

Water Quality in the Great Smoky Mountains National Park (2000 Annual Report)

The stream water resources of the Great Smoky Mountains Park are important as a habitat for fish and other aquatic biota, as a water source for park wildlife (bear, deer, re-introduced elk, etc.), and as a recreational resource for visitors. The Park has a diversity of stream characteristics, which reflects the diversity of elevations, geology, vegetation, and precipitation and consequent ecosystems. Monitoring the quality of the stream water resources in the Park is critical for identifying long term trends and potential problems as well as maintaining and managing the Park's aquatic and terrestrial fauna, e.g., helping to identify candidate streams for brook trout restoration. This work is being conducted under cooperative agreement with Drs. Smoot and Robinson, University of Tennessee, Department of Civil and Environmental Engineering. All work follows procedures described in Standard Methods for the Examination of Water and WasteWater, which is consistent with EPA and USGS protocols.

Currently, there are two major ongoing water quality monitoring programs in the Park:

- **Noland Divide (ND) monitoring:** Two adjacent high elevation streamlets in the Noland Divide watershed near Clingman's Dome are instrumented with YSI/Hydrolab units to measure and record flow, pH and conductivity every 15 minutes. Additionally, water quality samples have been collected weekly and analyzed for pH, conductivity, acid neutralizing capacity (ANC), major cations (calcium, magnesium, sodium, and potassium), major anions (sulfate, nitrate, and chloride), aluminum (periodically) and ammonium. Of these two streamlets, the southwest streamlet has been instrumented since 1991 and the northeast since 1998. This site has one of the highest atmospheric deposition rates of sulfate and nitrate in the U.S.
- **Park-Wide (PW) Monitoring:** Since 1993, samples have been collected four times per year from 90 stream sites Park-wide representing a range of hydrology, elevation, geology, and vegetation. Samples were collected in the months of March, May, August, and November during year 2000. Samples were analyzed for pH, conductivity, acid neutralizing capacity (ANC), major cations (calcium, magnesium, sodium, and potassium), major anions (sulfate, nitrate, and chloride), and ammonium.

Noland Divide. A major effort was undertaken in year 2000 to analyze the data available at that time. Conclusions resulting from those analyses include:

- Based on stream flow frequency curves compared to actual sampled flows, high flow events are under-represented; thus, stream water quality during high flow events is under-represented by current sampling schemes.
- Acid neutralizing capacity is very low, ranging from – 13.8 to 42.4 making these streamlets very sensitive to acid deposition.
- Higher sulfate concentrations are observed in the streams when more rainfall has occurred since the previous visit. In the SW stream, an increase of one inch of rainfall

produces a significant ($p < 0.05$) increase in sulfate concentration of 1.08 meq/L. In the NE stream, an increase of one inch of rainfall produces a significant increase in sulfate concentration of 1.32 meq/L.

- Lower sulfate concentrations are observed in the streams when the dry period prior to sampling has been longer. An increase in one consecutive dry day prior to sampling produces a significant decrease in sulfate concentration of about 0.65 meq/L.
- Nitrate concentrations observed in the streams are not significantly influenced by precipitation prior to sampling. However, lower nitrate concentrations are observed in the streams after a dry period prior to sampling. An increase in one consecutive dry day prior to sampling produces a significant decrease in nitrate concentration of about 0.5 meq/L.
- Regression modeling shows the following significant ($p < 0.10$) time trends in concentrations:
 - Chloride, sodium, ammonium, and aluminum concentrations are increasing over time
 - Nitrate and silica concentrations are decreasing over time
 - Sulfate and potassium concentrations are not changing over time
 - Hydrogen ion concentration is low, ranging from 4.7 to 6.4, but does not appear to be changing over time

Park Wide Monitoring.

