



# Stressor Analysis in Virginia:

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## Data Collection and Stressor Thresholds



**Water Quality Monitoring, Biological Monitoring and  
Water Quality Assessment Programs**

**Department of Environmental Quality**

**Richmond, Virginia**

**March 2017**

VDEQ Technical Bulletin WQA/2017-001

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## Contact:

### Jason Hill

Jason.Hill@deq.virginia.gov

### Chip Sparks

Chip.Sparks@deq.virginia.gov

### Mary Dail

Mary.Dail@deq.virginia.gov

### Emma Jones

Emma.Jones@deq.virginia.gov

## Acknowledgements:

Data analysis and overall document support: Larry Willis

Toxicity Sub-group: Roger Stewart, Ted Turner, Alex Barron, Mark Richards

CADDIS Sub-group: Ted Turner, George Devlin, Margaret Smigo

Reviewers: Martha Chapman, Greg Pond, Heather Govenor, Drew Miller

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# 1. Executive Summary

The Virginia Department of Environmental Quality (VDEQ) aims to uphold Virginia's aquatic life use standard by evaluating benthic macroinvertebrate communities. To meet both state and federal requirements, VDEQ is expected to assess water quality data, including chemical and biological data, every two years and subsequently list those waterbodies that do not meet Virginia's water quality standards on the 303(d) list

(<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx>). Benthic macroinvertebrate communities are assessed as impaired when a community shift has been observed and is reflected in multimetric index scores below Virginia's impairment threshold. VDEQ utilizes two Virginia specific multimetric indices, the Virginia Stream Condition Index and the Virginia Coastal Plain Macroinvertebrate Index, to evaluate benthic macroinvertebrate communities

(<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/BiologicalMonitoringOverview.aspx> and

<http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/ProbabilisticMonitoring/scival.pdf>). The root cause of a community shift is rarely obvious even though effects observed in the composition and/or abundance of the benthic macroinvertebrate community are clear. The method recommended by the U.S. Environmental Protection Agency (EPA) and utilized by VDEQ to systematically characterize the cause of a benthic macroinvertebrate community shift is called stressor analysis. The goal of the stressor analysis process is to apply a weight-of-evidence approach to define a/the most probable stressor(s) that explain(s) the shift in the benthic macroinvertebrate community. Stressor analysis takes into account all available information including, but not limited to, water chemistry, physical habitat, qualitative habitat, and sediment data. Benthic macroinvertebrate community stressors encompass a wide array of parameters that have varying degrees of synergistic interactions, further complicating the stressor analysis process.

The stressor analysis process is challenging. The ability to identify the most probable stressor, or stressors, is limited by the available dataset for the waterbody of interest. Resources and budgets are often stretched, making supplemental data collection difficult. Though the Commonwealth of Virginia has established water quality standards for some benthic community stressors (e.g. dissolved oxygen, pH, and some individual metals); factors like instream habitat and parameters including nutrients and total dissolved solids (TDS) do not have associated water quality criteria. Thus, it is difficult to defensibly link habitat degradation, elevated nutrients, and TDS to specific benthic community impacts. Traditionally, TMDL studies

utilize contractor-developed stressor analyses to identify the most likely stressor or stressors. Following review and approval from Regional TMDL Coordinators, with support from Regional Biologists and monitoring staff, selected stressor(s) may implicate regulatory permit limits, additional sampling requirements, and most often focused best management practice recommendations. The aforementioned results of a TMDL based on a stressor(s) are costly; therefore, defensibility and, to the greatest degree possible, certainty in stressor identification are critical. As such, VDEQ regional staff and contractors need robust tools to identify stressors.

Recognizing the challenges in developing stressor analyses, this document was developed as another tool to support that effort. The following chapters and appendices provide an evaluation of statewide applicability of existing tools like EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) and West Virginia's Dirty Reference Model. The data collection approaches included herein serve to guide parameter selection and sampling frequency but do not replace regional coordination among TMDL, biomonitoring, and monitoring staff. Data collected through VDEQ's Freshwater Probabilistic Monitoring Program were used to develop stressor thresholds, or concentration/measured ranges linked to probable stress to aquatic life. The stressor thresholds are not derived from literature values and are not intended to replace water quality criteria or define TMDL endpoints. These value ranges are provided to present context for stressor analyses reviewers and developers to evaluate water quality datasets and relate them to benthic community outcomes. As the probabilistic database expands and additional genus-level benthic macroinvertebrate data become available, the stressor thresholds will be revisited. It is expected that as more VDEQ staff and TMDL contractors utilize this document, their feedback will be assimilated. Through monitoring recommendations, including sampling schedules and parameter options for the generation of comprehensive datasets, this document provides statewide, ecoregion-, basin-, and stream order-specific contexts to common benthic stressors. This document presents background information on select parameters presented in this report which are considered widespread and common stressors in Virginia. Further, this document contains a guide to interpreting graphics and detailed appendices containing expanded statistical analyses related to the selected parameters. Though temperature and hydrology are not discussed in depth, VDEQ recognizes that they are potential stressors. VDEQ does not currently have datasets expansive enough to calculate the probability of stress to aquatic life from temperature and/or hydrology.

Nearly 40% of Virginia's stream miles have impaired benthic macroinvertebrate communities (VDEQ, 2012). A robust dataset containing extensive chemical, biological and habitat parameter data was made possible by Virginia's probabilistic monitoring program. Since 2005, VDEQ has

conducted extensive monitoring data collection at 50-60 randomly located sites annually across the Commonwealth. The probabilistic approach minimizes bias because it is a statistically designed study and sample sites are selected randomly across a geographical area. The probabilistic monitoring dataset allowed VDEQ to determine thresholds ranging from no stress to aquatic life to high probability of stress to aquatic life for the following parameters: dissolved oxygen, pH, total phosphorus, total nitrogen, ionic strength (specific conductivity, TDS, and dissolved sulfate, chloride, sodium, and potassium), dissolved metals cumulative criterion unit, total habitat and relative bed stability. The stress categories were developed by analyzing benthic macroinvertebrate community responses (represented by VSCI and CPMI scores) through a variety of peer-reviewed statistical techniques: relative risk, relative extent, conditional probability and quantile regression. The results were interpreted into stress categories. Specifically, “No Stress to Aquatic Life” means that a parameter range reflects an undisturbed, or background, condition in Virginia. “Low Probability of Stress to Aquatic Life” represents a benthic macroinvertebrate community response that is slightly above background conditions but unlikely to cause a major community shift. The next category is “Medium Probability of Stress to Aquatic Life” and means there is noticeable evidence of harm causing a possible shift in benthic communities with changes noticeably above background conditions. The “High Probability of Stress to Aquatic Life” threshold corresponds to values that are among the highest in the Commonwealth and result in degradation of the benthic community. The stressor threshold summary of tables is presented in Table 1.

A spreadsheet tool was developed as a complement to this document. The tool is designed to automate stressor parameter interpretation by projecting a user-entered parameter average or other value on appropriate tables and cumulative distribution function charts. A user may then have a(n) statewide, basin, ecoregional, and stream order context for specific parameter results for a given water quality monitoring station. Simply, the spreadsheet tool combines the information from Chapter 4 Stressor Thresholds and the Appendices B through N such that a user populates certain cells with a representative value for each stressor parameter and the resulting changes to the tables and charts display context for evaluation of said parameter. The stressor threshold spreadsheet tool is located on DEQ’s probabilistic monitoring webpage under “ProbMon Data Sources”:

<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring/ProbMonDataSources.aspx>. *Stressor Analysis in Virginia: Data Collection and Stressor Thresholds* is intended to enhance stressor analyses by providing guidelines for data collection and defensibility for defining most probable stressor(s).

Table 1. Summary of stressor thresholds tables.

