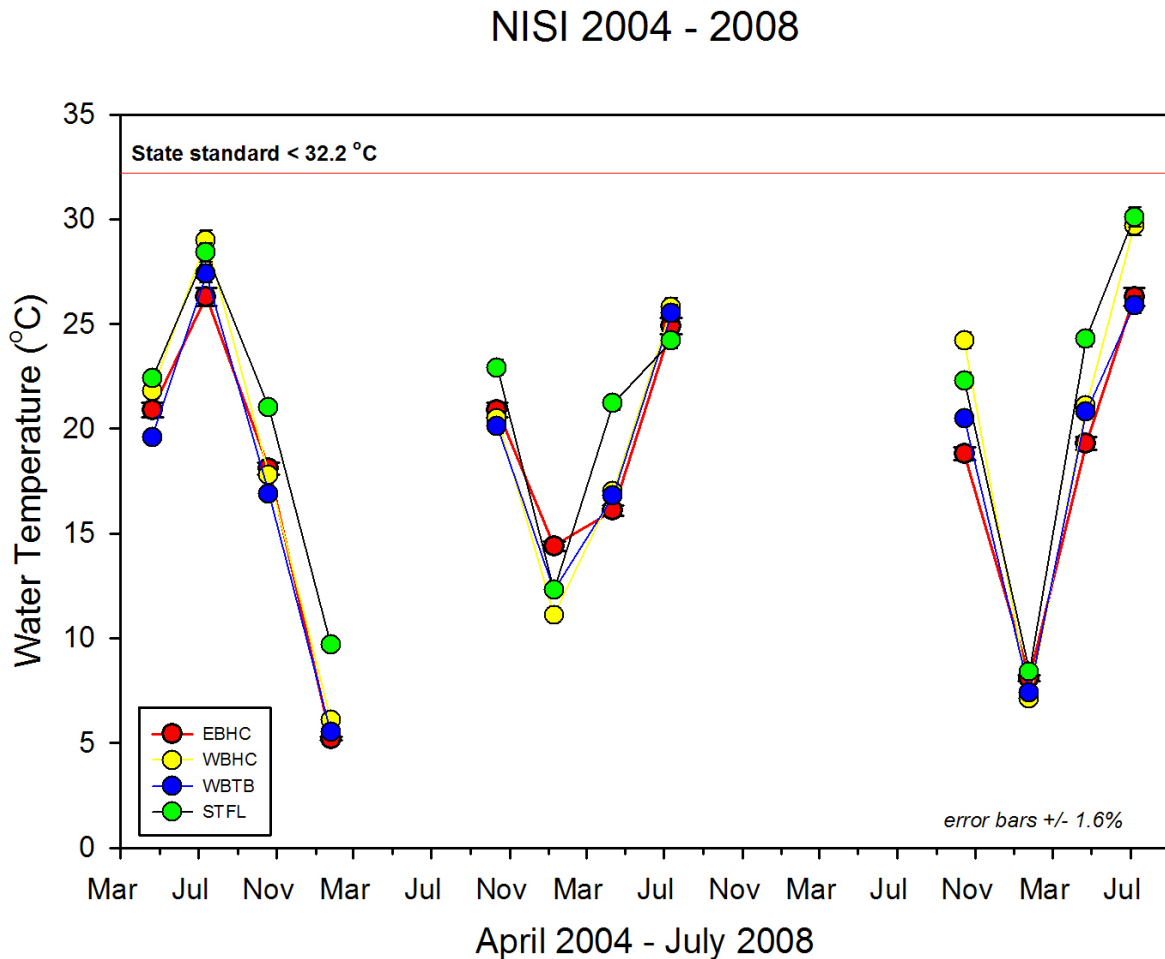


Figure 2. Water Temperature at NISI

Specific Conductance

The distribution of specific conductance (SpC) of NISI is reflective of moderate ionic-strength waters. In general, the more dissolved ions in the water, the higher the SpC. There is an overall decrease in park-wide SpC during the FY06 sampling year. This may be due to generally higher flow conditions when compared to the FY04 effort. It is common that higher flow corresponds to low ionic strength as the water is somewhat diluted. The reverse is seen during the last round of sampling as the region was experiencing a drought, thus low flows and higher SpC. There is no SpC standard for South Carolina.