- Significant elevation trends exist for pH, acid neutralizing capacity, nitrate, sodium, and sulfate (below 4,500 feet) (See attached Figure 1). For pH and ANC, values decrease with increases in elevation. Nitrate and sulfate concentrations increase with increases in elevation. Sodium concentrations decrease with increases in elevation.
- Nine sampling sites show median pH values less than or equal to 5.6, the lower limit for brook trout populations to exist. The regression equation predicts pH at downstream sampling sites with less than 10% error. Therefore, pH decreases by about 0.28 units for every 1,000-ft increase in elevation.
- Almost all of the sampled surface water in The Great Smoky Mountains (97%) has median ANC values below 200 meq/L, the point at which water is considered sensitive. Most sampled surface water (57%) has median ANC values less than 50 meq/L, the point at which water is considered extremely sensitive. About 36% of the sampling sites have median ANC values between 50 and 200 meq/L, and 4% are considered acidic with 0 meq/L. Only 3% of the sampling sites have median values greater than 200 meq/L and these are all within Abrams watershed in Cades Cove. The loss of the buffering capacity of streams can result in sudden decreases in pH after small inputs of acidifying species.
- Time trend analysis revealed a significant decreasing trend in pH over time (0.0080 units per year), particularly at lower elevations. Other results are less conclusive at this time.

Le Conte Creek Summaries. For the past two years, two temporary storm event samplers have been installed at two different locations on Le Conte Creek. Equipment problems and dry weather has limited the results. Preliminary results indicate so far that the higher elevation upper

site on Le Conte Creek is much more effected during high flow periods. Storm events so far have caused major drops in pH and ANC.