<b>Dissolved Oxygen</b>		<b>pH</b>	
<b>Probability of Stress to Aquatic Life</b>	<b>Concentration (mg/L)</b>	<b>Probability of Stress to Aquatic Life</b>	<b>Concentration (unitless)</b>
High	< 7	Medium	< 6
Medium	> 7, < 8	Low	6 to 9
Low	> 8, < 10	Medium	> 9
None	> 10		
<b>Total Phosphorus</b>		<b>Total Nitrogen</b>	
<b>Probability of Stress to Aquatic Life</b>	<b>Concentration (mg/L)</b>	<b>Probability of Stress to Aquatic Life</b>	<b>Concentration (mg/L)</b>
High	> 0.1	High	> 2
Medium	> 0.05, < 0.1	Medium	> 1, < 2
Low	> 0.02, < 0.05	Low	> 0.5, < 1
None	< 0.02	None	< 0.5
<b>Specific Conductivity</b>		<b>Dissolved Metals Cumulative Criterion Unit (CCU)</b>	
<b>Probability of Stress to Aquatic Life</b>	<b>Electrical Conductivity (uS/cm)</b>	<b>Probability of Stress to Aquatic Life</b>	<b>Metals CCU (unitless)</b>
High	> 500	High	> 2.0
Medium	> 350, < 500	Medium	> 1.5, < 2.0
Low	> 250, < 350	Low	> 0.75, < 1.5
None	< 250	None	< 0.75
<b>Total Habitat - Qualitative</b>		<b>Relative Bed Stability (RBS) – Quantitative Habitat</b>	
<b>Probability of Stress to Aquatic Life</b>	<b>Total Habitat (unitless)</b>	<b>Probability of Stress to Aquatic Life</b>	<b>Relative Bed Stability (unitless)</b>
High	< 100	High	LRBS < -1.5
Medium	> 100, < 130	Medium	-1.5 < LRBS < -1.0
Low	> 130, < 150	Low	-1.0 < LRBS < -0.5
None	< 150	None	-0.5 < LRBS < 0.5
		Medium	LRBS > 0.5

Total Dissolved Solids		Dissolved Sulfate	
Probability of Stress to Aquatic Life	Concentration (mg/L)	Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 350	High	> 75
Medium	> 250 , < 350	Medium	> 25, < 75
Low	> 100, < 250	Low	> 10, < 25
None	< 100	None	< 10

Dissolved Chloride		Dissolved Potassium	
Probability of Stress to Aquatic Life	Concentration (mg/L)	Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 50	High	> 10
Medium	> 25 , < 50	Medium	> 2, < 10
Low	> 10, < 25	Low	> 1, < 2
None	< 10	None	< 1

Dissolved Sodium	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 20
Medium	> 10, < 20
Low	> 7, < 10
None	< 7



## **2. Introduction**

### **Background**

This document originated as part of the Virginia Department of Environmental Quality's (VDEQ) Biomonitoring Program 2008(9) self-assessment process. During the self-assessment, the Biomonitoring program staff identified areas in need of improvement and/or further exploration. Total Maximum Daily Load (TMDL) studies based on violations of Virginia's Aquatic Life Narrative Water Quality Standard (WQS), or Benthic TMDLs, were highlighted as a priority area in need of improvement. Virginia's Aquatic Life WQS is evaluated based on biological monitoring, or biomonitoring, of benthic macroinvertebrate community surveys and assessment of said communities using the Virginia Stream Condition Index (VSCI) or Coastal Plain Macroinvertebrate Index (CPMI). A workgroup was formed to further explore methods of improving the stressor identification process, which is a weight of evidence approach used in Virginia to isolate the most probable stressor(s) causing the aquatic community to shift. Once the stressor(s) is/are identified, the TMDL study focuses on quantifying existing sources of the stressor(s) and requires reductions based on watershed modeling coupled with empirical data. The reductions are intended to decrease pollutants causing stress to aquatic life, ultimately allowing aquatic communities to recover. The importance of precision regarding stressor identification is critical due to the amount of resources required to monitor and restore impaired stream segments and develop TMDLs to address problems.

### **Purpose**

The intent of this document, is to (1.) make recommendations regarding the selection of water quality monitoring parameters in order to prepare for a stressor analysis, (2.) present thresholds for water quality parameters that are major stressors, (3.) provide tools for interpreting water quality data, (4.) explore options related to possible toxicity problems, and (5.) pilot new and existing tools for stressor analysis. The bulk of this document focuses on widespread and common stressors in Virginia ((2.) above). The chapters dedicated to these select stressor parameters include a comprehensive evaluation using Virginia data and applied statistics to delineate probability of stress thresholds relative to benthic macroinvertebrate communities. The idea was not to develop water quality standards or TMDL endpoints, but to provide Virginia-specific context to evaluate benthic macroinvertebrate responses to parameter concentration ranges.

The following sections in this chapter discuss VDEQ biological monitoring, the Benthic TMDL process, and assessment tools applied to benthic macroinvertebrate communities in greater detail. Chapter 2 discusses data collection strategies to prepare for stressor analysis. Chapter 3, Stressor Thresholds, begins with a summary of the main stressors in Virginia, then presents a “how-to” section for data interpretation, and finally specific sections detailing the following for each major stressor: background information, statewide, basin, stream order, and ecoregional context, and linkages to effects on aquatic life. Chapter 4 explores topics related to toxicity in benthic TMDLs. Chapter 5 discusses existing approaches to stressor analysis and Biologist/TMDL Staff Workgroup goals for continued involvement in developing and enhancing tools for improved stressor analyses. Appendix sections correspond to the parameter evaluations presented in Chapter 3 by providing detailed statistical analyses results.

## **Biological Monitoring**

### ***Biological Monitoring and Assessment Tools***

Biological monitoring, or Biomonitoring, of streams and rivers is an integral component of VDEQ’s water quality monitoring program. Biological indicators represent the long-term water quality conditions and respond to all sources of stress. Biomonitoring allows VDEQ to assess the overall ecological condition of streams and rivers by evaluating stream condition with respect to suitability for the support of aquatic communities. In Virginia, benthic macroinvertebrate communities are used as indicators of ecological condition and to identify if a waterbody supports the aquatic life designated use and narrative water quality standards. A sample of the benthic macroinvertebrate community is collected, preserved, sorted, and identified according to VDEQ’s Biomonitoring Quality Assurance Project Plan for Wadeable Streams and Rivers (VDEQ, 2008).

VDEQ uses multimetric macroinvertebrate indices, specifically the Virginia Stream Condition Index (VSCI) and the Coastal Plain Macroinvertebrate Index (CPMI), to assess the aquatic life use status of wadeable streams and rivers. The VSCI and the CPMI are applied to biomonitoring data collected in freshwater non-coastal areas and freshwater coastal areas, respectively. These indices utilize several biological metrics that are regionally calibrated to the appropriate reference condition (VDEQa, 2006; Maxted, 2000). Results are calculated into a single value, or score that is sensitive to a wide range of stressors. The eight Virginia Stream Condition Index (VSCI) metrics are as follows (VDEQ, 2008): total taxa, EPT Taxa, percent Ephemeroptera,

percent Plecoptera and Trichoptera less Hydropsychidae, percent scrapers, percent Chironomidae, percent top two dominant taxa, and Hilsenhoff Biotic Index (HBI) (family taxonomic level). The five Coastal Plain Macroinvertebrate Index (CPMI) metrics are as follows: total taxa, EPT Taxa, % Ephemeroptera, Hilsenhoff Biotic Index (HBI) (family), and percent clingers. VDEQ now uses the Virginia CPMI (VCPMI); however at the time data was analyzed for this document, the CPMI was applied to the coastal plain and mid-atlantic coastal plain ecoregions of the Commonwealth. The VCPMI report may be viewed at the following link: <http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/ProbabilisticMonitoring/vcpmi.pdf>.