NISI 2004 - 2008

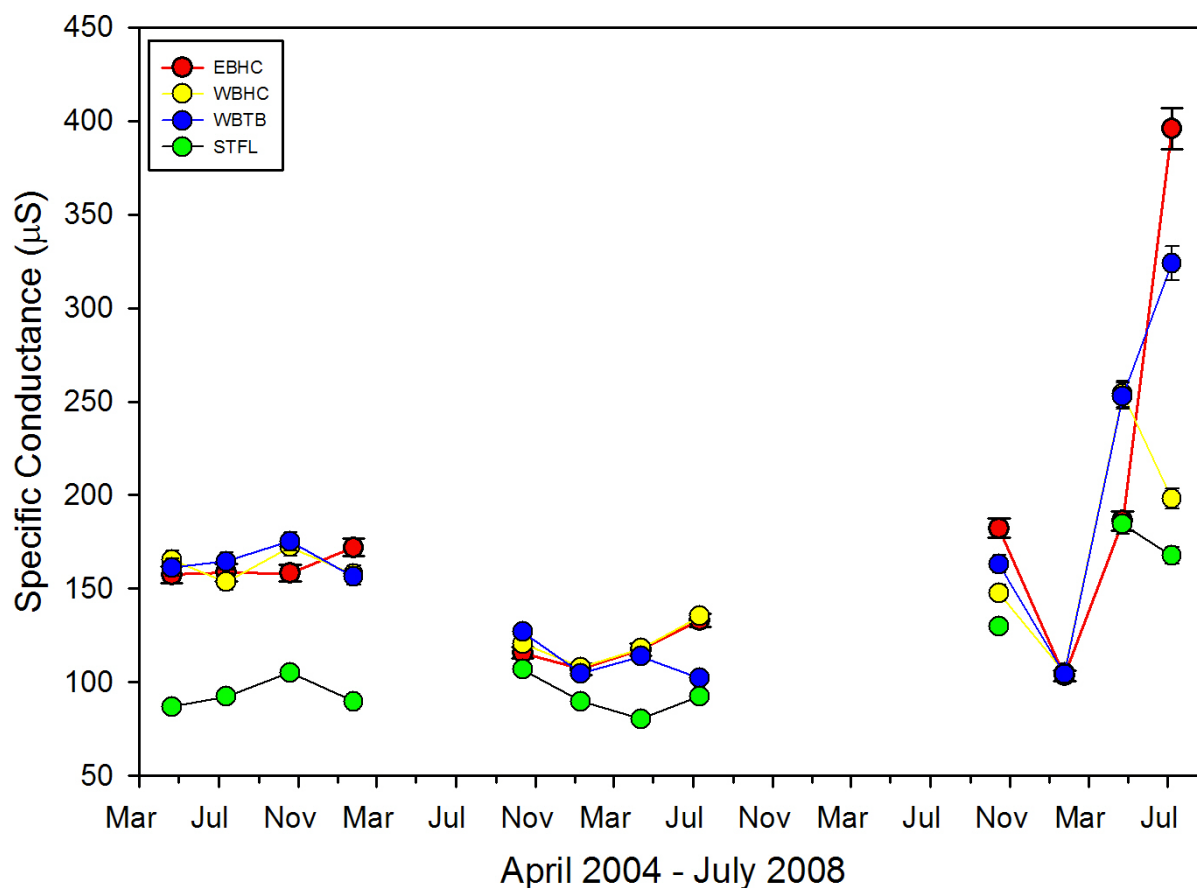


Figure 3. Specific Conductance at NISI

pH

Waters of NISI range from slightly acidic to moderately basic. South Carolina freshwater standards set pH limits between 6.0 and 8.5 SU. It is likely that the low pH readings for the January 2005 sample at West Boundary Tolbert Creek (WBTB) is due to equipment/operator error. This possibility is given credibility when the QA/QC pH values are reviewed. The WBTB site was sampled twice during the January round and there is a 0.6 SU difference between the two – beyond acceptable quality tolerance. It appears that the pH of Star Fort Lake (STFL) rises to and sometimes above the state upper limit of 9.0 SU. It is possible that the cause of the increased pH is a product of photosynthesis of algae in the lake. If photosynthesis consumes more CO_2 than can be atmospherically in-gassed into the lake, plants will begin to use other dissolved carbonates such as H_2CO_3 , HCO_3^- and CO_3^{2-} . The end result is the production of hydroxyl ions which raise the pH.

