



Cumberland Piedmont Network Water Quality Report; Third Serial

Kings Mountain National Military Park



ON THE COVER

Shepard McAninch samples Garner Branch, December 2002.

Photograph by: Joe Meiman

Cumberland Piedmont Network Water Quality Report; Third Serial *Kings Mountain National Military Park*

Joe Meiman
National Park Service
P.O. Box 8
Mammoth Cave, KY 42259

January 2008

U.S. Department of the Interior
National Park Service
Southeast Regional Office
Atlanta, Georgia

Views and conclusions in this report are those of the authors and do not necessarily reflect policies of the National Park Service. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the Cumberland Piedmont I&M Network website or searching the NPS Integrated Resource Management Applications website.

Please cite this publication as:

Meiman, Joe 2008. Cumberland Piedmont Water Quality Report; Third Serial: Kings Mountain National Military Park. National Park Service, Atlanta, Georgia.

January 2008

Contents

	Page
List of Figures	iv
Introduction.....	1
Sampling Sites	2
Description of Sampling Sites	2
Stream Designated Uses	3
Results.....	4
General Water Quality Status	12
Future Water Quality Monitoring Recommendations	12

Figures

	Page
Figure 1. Map of water quality sampling sites at KIMO	2
Figure 2. Water Temperature at KIMO	5
Figure 3. Specific Conductance at KIMO.....	6
Figure 4. pH levels at KIMO	7
Figure 5. Dissolved Oxygen levels at KIMO.....	8
Figure 6. Acid Nuetralizing Capacity at KIMO.....	9
Figure 7. Bacteria levels at KIMO.....	10
Figure 8. Discharge measured at KIMO	11

Tables

Table 1. Table of Stream Designated Use	3
---	---

Introduction

This is the third report on water quality of Kings Mountain National Military Park (KIMO) 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 those early findings as well as data gathered in fiscal year 2005. This report will include those data as well as data collected in fiscal year 2007 and display these results in graphic form (accompanied with a brief interpretation), and concludes with a water quality summary and recommendations. Water quality is measured six times per year (bimonthly) on alternate years at six sites; Dellingham Branch, Garner Branch, Long Branch, Kings Creek, Stonehouse Creek, and Upper Dellingham Branch. 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