## Virginia Stream Condition Index VSCI

Total Taxa = the number of different types of invertebrates present

Total EPT = Total number of organisms that are either mayflies, stoneflies or caddisflies

% Ephemeroptera = Percent of mayfly organisms

% Plecoptera + Trichoptera less Hydropsychidae = Percent of stonefly and caddisfly organisms; excluding net-spinners in Family Hydropsychidae

% Scrapers = Percent of organisms that obtain food by scraping the stream substrate

% Chironomidae = Percent of organisms that are midges

% Top 2 Dominant Taxa = Percentage of organisms occupying the top two most dominant families

Hilsenhoff Biotic Index (Family) = Index that factors in pollution tolerance for each family

## Coastal Plain Macroinvertebrate Index CPMI

Total Taxa = the number of different types of invertebrates present

EPT Taxa = number of different mayfly, stonefly or caddisfly families

% Ephemeroptera = Percent of mayfly organisms

% Clingers = Percent of organisms that spend time clinging to the substrate

Hilsenhoff Biotic Index (Family) = Index that factors in pollution tolerance for each family

Virginia has established impairment thresholds for the VSCI and CPMI at 60 and 16, respectively (VDEQ, 2009). Streams are considered impaired if they fall below those established thresholds. During the 2012 303(d)/305(b) Integrated Report period (data collection 2004-2010), VSCI and CPMI probabilistic monitoring results indicate that 39.7% (+/- 6.9%) of Virginia streams and rivers do not meet the aquatic life use standard (Figure 1).

Figure 1.VSCI/CPMI (n = 268) Scores compared to Virginia's Assessment Thresholds based on 2012 303(d)/305(b) Integrated Report (VDEQ, 2012).

<p><b>Virginia's Narrative Water Quality Criteria states:</b></p> <p>"All State waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.."</p> <p>9VAC25-260-20</p>	
<p><b>Assessment Tool used to evaluate Virginia's Narrative Criteria</b></p>	<p><b>Impairment Threshold</b></p>
<p><i>Virginia Stream Condition Index</i></p>	<p>&lt; 60</p>
<p><i>Coastal Plain Macroinvertebrate Index</i></p>	<p>&lt; 16</p>
<p>Percentage of stream miles not meeting Virginia's Narrative Criteria:</p> <p><b>39.7 %</b></p>	

## Habitat Assessment

Habitat assessment is conducted at each biomonitoring site according to VDEQ's Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers (VDEQ, 2008) (Table 2). Both in-stream and riparian habitat are important determinants of the composition, structure, and function of macroinvertebrate communities. Habitat quality is often an indicator of water quality stressors in streams. A systematic evaluation of in-stream and riparian habitat quality is necessary to fully understand water quality conditions in streams and rivers.

Benthic macroinvertebrate community composition is often determined by the immediate surroundings and water quality conditions, including habitat. Habitat assessment is considered an important tool for the final evaluation of impairment. Habitat parameters that are evaluated are related to the overall aquatic life use and are a potential source of limitation to aquatic life. Both the quality and quantity of available habitat can affect the resident biological community structure and composition. The final conclusion of a biological assessment should take into consideration the habitat quality of a water body and whether the health of aquatic biological communities is limited by habitat conditions.

The diversity of Virginia's terrain leads to the need for habitat parameters applicable to low gradient and high gradient streams. The former is characterized by more pools, snags and leaf packs; the latter tends to contain riffles and coarse substrate. There is overlap in habitat parameters for the aforementioned stream gradients as some habitat measures are appropriate for both low and high gradient streams. The following parameters are assessed in high gradient streams (VDEQ, 2008): (1.) epifaunal substrate/available cover, (2.) embeddedness, (3.) velocity/depth regime, (4.) sediment deposition, (5.) channel flow status, (6.) channel alteration, (7.) frequency of riffles (or bends), (8.) bank stability, (9.) bank vegetative protection, and (10.) riparian vegetative zone width. The following parameters are assessed in low gradient streams: (1.) epifaunal substrate/available cover, (2.) pool substrate characterization, (3.) pool variability, (4.) sediment deposition, (5.) channel flow status, (6.) channel alteration, (7.) channel sinuosity, (8.) bank stability, (9.) bank vegetative protection, and (10.) riparian vegetative zone width. A more detailed discussion of total habitat measures is presented in Chapter 4.

Table 2. High gradient and low gradient qualitative habitat measures evaluated at Virginia streams.

Habitat Parameter	Description
Epifaunal substrate/ available cover	Amount of naturally occurring structures suitable for organism inhabitation; higher diversity of habitats increase biological diversity
Sediment deposition	Measures sediment accumulation on bottom substrate and in pools; indicates sediment movement issues
Channel flow status	Amount of channel filled with water and thus available habitat for diverse species colonization
Channel alteration	Human modifications to natural stream condition- channelization, artificial bank stabilization, dams, etc.
Bank stability (Score left and right bank separately)	Measures degree of erosion (or erosion potential) persistent on stream banks; indicates stability of habitat, sediment transport dynamics, and vegetative cover
Bank vegetative protection (Score left and right bank separately)	Measures stream bank vegetation cover; indicates bank stability and offers stream shading, among other habitat controls
Riparian vegetative zone width (Score left and right bank separately)	Measures vegetation cover width from stream bank through riparian zone; diminishes runoff nutrient input, mitigates stream bank erosion, and increases instream habitat diversity
<b>HIGH GRADIENT STREAMS</b>	
Embeddedness	Degree larger rocks are surrounded by smaller sediments; increased imbeddedness reduces macroinvertebrate habitat & indicates sediment movement problems
Velocity/depth combinations	Characterizes water flow patterns; multiple regimes promote habitat and biologic diversity
Frequency of riffles (or bends)	Numerous riffles/bends provides diverse habitats and dissipates flood power
<b>LOW GRADIENT STREAMS</b>	
Pool substrate characterization	Identifies pool sediment type; uniform substrates reduce biologic diversity
Pool variability	Characterizes pool patterns; multiple pool types promote habitat and biologic diversity
Channel sinuosity	Increased sinuosity increases habitat diversity and moderates flooding conditions

## Benthic Macroinvertebrate Community TMDL Development

### *Benthic TMDLs: The Basics*

In the Commonwealth, VDEQ is required to assess water quality monitoring data (including biomonitoring data) periodically in accordance with applicable guidance and produce a biennial Water Quality Assessment 303(d)/305(b) Integrated Report

(<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx>). Each biennial report reflects a six-year window of data collection. Stream segments are listed on the statewide impaired waters list, or 303(d) list, if they do not meet Virginia's Water Quality Standards. With respect to benthic macroinvertebrate communities, the Water Quality Standards (WQS) general narrative criteria that states **"All state waters shall**

**be free from substances ... harmful to human, animal, plant, or aquatic life”** applies. Further, according to Virginia WQS (9 VAC 25-260-10), designated uses must be protected such that **“All State waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.”** Benthic macroinvertebrate communities are used as indicators of whether or not the narrative criterion and aquatic life designated use are met at a given site. The stream segment represented by a biomonitoring station is considered impaired if the VDEQ Regional staff finds that its benthic community is not within acceptable VSCI (or CPMI) score ranges. Impaired stream segments are listed on the 303(d) list and ultimately must have a TMDL (or comparable EPA-accepted watershed plan) developed for them. VDEQ Regional staff prioritizes the TMDL segments and work with Central Office TMDL staff to group the TMDL segments into watershed-scale projects. These projects may incorporate multiple TMDL segments with a variety of listing parameters. In most cases, a TMDL contractor is hired to assist with the watershed modeling, public participation, and other technical aspects of TMDL development. A crucial part of developing benthic TMDLs is identifying the stressor(s) to the benthic macroinvertebrate communities. The ultimate goal of Benthic TMDLs is to establish pollutant reductions that, once implemented, results in recovery of benthic macroinvertebrate communities and attainment of water quality standards.