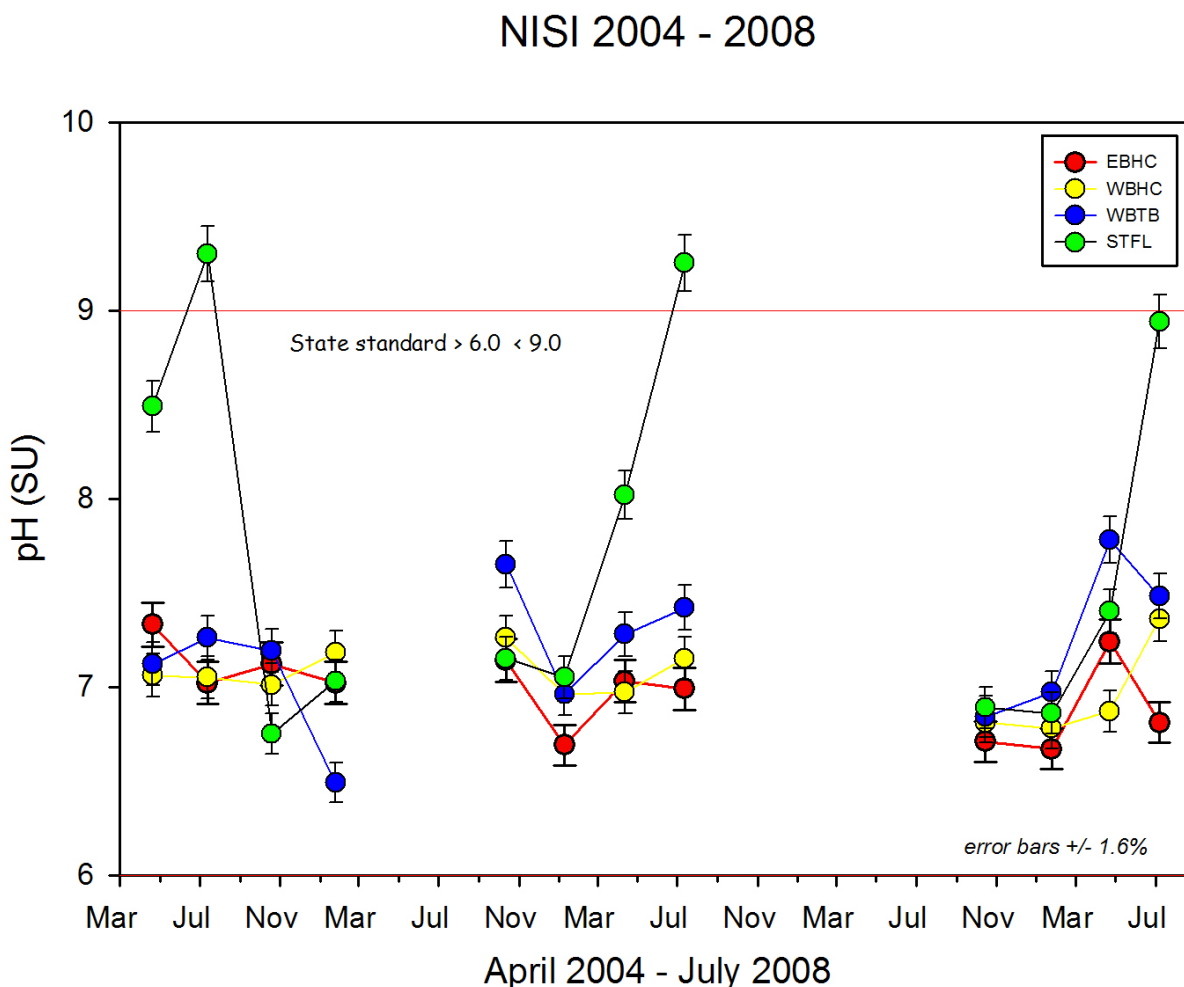


Figure 4. pH at NISI

Dissolved Oxygen

The waters of NISI typically meet the state requirements of at least 4.0 mg/l dissolved oxygen. The apparent low DO values seen at Star Fort Lake during the first round are artifacts of an undesirable sampling site. On two other occasions the DO of East Boundary Henley Creek dipped below the state limit. In both occasions the stream had ceased to flow and a sample was taken in a stagnant pool in the streambed.