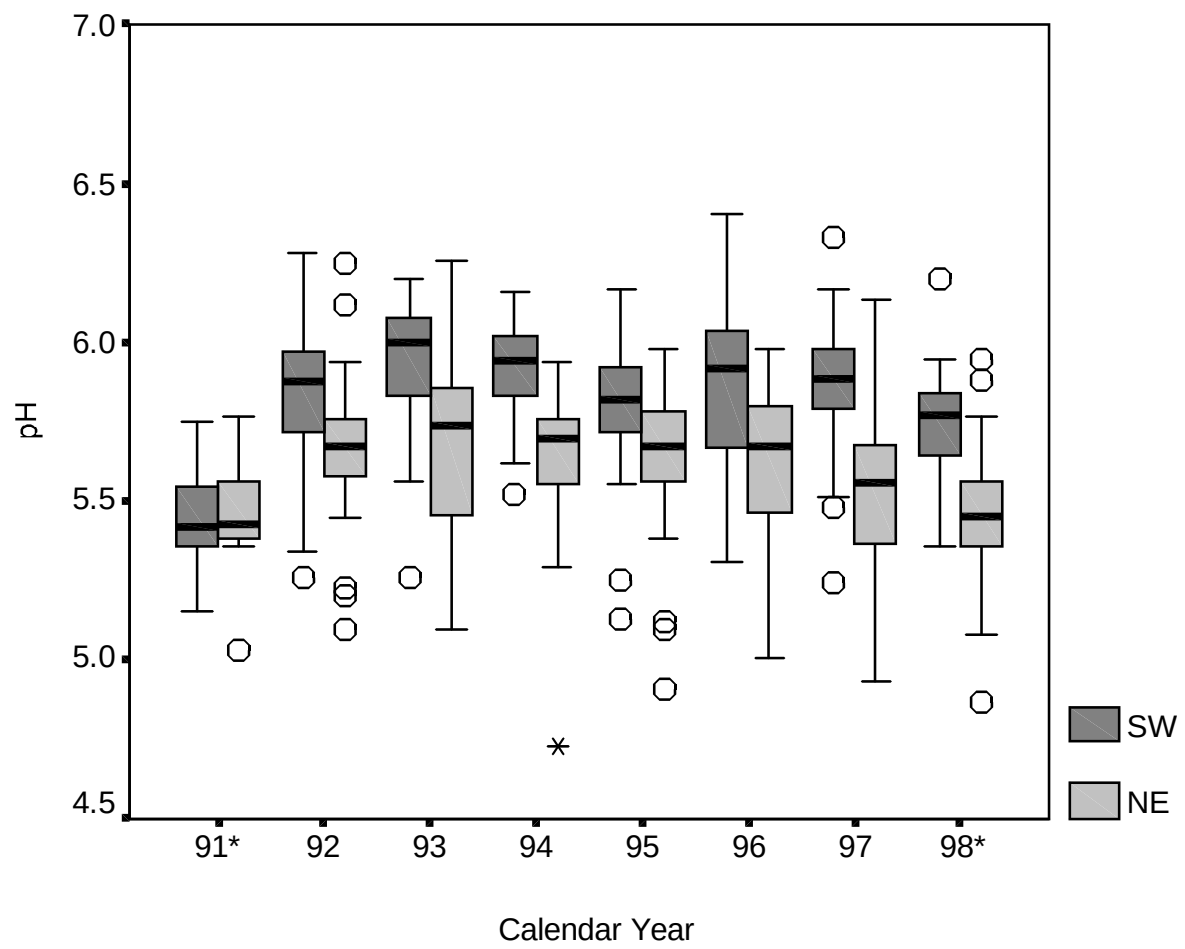


Figure 1. pH trend at Noland Divide

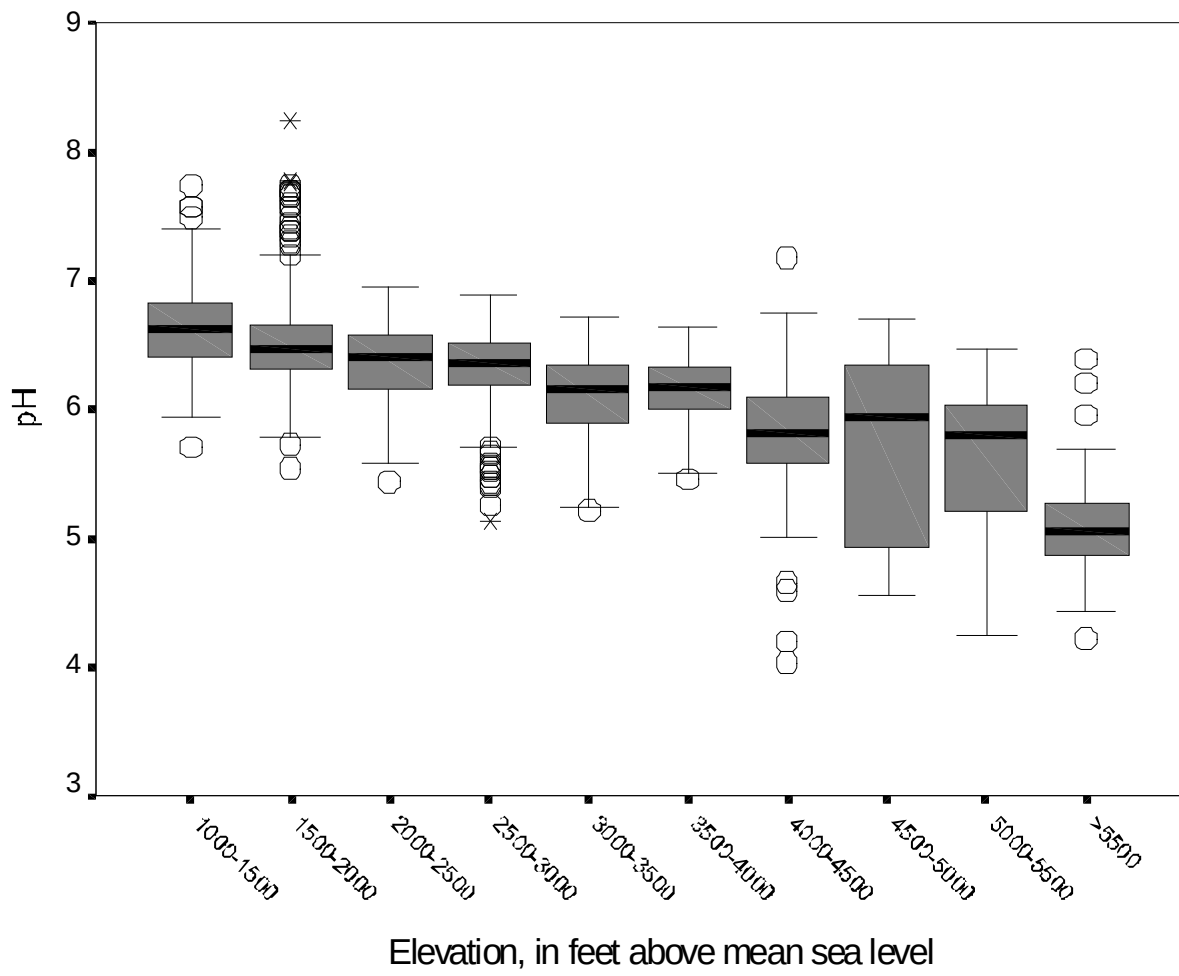


Figure 2. Elevational trends for pH in sampled Park Streams.