Benthic communities respond to chronic conditions where the stressor or combinations of stressors are not always obvious based on the composition of the community. In essence, benthic communities indicate that a problem exists, but a “smoking gun” or obvious cause isn’t always apparent. Through the evolution of the stressor analysis process, a systematic approach has been developed that eliminates non-stressors and categorizes possible and probable stressors. The stressor(s) is/are tied to a pollutant (or pollutants) that subsequently become the focus of the TMDL. Pollutant reductions are calculated to match a predicted benthic macroinvertebrate community response. In many cases, a surrogate stressor like sediment is utilized to represent an environmental stressor like flashy flows from stormwater runoff. In fact, the majority of benthic TMDLs in Virginia are developed for a sediment stressor. To a lesser degree, nutrients (total phosphorus and/or total nitrogen), polycyclic aromatic hydrocarbons (PAHs), and metals have been identified as stressors.



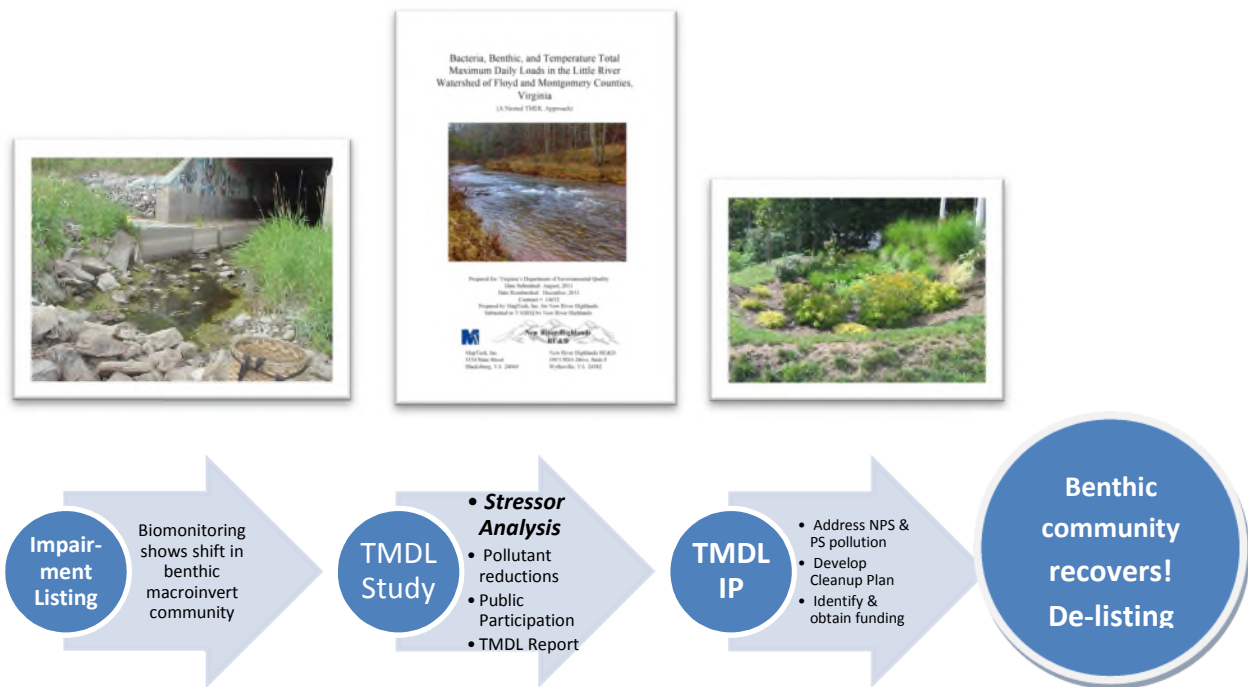


Figure 2. Schematic showing Benthic Total Maximum Daily Load process in Virginia.

## Stressor Analysis

Stressor analysis, or stressor identification, is the process by which potential stressors are eliminated and remaining stressors are categorized by their potential to impact aquatic life. EPA’s Stressor Identification Guidance Document (EPA, 2000) establishes the foundation for identifying causal relationships between environmental stressors and biological communities. EPA states that **“the ability to accurately identify stressors and defend the evidence supporting those findings is a critical step in developing strategies that will improve the quality of aquatic resources”** (EPA, 2000). In Virginia, TMDL staff and contractors utilize the process as a guide for evaluating candidate stressors to benthic macroinvertebrate communities in impaired stream segments. Stressor analysis incorporates a weight-of-evidence approach, relies on all available data, and formally guides stressor classification into the following categories: non-stressor, possible stressor, or most probable stressor. In some cases, multiple most probable stressors are identified. Categorizing stressors employs knowledge of parameter interactions with benthic macroinvertebrate communities and often requires close collaboration among VDEQ TMDL and Biomonitoring staff along with contractors. Parameters with applicable Water Quality Standards provide regulatory thresholds which may be useful in evaluating impacts to aquatic life and developing endpoints. The stressor(s) identified become



the focus of TMDL pollutant reductions, drive the watershed modeling, and result in load allocations to associated pollutant sources (non-point and point sources). Figure 3 depicts the overall approach to identifying cause of biological community impairment.

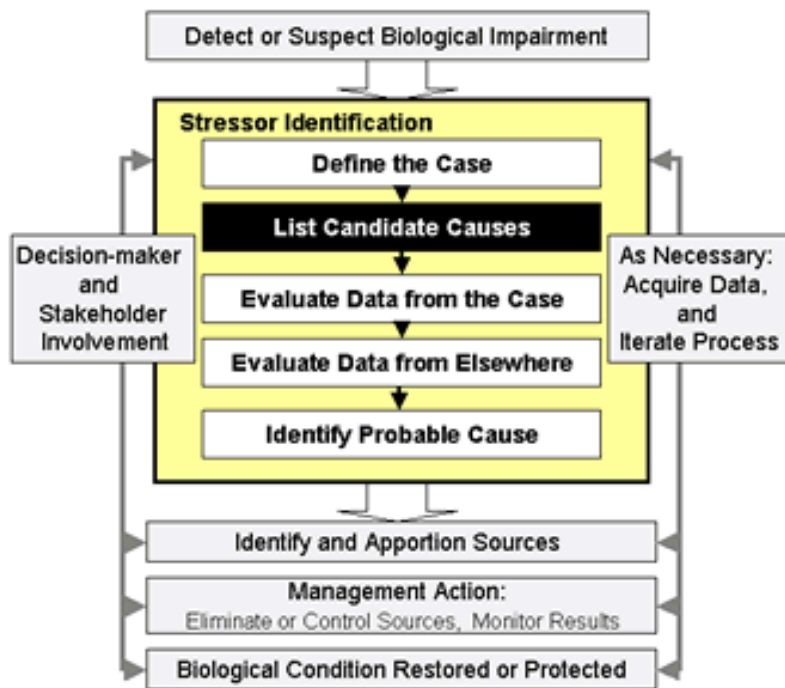


Figure 3. EPA's Causal Analysis Approach.

### *EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS)*

The Causal Analysis/Diagnosis Decision Information System (CADDIS) is available online and automates the stressor identification process in a step-by-step online approach. CADDIS attempts to determine which candidate causes best account for the observed effects. The CADDIS worksheet is used to assign semi-quantitative probabilities to potential stressors when the cause of impairment is unknown. The first objective is to define the site by investigating background and historical information of the drainage. Additionally, adjacent watershed characteristics are identified for comparison. The user then compiles all available monitoring data, and looks for candidate causes which include chemical, physical, and biological variables. The information is then evaluated in relation to the watershed of interest. The next step includes comparing adjacent watershed information to the impaired watershed. The final step is identifying a probable cause. During this evaluation likely, unlikely, and uncertain contributors are determined. Once a potential stressor is identified, the remaining steps of the

process include identifying sources and implementing actions to eliminate, reduce, or control the problem. Monitoring is initiated to gauge the effectiveness of remediation efforts. Theoretically, the end result is improved and/or protected biological conditions. Additional information is available on EPA's CADDIS website: <http://www.epa.gov/caddis/index.html>.