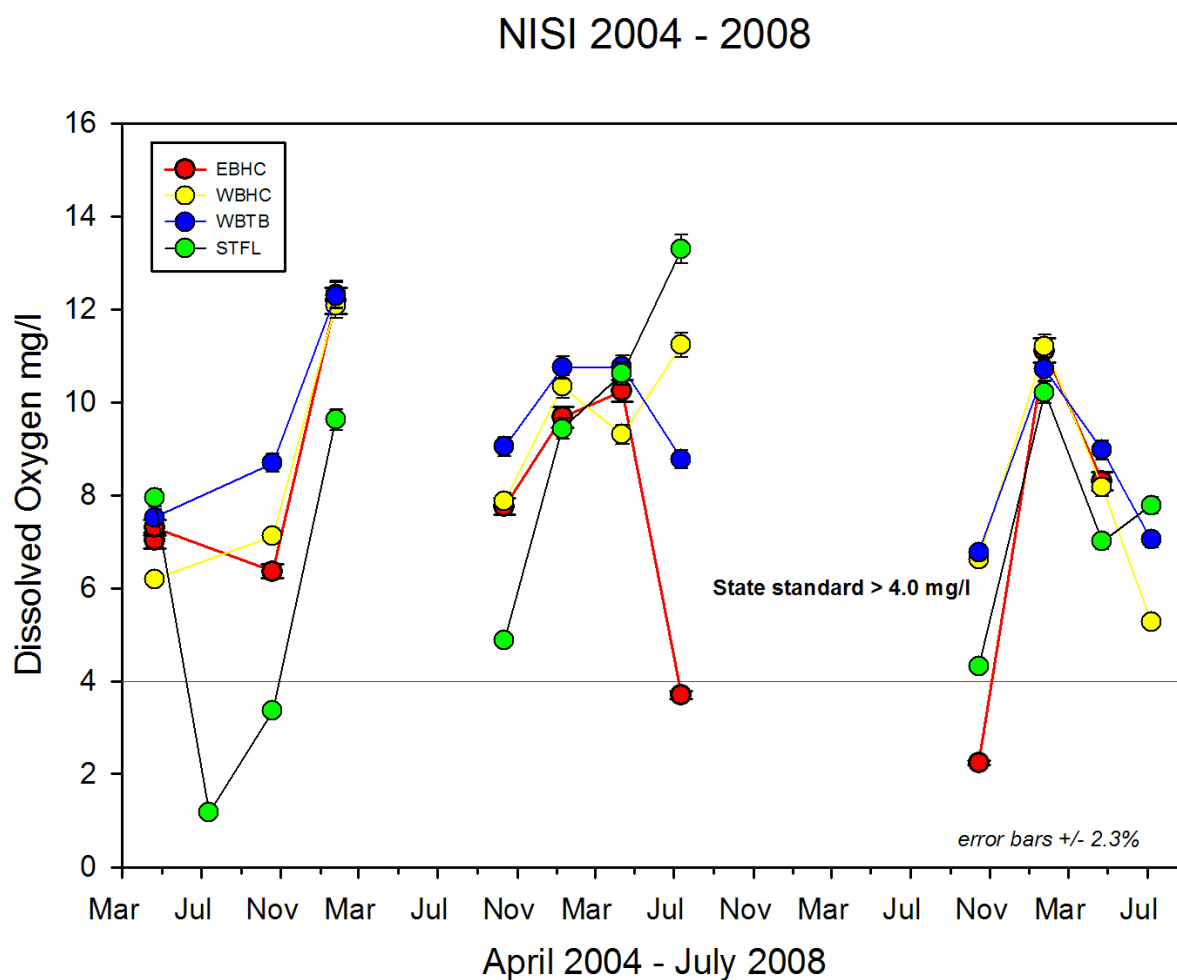


Figure 5. Dissolved Oxygen at NISI

Acid Neutralizing Capacity

Low Acid Neutralizing Capacity (ANC) levels make waters more susceptible to acid precipitation as there are limited amounts of bicarbonates available to counter additional acids. In general ANC values at NISI are sufficient to buffer additional acids and should not be greatly influenced by acid precipitation. The general increase in ANC during FY 2008 is a reflection of the drought. The longer water is in contact with rock, the greater the opportunity to dissolve the rock – including bicarbonates. The runoff produced from the rainfall event in February 2008 is the inverse, as the water had little interaction time with the rock. A nearly identical pattern is seen in SpC data. There are no state standards for ANC.