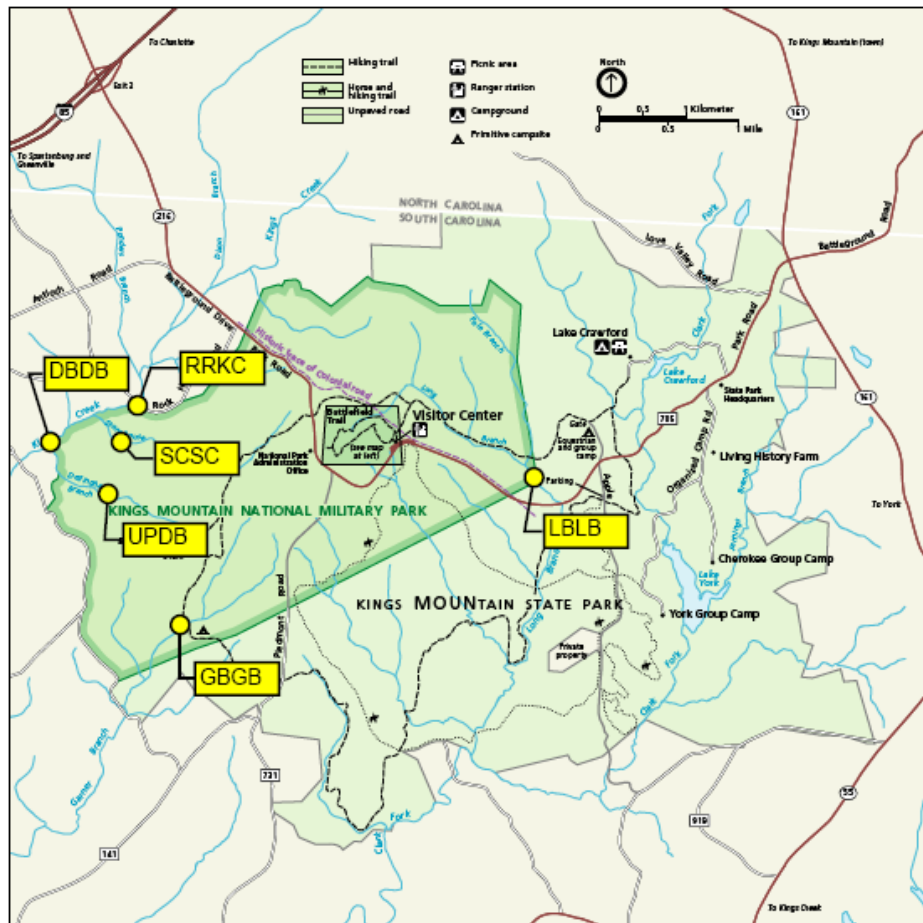


Figure 1: Map of water quality sampling sites at KIMO

Description of Sampling Sites

Long Branch (LBLB)

This stream, which drains the primary front-country attraction (Visitor Center area and Battlefield Trail) is sampled at the boundary of the state park.

Garner Branch (GBGB)

This stream is located in the southwestern portion of the park and can be accessed via a hiking trail (about 1.5 km) from the Piedmont Road within the state park. The sampling location is within the National Park at the trail crossing.

Dellingham Branch (DBDB)

This stream is primarily recharged by park lands with the exception of its final 0.5 km, which borders private, agricultural lands (primarily pasture). The stream is sampled at its confluence with Kings Creek. Access to this point was granted by the landowner prior to sampling.

Upper Dellingham Branch (UPDB)

This site was added during the first year (FY03) of sampling based upon high fecal coliform levels found at the Dellingham Branch site. This site receives flow exclusively from the park.

Stonehouse Creek (SCSC)

This stream is recharged entirely by park lands and is sampled at its confluence with Kings Creek. Access is gained via a park road to the Stonehouse, which leads to the Kings Creek floodplain.

Kings Creek (RRKC)

The largest stream in the park is sampled at the bridge of Rockhouse Road. This site is representative of waters entering the park from the private lands to the north.

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 South Carolina water quality standards, please see:

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

<i>Park</i>	<i>Code</i>	<i>Site</i>	<i>State</i>	<i>Designated Use</i>
KIMO	LBLB	Long Branch	SC	Freshwater
KIMO	GBGB	Garner Branch	SC	Freshwater
KIMO	DBDB	Dellingham Branch	SC	Freshwater
KIMO	UPDB	Upper Dellingham Branch	SC	Freshwater
KIMO	SCSC	Stonehouse Creek	SC	Freshwater
KIMO	RRKC	Kings Creek	SC	Freshwater

Table 1: The table shows that only Kings Creek is officially listed. Other streams of KIMO were “listed” (those sites in red text) by the author using the same criteria used by the state.

Results

Quarterly sampling commenced in December 2002 and continued until October 2003. After a one-year hiatus six more rounds were collected between October 2004 and August 2005. Again, six rounds of samples were collected between November 2006 and September 2007, for a total of 18 sampling events.

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. 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. 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 of KIMO are considered to be within range to support native aquatic life. Seasonal variations of water temperature are obvious in this graph. The temperature limit set by the state is 29 °C. Through the long, hot drought of the summer of 2007 the streams of KIMO were still below this standard.