In Virginia, the Stressor Analysis process for benthic TMDLs follows the steps outlined EPA's Stressor Identification Guidance manual. VDEQ has not officially implemented the use of the automated CADDIS version; however, regions are encouraged to utilize available tools to enhance the stressor analysis process. As part of the Benthic TMDLs workgroup, two impaired stream segments were piloted through the CADDIS process in order to evaluate it for use in the Commonwealth. Appendix N describes the case study for Mill Creek in Rockingham County, Virginia.

### 3. Data Collection Strategies

Stressor analysis is based on available data and only in rare occasions is there time to fill data gaps by collecting additional data. It is critical to have a comprehensive dataset that includes collocated benthic macroinvertebrate community data and chemical data prior to beginning the stressor analysis process. Communication among TMDL, monitoring and biomonitoring staff is important especially during annual monitoring planning. An approved Quality Assurance Project Plan may be required for data collection outside of the annual monitoring plan. The data collection recommendations in Table 3 are intended to be used as a basic outline for developing a waterbody-specific monitoring plan. Parameter group codes included in the table may change so TMDL staff is encouraged to work with the regional monitoring staff to ensure that appropriate data is collected prior to stressor analysis. As a result of developing this document and the stressor tool, a new parameter group code was developed to aid in appropriate data collection in advance of stressor analysis. Called BENSTRESS, the new parameter group code directs the analysis of samples for total nitrogen, total phosphorus and dissolved ions (sulfates, chlorides, potassium, and sodium) that correspond to this document. Dissolved oxygen, pH, total phosphorus, total nitrogen, dissolved ions (sulfates, chlorides, potassium, and sodium), total dissolved solids, dissolved metals, and relative bed stability are discussed in detail in the next chapter. Special studies, such as continuous temperature and diurnal dissolved oxygen data collection, should be discussed among TMDL, biologist and monitoring staff to determine applicability and resource needs.

Timing and coordination of data collection is important so that the appropriate data is available at the time of stressor analysis. Water chemistry and benthic macroinvertebrate community data needs to be collected two years prior to beginning a stressor analysis. Annual monitoring plans are coordinated regionally among biologists, monitoring and TMDL staff. Benthic macroinvertebrate sampling occurs in the spring and fall and up to three months following the end of field season provides adequate time for laboratory and data processing. If special continuous monitoring studies are recommended, planning needs to accommodate the target season(s) and adequate time for data processing.

Analytical, habitat and benthic macroinvertebrate community data is managed in different database systems depending on data type. The former is housed in DEQ's Comprehensive Environmental Data System (CEDS) which is an Oracle platform. The benthic macroinvertebrate community taxonomic and qualitative habitat data is entered by the Regional Biologists into the Access databased Environmental Data Analysis System (EDAS). A computer located in the Blue Ridge Regional Roanoke Office and serves as the master computer for the EDAS database.

Regional Biologists enter their own data and run reports and queries in order to provide multimetric index scores and other data needs. A copy of EDAS is uploaded semiannually to DEQ's Probabilistic Monitoring Data Sources website:

<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring/ProbMonDataSources.aspx>. The Relative Bed Stability (LRBS), or quantitative habitat, data is also uploaded to the aforementioned website. Water chemistry data is available internal to DEQ through the Discoverer/Logi system.

Table 3. Guidelines for Benthic TMDL data collection.

Phase of TMDL Process	Parameter	Frequency	Duration	Station Purpose	Comments
Two Years Prior to TMDL Contract	Benthic Macroinvertebrates, RBP Habitat	Spring & Fall	Annually	Listing station(s); stressor analysis/impairment confirmation	
	Relative Bed Stability (LRBS)	Once	Once	Co-location with biomonitoring sites	
	Field Data, Nutrients (N & P), Total Dissolved Solids, dissolved ions (sulfate, chloride, potassium, sodium), <i>E.Coli</i> bacteria	Bimonthly	In conjunction with annual monitoring plan	Co-location with biomonitoring sites; stressor analysis	CEDS Parameter Group Code: BENSTRESS, bacteria parameter
	Diurnal Dissolved Oxygen	During stressful times of year	TBD	Co-location with biomonitoring sites; stressor analysis	If needed; As determined by Regional Biologist/TMDL Coordinator
	Diurnal Temperature	During stressful times of year	TBD	Co-location with biomonitoring sites; stressor analysis	If needed; As determined by Regional Biologist/TMDL Coordinator
	Water column (clean) metals	Annually	Once	Listing station(s); stressor analysis	As determined by Regional Biologist/TMDL Coordinator
	Diatoms/Fish Community	Annually	Once		
Post-TMDL and/or Implementation Plan Development	Benthic macroinvertebrates; RBP Habitat	Spring & Fall	TBD	Update data if needed	As determined by Regional Biologist/TMDL Coordinator
Segment De-list	Benthic macroinvertebrates; RBP Habitat	Spring & Fall	2 years	303(d)/305(b) Integrated Report de-listing	

## 4. Stressor Thresholds

Stressors in Virginia vary widely and are rarely attributable to a constituent with established water quality standards. Tools for interpreting and evaluating potential stressor parameters and to inform the stressor analysis process are presented in the following sections. Freshwater probabilistic monitoring data from 2001-2010 were used to develop stressor thresholds for common parameters that relate to benthic macroinvertebrate community changes.

Probabilistic monitoring data represents statistically valid estimates of 100% of Virginia stream miles. More precisely, the probabilistic dataset consists of data from randomly located sampling stations; thus, the dataset lends itself to being utilized for developing statistically valid statements about water quality. Parameter estimates are generated with known confidence.

Virginia's probabilistic monitoring dataset used in developing the stressor thresholds presented herein reflects 49,142 miles of perennial freshwater rivers and streams based on the 1999 National Hydrographic Dataset. These data reflect 473 randomly selected stations across Virginia; however, number of stations utilized may vary by parameter due to quality assurance/quality control issues and some variation among parameter collection from year to year. A majority of the samples were collected during the spring and fall; samples are averaged into one number per year of analysis. Data collected at the probabilistic sites includes field parameters (dissolved oxygen, temperature, pH, specific conductivity), benthic macroinvertebrate community, fish and algae community data, habitat, bacteria, total organic carbon, nutrients, solids, hardness, alkalinity, turbidity, chlorides, sulfates, sediment metals and pesticides, dissolved metals, and land cover (GIS). The data in the following analyses comes from wadeable sites where biological samples were co-located with stream chemistry data collection; non-wadeable (boatable) sites were excluded from these analyses. The colocation of water quality and benthic macroinvertebrate community data within non-tidal streams and rivers in Virginia allowed for relationships between benthic community changes at different parameter concentration ranges to be identified.

The 2012 303(d)/305(b) Integrated report established that nearly 40% of stream miles are considered impaired for aquatic life (as evaluated by benthic macroinvertebrate communities); thus 40% of streams have a VSCI < 60 or CPMI <16 (VDEQ, 2012). Figure 4 was generated using VDEQ's probabilistic monitoring data collected from 2001 through 2010 (n=473) to provide perspective on the parameters commonly linked to benthic macroinvertebrate community impacts and those parameters addressed in the following sections. The major stressors in Virginia are depicted by the horizontal bars in Figure 4. The white and solid circles correspond to parameters with no associated water quality standards (WQS) and those with WQS,

respectively. The percentages shown in the parentheses are the confidence intervals. Thirty-nine percent of Virginia stream miles have excessive sedimentation. Total phosphorus affects over 23% of stream miles. Habitat disturbance affects 17.5% of stream miles and pH < 6 impacts just under 10%. Total Nitrogen, dissolved oxygen, and dissolved metals (Cumulative Criterion Unit discussed later in this document) affect 5% or fewer stream miles. Because WQS are seldom based on biological community response data, the challenge emerges as TMDL Coordinators and contractors attempt to categorize constituents as non-stressors, possible stressors, and probable stressors in a defensible manner. This chapter provides context for the major stressors and linkages to aquatic life effects.