NISI 2004 - 2008

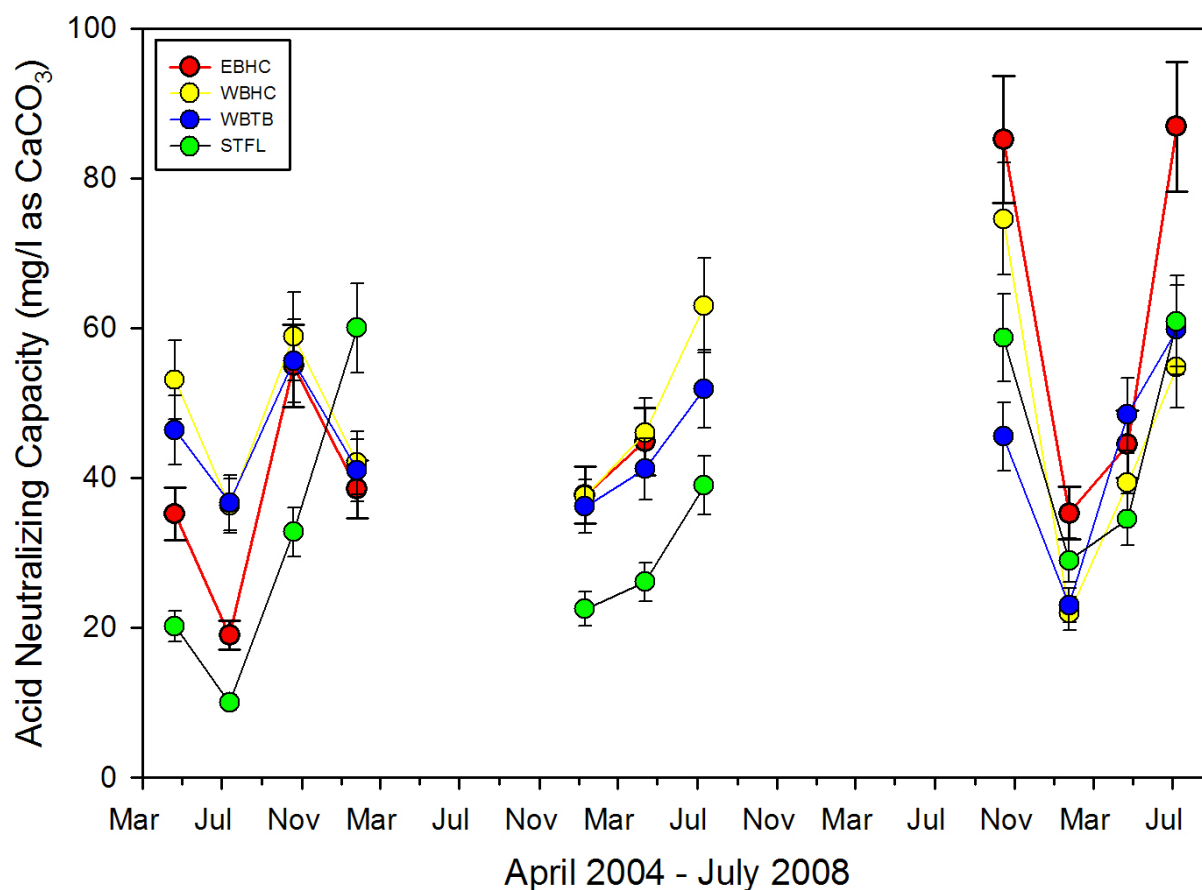


Figure 6. Acid Neutralizing Capacity at NISI

Bacteria

In general, *Escherichia coli* bacteria levels at NISI are low to moderate. The likely bacteria source is animal waste – both livestock and wildlife. West Boundary Henley Creek (WBHC), is sampled where the stream enters the park, and routinely has the highest *E. coli* levels. Single spikes, as seen in the October 2007 sample, can be caused by an animal (domestic or otherwise) “visit” upstream of the sampling site prior to sample collection. At first one might expect that very low *E. coli* numbers should accompany a drought as there is no runoff to carry bacteria into the stream. Although the streams are barely flowing, if at all, it appears that wildlife is concentrated at the streams during drought, thus easily contaminating the streams.