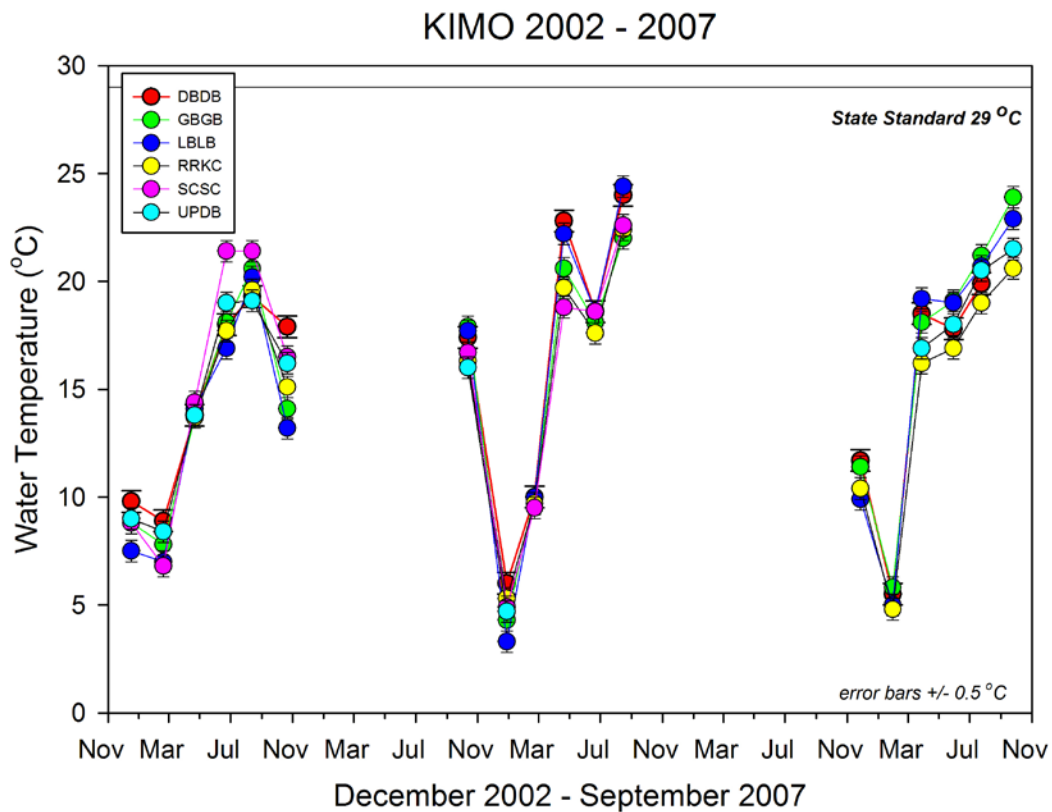


Figure 2: Water Temperature at KIMO

Specific Conductance

The distribution of specific conductance (SpC) of KIMO is, with exception of RRKC, reflective of low ionic-strength waters. The lithology of the park is largely crystalline and are relatively insoluble, thus the dissolved load is limited. Kings Creek, however, is a much larger watershed, bringing waters from far beyond park boundaries, and its higher SpC is indicative of a different, more soluble stratigraphy. The low SpC value for October 2005 at Garner Branch may be the result of equipment/operator error. While discharge decreases (most evident in the summer months), SpC values increase as a higher percentage of discharge are from groundwater sources as well as general longer contact with its substrates and thus increase their dissolved ionic loads. An exception is the SpC of RRKC which typically decreases during the summer. There are no state standards for SpC.