The stressor thresholds were developed using Virginia's probabilistic dataset and are categorized based on their effect on benthic macroinvertebrate communities. The approach in developing the probability of stress categories began with simple graphical analyses to look for relationships between parameter results gradients and benthic macroinvertebrate community response. Basically, this visual analysis determined which parameters were showing an effect on benthic macroinvertebrate multimetric index scores. Once the parameters were identified, the following literature-published statistical tools were applied to the datasets: quantile regression and conditional probability. The stressor thresholds were defined at levels where a change in benthic macroinvertebrate community structure was detected. The stressor threshold cutoff ranges were then tested using box-and-whisker plots to confirm the multimetric index response. Box-and-whisker plots are a graphical technique used to display a spread of data. Appendices A-M provide supporting statistical analysis.

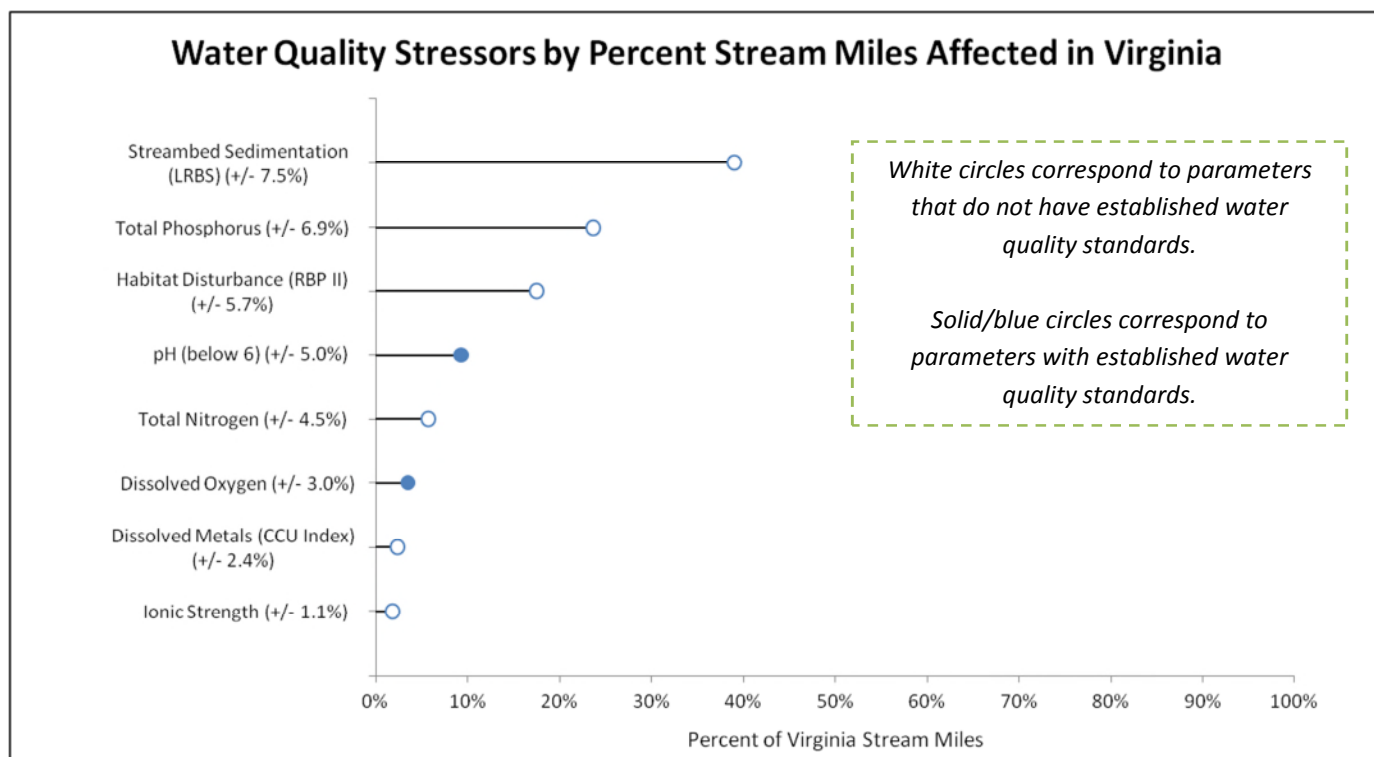


Figure 4. Water quality stressors by percent stream miles affected. Confidence limits range from +/-0.1% to +/- 7.5% from the constituent corresponding to the lowest % stream miles affected to the highest, respectively.

The following sections include a discussion of background information and statewide perspective on the following parameters that can be considered stressors: dissolved oxygen, pH, Total Phosphorus, Total Nitrogen, dissolved metals, conductivity, ionic strength/total dissolved solids, streambed sedimentation (Relative Bed Stability), habitat and SOCINaK (dissolved sulfate, chlorides, sodium, potassium). The sections are set up to (1.) provide a foundation for understanding the parameter, (2.) discuss how the parameter interacts in the environment and affects aquatic life, (3.) show categories of probability of stress to aquatic life, and (4.) present box-and-whisker plots and corresponding percentile tables of the parameter by basin, stream order and Level III Ecoregion. Of particular importance is the fact that the Commonwealth does not have WQS for many of these parameters. Without WQS, it is a challenge to evaluate these stressors during the TMDL development process.

In-depth analyses including conditional probability and cumulative distribution functions for each parameter are presented in the appendices. Note that Section 3.1 provides a foundation for interpreting the analytical techniques used to illustrate parameter presence and relation to benthic macroinvertebrate communities. Though temperature and hydrology are not discussed



in depth, VDEQ recognizes that they are potential stressors. VDEQ does not currently have datasets expansive enough to calculate the probability of stress to aquatic life from temperature and/or hydrology.

## **Guide for Interpreting Graphics**

The following graphics prepare readers for informed graph interpretation and facilitate an understanding of fundamental concepts that are critical to using the information presented in this document. Additional statistical analyses related to the stressor parameters may be found in the appendices.

## ***Interpreting Box-and-Whisker plots***

Figure 5 presents an example box and whisker plot. These graphs are heavily utilized throughout the document to compare each parameter to specific variables (Basins, Stream Order, and Virginia Level III Ecoregions). Box and whisker plots reveal more information about the spread of a dataset than simply stating averages or ranges, for example. The “box” is bounded by lines on the top and bottom corresponding to values of the 75<sup>th</sup> and 25<sup>th</sup> percentile, respectively, with a median line plotting within the box indicating the middle value in the dataset. “Whiskers” protrude from each end of the box with lengths corresponding to the highest and lowest values. One identifies skew in the spread of the data when the median drifts closer to either the 25<sup>th</sup> or 75<sup>th</sup> percentile and/or one whisker is elongated compared to the other.

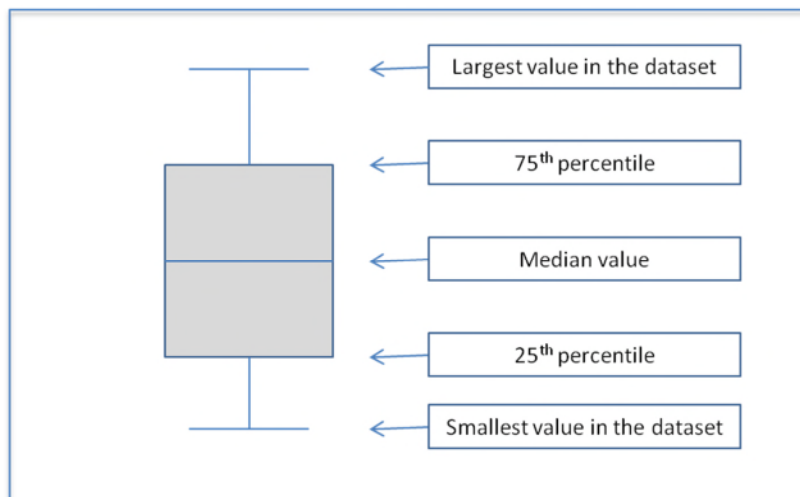


Figure 5. Sample box-and-whisker plot.