NISI 2005 - 2008

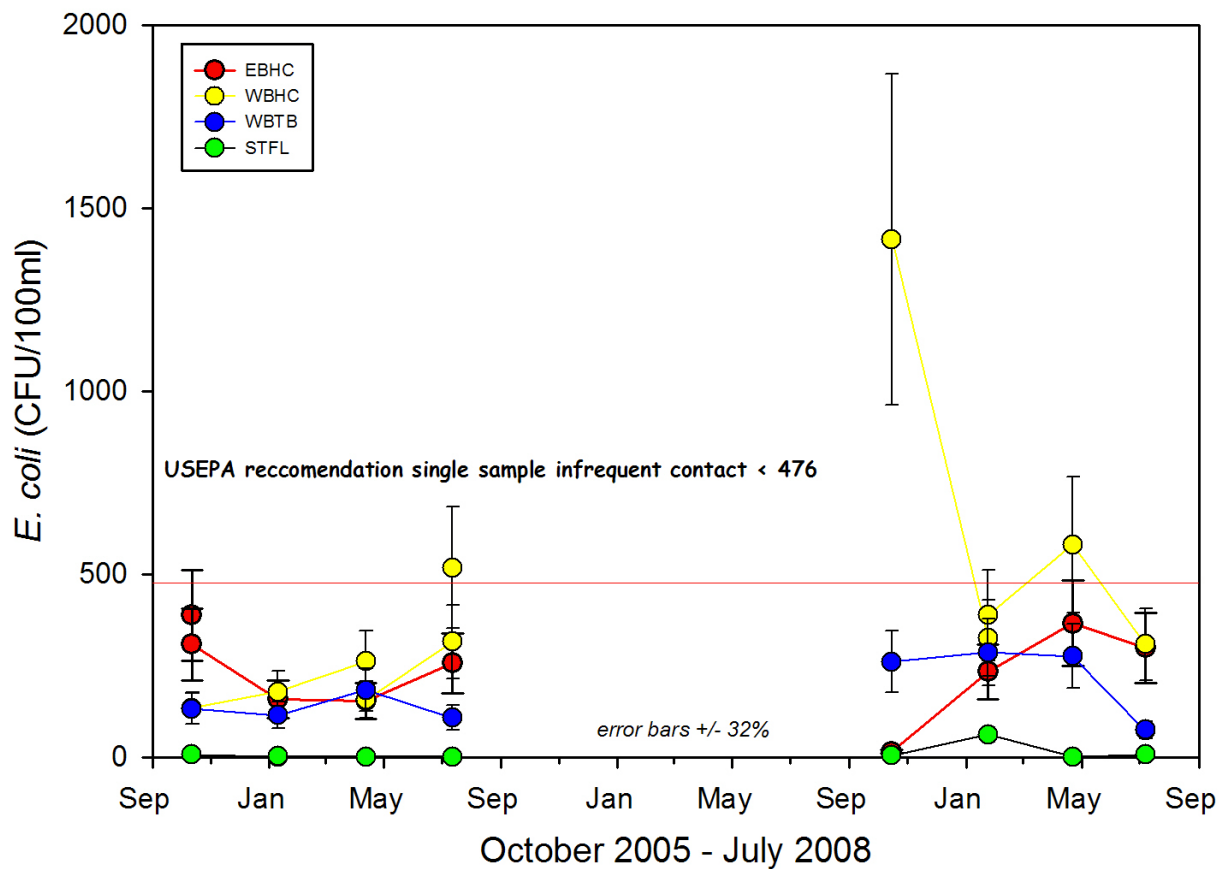


Figure 7. Bacteria at NISI

General Water Quality Status

In spite of the long drought, water quality of NISI is good. There are times where the USEPA *E. coli* recommended single sample for infrequent contact (<476 CFU/100ml) is exceeded in West Boundary Henley Creek (the state has no *E. coli* standard). It will be interesting to see if these values fall when the drought is finally broken.

The low Dissolved Oxygen in East Boundary Henley Creek and high summer pH in Star Fort Lake are not considered violations of state standards. South Carolina Water Classifications and Standards Regulation 61-68 allows “for the exception to be used for waters of the State that do not meet the numeric criteria established for the waterbody due to natural conditions.

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. As *Escherichia coli* levels have exceeded recommended standards, this parameter will continue for at least one more sampling year. This group of parameters should be sufficient to monitor the general water quality of NISI. It is recommended that ANC monitoring at NISI be discontinued, as it appears waters of NISI have sufficient buffering capacity. NISI will be re-sampled in FY 2010 in accordance with the CUPN Water Quality Monitoring Program.