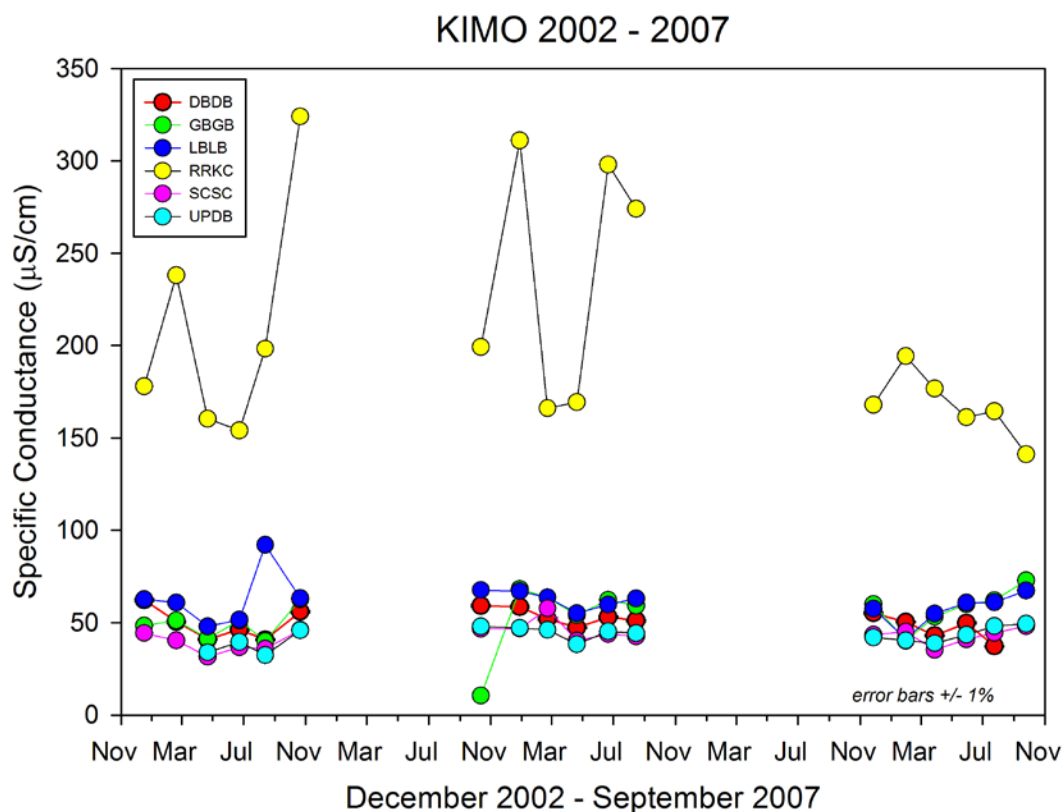


Figure 3: Specific Conductance at KIMO

pH

Waters of KIMO, again with the exception of Kings Creek (RRKC), are generally slightly acidic. The slightly alkaline waters of RRKC, as will be seen in the forthcoming ANC graph, is due, in part, to a higher load bicarbonates. State standards for freshwater pH are between 6.0 and 9.0 SU. We can see that both Dellingham Branch sites exceeded this lower pH limit, and all sites, with exception of RRKC, neared this lower limit in the winter and spring of 2005. The lithology and supporting water chemistry suggest that the waters of KIMO are naturally acidic, and at times, may surpass the lower state pH standard. pH values rebounded during the FY 2007 round. This rebound was also seen at Carl Sandburg Home National Historic Site and Cowpens National Battlefield.