### ***Level III Ecoregions***

Ecoregions provide a hierarchical organizational structure to spatially describe interrelated environmental regions. The US EPA subdivides geographically and ecologically similar ecosystems into levels of ecoregions presenting homogenous components (e.g. geology, soils, vegetation, climate, etc.). Level III ecoregions in Virginia include the Piedmont, Northern Piedmont, Ridges and Valleys, Southeastern Plains, Blue Ridge Mountains, Central Appalachians, and Middle Atlantic Coastal Plains (Figure 6). The focus of this document on freshwater systems excludes Middle Atlantic Coastal Plain ecoregion sites in analyses.

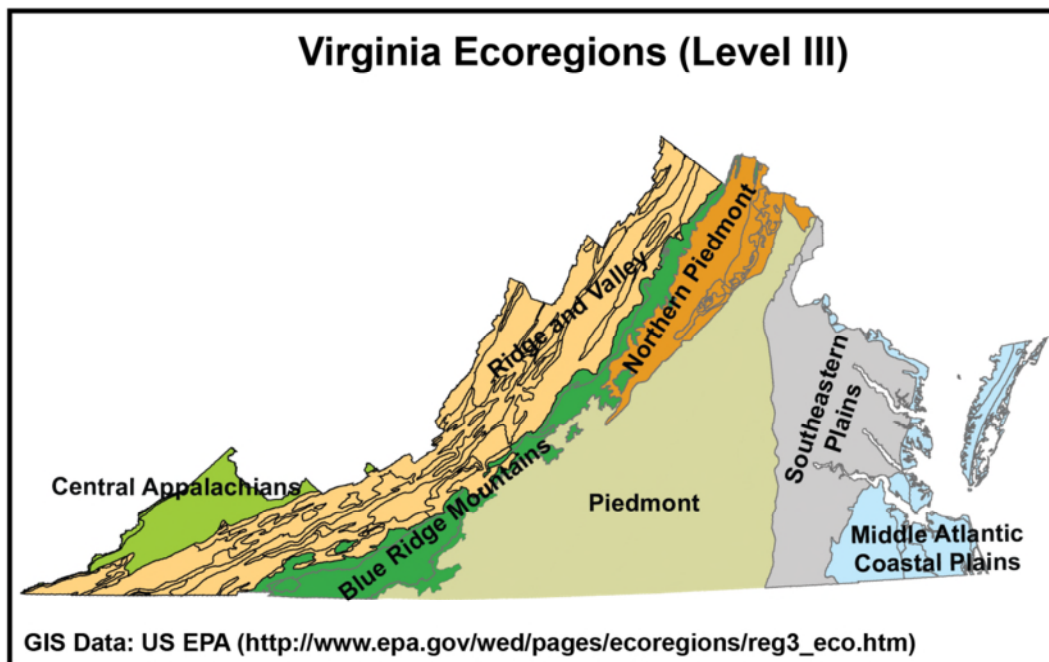


Figure 6. Virginia Ecoregions (Level III).

### ***Virginia's Major River Basins***

Data is presented by major river basin and in some cases basins are combined into larger basins. The map in Figure 7 depicts the location and grouping of river basins. The Potomac and Shenandoah were combined into a larger basin as were the Rappahannock and York for analyses purposes. These basins and combined basins are called "Superbasins."

# Virginia Superbasins



Figure 7. Major Virginia river basins.

## Stressor Parameters

The following sections include a description of each evaluated stressor parameter, a discussion of the parameter's presence/interactions in the environment, the parameter's stressor thresholds, and a presentation of those thresholds in the context of basin, ecoregion and stream order.

The threshold ranges are depicted by the following colors relating to no, low, medium and high probability of stress to aquatic life: blue, green, yellow and red, respectively. The stressor threshold colors correspond to the associated table and box-and-whisker plots. Each parameter has additional statistical analyses presented in the Appendices of this document. The probability of stress categories were developed by analyzing benthic macroinvertebrate

community responses (represented by VSCI and CPMI scores) through a variety of statistical techniques: relative risk, relative extent, conditional probability and quantile regression. The results were interpreted into probability of stress categories. The results were interpreted into stress categories. Specifically, “No Stress to Aquatic Life” means that a parameter range reflects an undisturbed, or background, condition in Virginia. “Low Probability of Stress to Aquatic Life” represents a benthic macroinvertebrate community response that is slightly above background conditions but unlikely to cause a major community shift. The next category is “Medium Probability of Stress to Aquatic Life” and means there is noticeable evidence of harm causing a possible shift in benthic communities with changes noticeably above background conditions. The “High Probability of Stress to Aquatic Life” threshold corresponds to values that are among the highest in the Commonwealth and result in degradation of the benthic community. The stressor threshold summary of tables is presented in Table 1.

## ***Dissolved Oxygen***

Most organisms require oxygen to sustain life. While terrestrial plants and animals enjoy consistent oxygen levels nearly everywhere on Earth, oxygen availability in aquatic environments can vary drastically. The amount of oxygen available to organisms living in water is known as dissolved oxygen (DO). Healthy aquatic communities require higher DO concentrations to sustain life while low DO levels stress sensitive organisms, forcing them to use more energy to perform basic life functions.

To assess the quality of an aquatic habitat, scientists measure the concentration of DO in units of milligrams of oxygen per liter of water (mg/L). If DO levels drop below optimum oxygen concentrations, mobile organisms (e.g. fish) swim or crawl away to more hospitable environments leaving immobile organisms (e.g. benthic invertebrates) to risk death in a stressed environment. Some tolerant organisms thrive in lower oxygen environments (e.g. snails and black fly larva) and an increased abundance of these tolerant species indicates low DO conditions that can lead to hypoxia or anoxia.

Dissolved oxygen levels vary with environmental conditions, thus DO concentrations are expected to differ between mountainous, high grade streams and low gradient, meandering rivers. Water temperature, salinity, turbulence, and stream elevation are natural variables that affect DO concentrations, in addition to biologically-controlled photosynthesis-respiration processes (Figure 8).

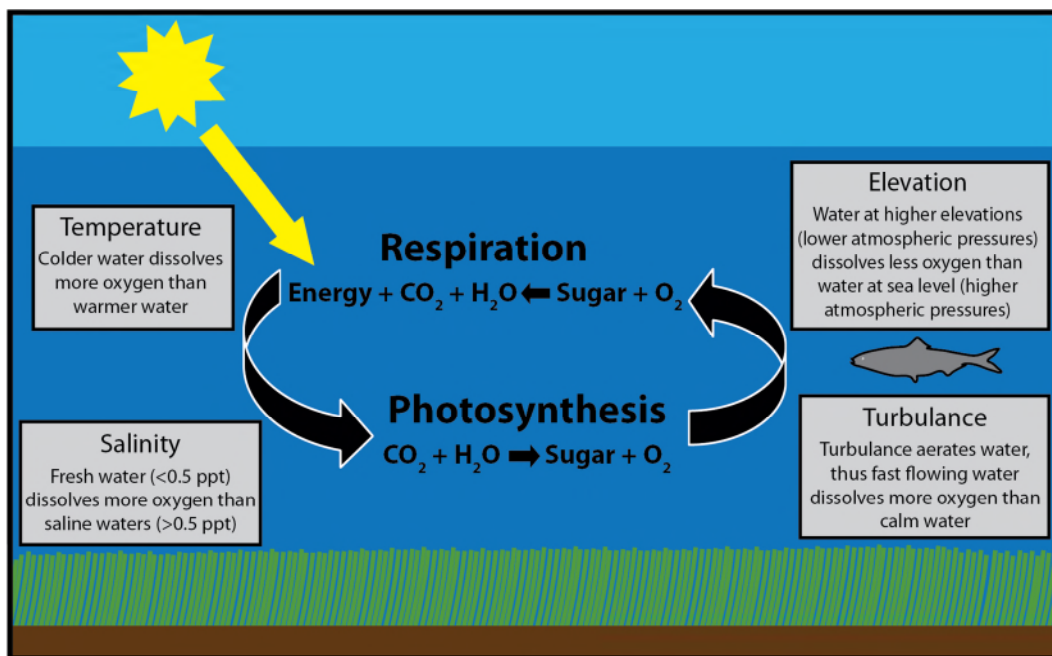


Figure 8. Natural controls of Dissolved Oxygen concentrations.