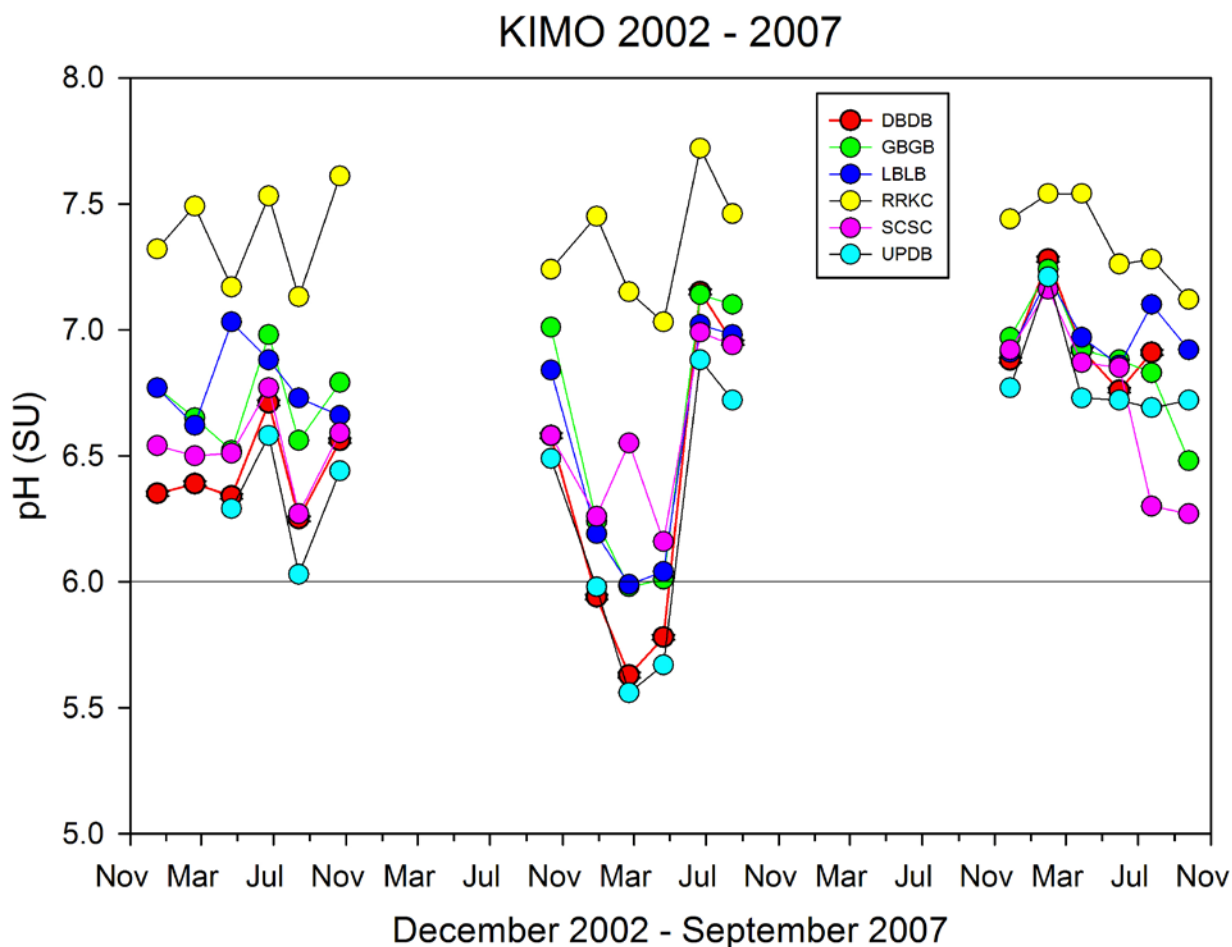


Figure 4: pH levels at KIMO

Dissolved Oxygen

All waters monitored at KIMO are saturated, or even supersaturated with oxygen – unless they cease to flow as in the late summer of 2007. Both Garner Branch (GBGB) and Stonehouse Creek (SCSC) reported very low DO during the September 2007 round. This was due to no flow in Garner Branch and the sample was taken from an isolated pool. While not dry, the flow of Stonehouse Creek was reduced to 0.3 l/s, a direct result of the drought. Aside from these extreme conditions in the summer of 2007, KIMO streams have generally high DO values, which are concordant with limited nutrient loading and numerous occasions of the water to be fully aerated as it cascades down Kings Mountain. State standards require freshwaters to contain at least 5.0 mg/l oxygen to maintain healthy aquatic life.

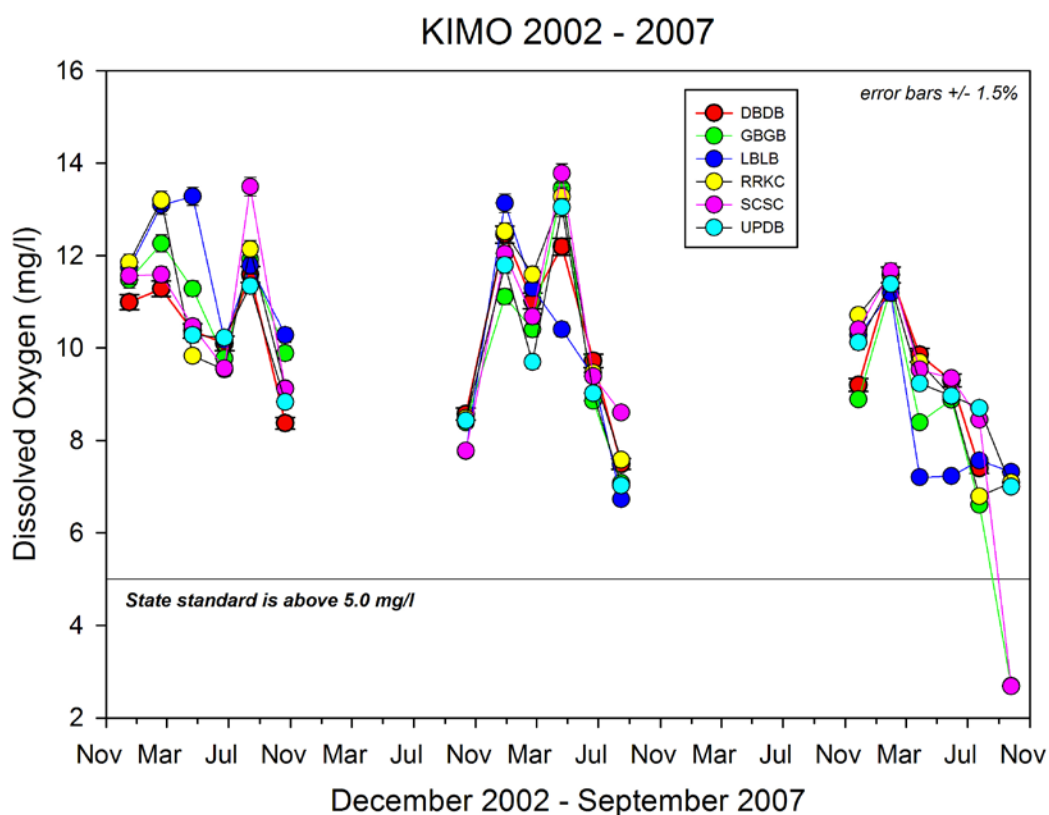


Figure 5: Dissolve Oxygen levels at KIMO

Acid Neutralizing Capacity

A nearly identical signature as was seen with SPC. Acid neutralizing capacity (ANC) of KIMO waters is fairly low, indicating a lack of contact with carbonate strata – with exception of Kings Creek. Low ANC levels make waters more susceptible to acid precipitation as there are limited amounts of bicarbonates available to counter additional acids. Kings Creek must have a source of bicarbonates – likely carbonate rock – within its watershed upstream of the park. The high values across the board in the June 2005 samples may be due to a titration or equipment malfunction. This graph shows only the last two rounds of FY 2005 and those of FY 2007 as a more accurate method was adapted following protocol review (old data are not included in this graph as their accuracy is doubtful). There are no state standards for ANC.

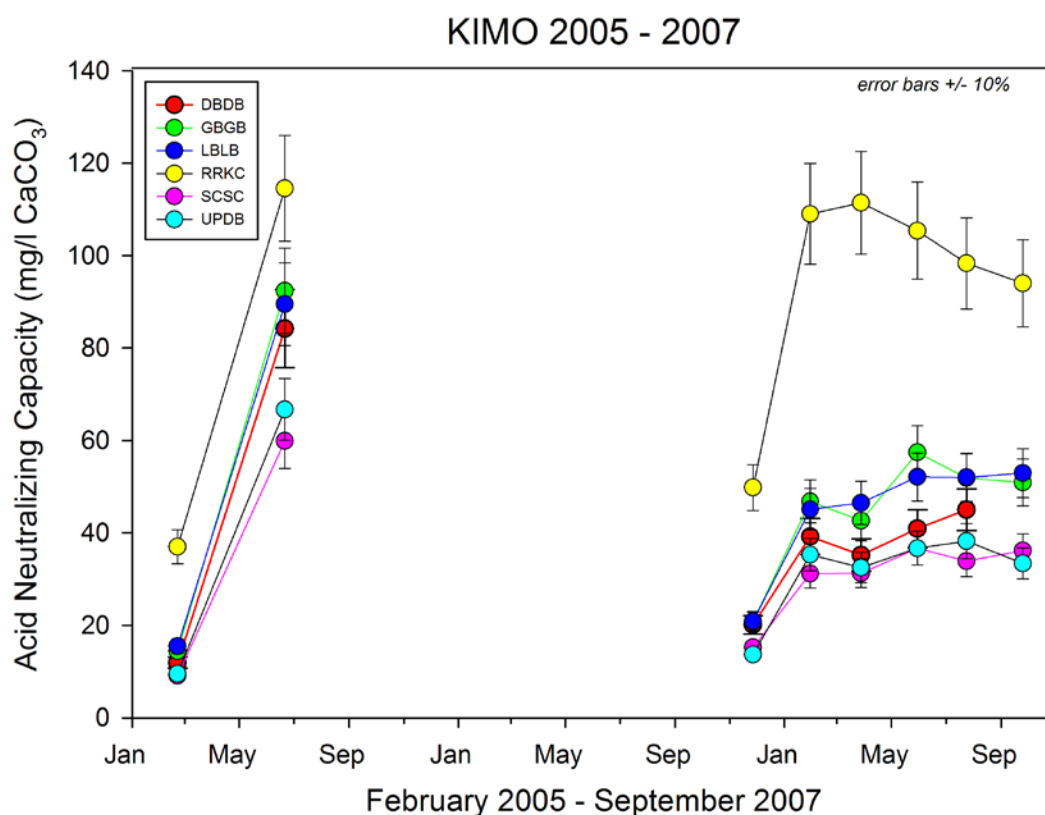


Figure 6: Acid Neutralizing Capacity at KIMO

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 USEPA recommends a single sample *E. coli* standard for limited contact waters as 576 CFU (colony forming units) per 100 ml.

In general *E. coli* levels are low and reflective of wildlife sources at KIMO. On occasion there are “spikes” in bacterial levels, as seen in the February 2007 SCSC and September 2007 UPDB samples for example. Recent wildlife activity upstream of the sampling site prior to collection seems to be the likely cause.

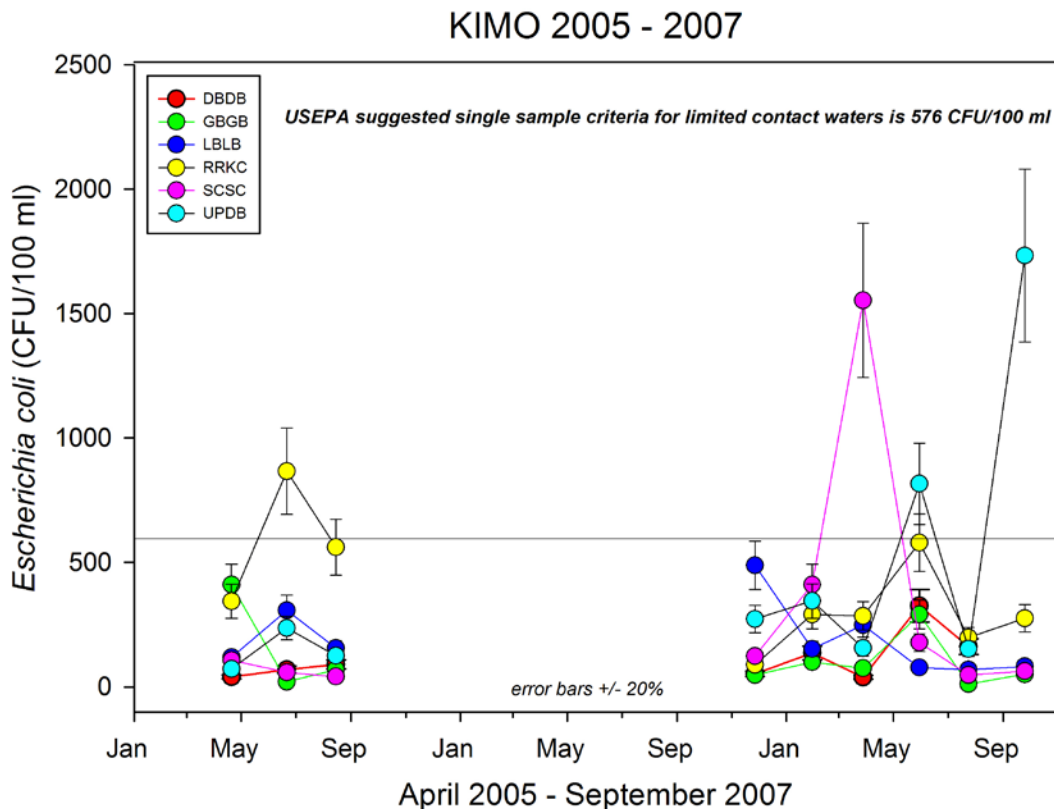


Figure 7: Bacteria levels at KIMO

Discharge

With each sample taken, the stream's discharge is measured. If discharge (flow) is known, it puts the results in context with the state of flow during the sampling event. Over several rounds of set-date sampling (as used by this program) samples will be taken during normal, low and flood states. The high flows of 2003 and the response of the 2007 drought are easily observed.

The relative size of the watershed is seen in amount of discharge; RRKC is by far the largest watershed as others are fairly equal – note the values for RRKC are 20% of measured values for graphing purposes.

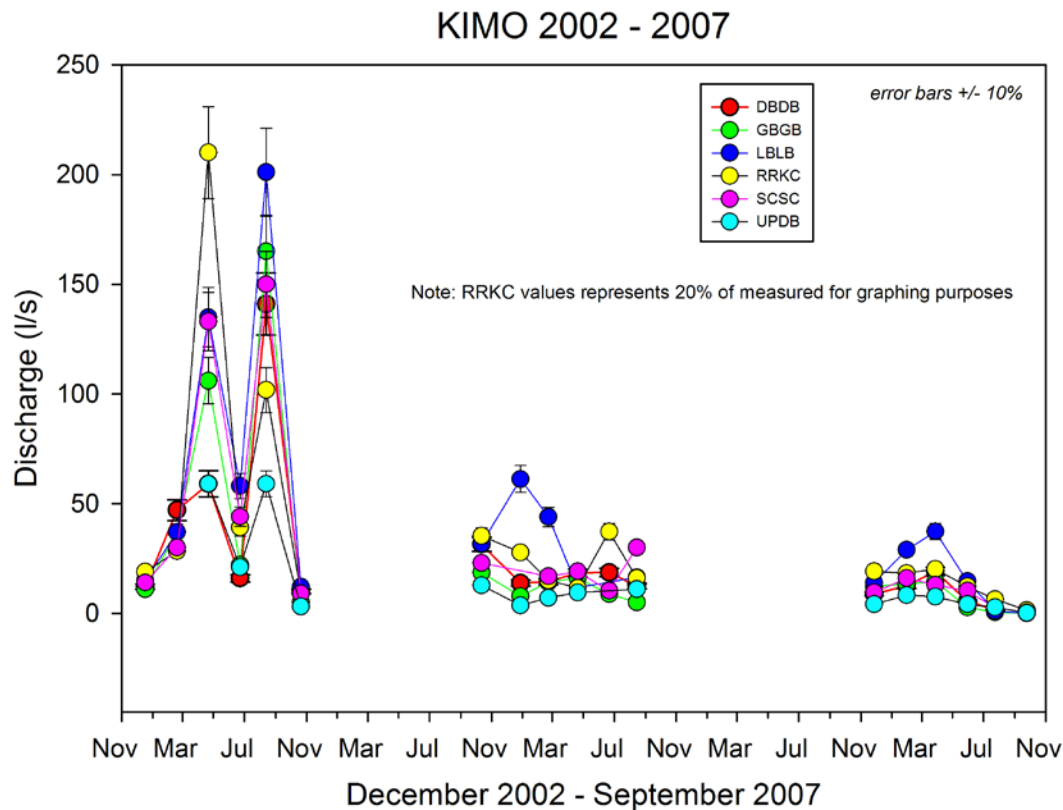


Figure 8: Discharge measured at KIMO.

General Water Quality Status

For the most part, water quality of the six sites sampled at KIMO is very good. Waters of KIMO, with the exception of Kings Creek, are naturally low in ANC, and pH. The historically and naturally low ANC and pH values are not much of an issue. However, with the increase in acid precipitation over the past decades, streams with low buffering capacity and low pH, such as those at KIMO are susceptible to becoming more acidic.

It is obvious that the pH of both Dellingham Branch sites are, at times, below the state standard of 6.0 SU – and other sites approach this limit (although all recovered during the FY 2007 sampling round). In the most general sense this is a violation of standard for Freshwaters, thus non-attainment of designated uses under the Clean Water Act. It is my belief that the waters of KIMO, due to their headwater position within a crystalline bedrock watershed are naturally acidic – at or below 6.0 SU. This is supported by low ANC values. South 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. *Regulation 61-68 C.9*: “Because of natural conditions some surface and ground waters may have characteristics outside the standards established by this regulation. Such natural conditions do not constitute a violation of water quality standards: however, degradation of existing water quality is prohibited unless consistent with Section D.4. of this regulation.”

Future Water Quality Monitoring Recommendations

The CUPN is required in accord with the national water quality program to monitor water temperature, specific conductance, pH, dissolved oxygen and discharge. In addition, there is sufficient reason to continue to monitor *Escherichia coli* and ANC, as long-term data may serve to alert the park to impending water quality issues.