Dense plant growth can alter DO concentrations on daily and seasonal cycles. In this situation, extremely high oxygen levels develop during the day as a byproduct of photosynthesis, followed by dramatic drops in the oxygen concentration at night due to respiration. In natural systems, these processes remain in balance, creating healthy aquatic environments; however, anthropogenic modifications alter this equilibrium and often induce eutrophic conditions.

Humans primarily modify natural DO levels through nutrient loading and organic waste deposition from residential, agricultural, and industrial sources polluting waterways. Pollution and excess nutrients stimulate increases in algal growth, contributing to daily swings in both DO and pH levels.

#### Dissolved Oxygen in Virginia

The following figures present a baseline for DO concentrations, offer a variety of approaches to interpreting DO data, and provide perspective on DO concentrations relative to impacts on aquatic life. DO data are reflective of 471 stations that were randomly selected across Virginia. Two samples were excluded because equipment failed a routine check. A majority of the samples were collected during spring and fall; in order to use all available data, DO (mg/L) samples are averaged into one number per year for analysis. The data in the following analyses

comes from wadeable sites where biological samples were co-located; non-wadeable (boatable) sites were excluded from this work.

The first section shows DO (mg/L) distributions statewide, by ecoregion, by Strahler stream order, and by major river basin. To ease visualization of stressor categories, all graphics follow a uniform background color scheme based on thresholds of relative probability of stress to aquatic health (Table 4). Appendix B presents linkages between the stressor and aquatic health and contains the statistical basis for the probability of stress categories. Specifically, “No Stress to Aquatic Life” means that a parameter range reflects an undisturbed, or background, condition in Virginia. “Low Probability of Stress to Aquatic Life” represents a benthic macroinvertebrate community response that is slightly above background conditions but unlikely to cause a major community shift. The next category is “Medium Probability of Stress to Aquatic Life” and means there is noticeable evidence of harm causing a possible shift in benthic communities with changes noticeably above background conditions. The “High Probability of Stress to Aquatic Life” threshold corresponds to values that are among the highest in the Commonwealth and result in degeneration of the benthic community. The stressor threshold summary of tables is presented in Table 1.

Table 4. Dissolved Oxygen (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Probability of Stress to Aquatic Life	Dissolved Oxygen (mg/L)
High	< 7
Medium	> 7, < 8
Low	>8, <10
None	>10

Though the Virginia freshwater DO standard is 4.0 mg/L (Class II – IV, 9VAC25-260-50 Virginia Water Quality Standards), high stress conditions for benthic macroinvertebrate communities most likely occur when DO values fall below 7.0 mg/L. This discrepancy derives from VDEQ’s monitoring of DO conditions during daylight hours when measured oxygen levels are higher due to algal photosynthesis. Thus, when oxygen levels are observed in the field that fall in the medium and high probability of stress categories during daylight hours, it is highly recommended that a diurnal DO study take place during a low flow, high temperature time of year to determine if oxygen levels are meeting water quality standards. The DO probability of stress categories presented in Table 4 applies to non-tidal, or non-coastal, streams. In order to

fully understand the effect of DO in the coastal plain areas of Virginia, a natural conditions evaluation needs to be performed.

Figure 9 presents box-and-whisker plots of DO statewide and by basin. The shading in Figure 9 corresponds to the probability of stress categories in Table 4.

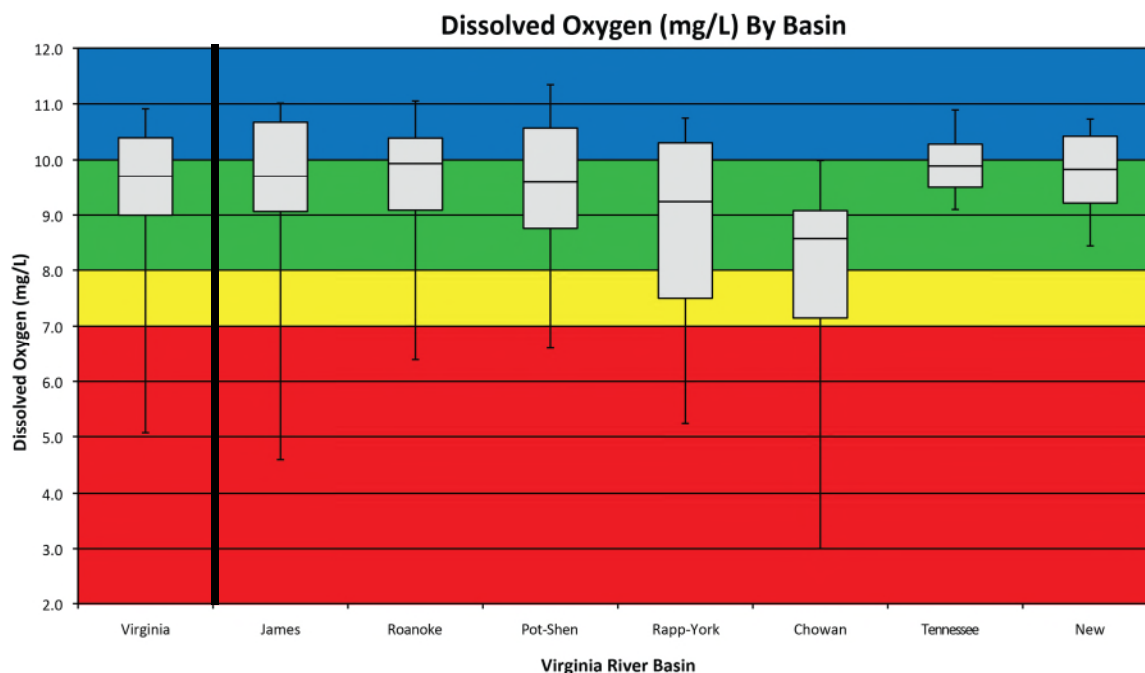


Figure 9. Boxplots of Dissolved Oxygen statewide and by basin (n = 471).

All median DO measures, including statewide (first box-and-whisker plot in Figure 9), fall within the low probability range from 8.0 mg/L to 10.0 mg/L. Quartile ranges, the top and bottom lines of the box and whisker plot, delineate the 75<sup>th</sup> and 25<sup>th</sup> percentiles, respectively. The Chowan basin is significantly different from all other basins based on DO levels as nearly 75% of sites within the Chowan lie below 9.0 mg/L. Table 5 depicts the percentiles associated with Figure 9.



Table 5. Percentile Tables of Dissolved Oxygen statewide and by basin (n = 471).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	5.068	4.593	6.390	6.600	5.250	3.000	9.100	8.450
5Pct	7.093	7.771	7.062	6.600	5.250	5.850	9.100	8.980
10Pct	7.794	8.504	8.433	7.932	6.906	5.856	9.105	8.995
25Pct	8.996	9.062	9.086	8.763	7.499	7.146	9.497	9.214
50Pct	9.698	9.698	9.937	9.592	9.239	8.582	9.892	9.833
75Pct	10.394	10.672	10.389	10.568	10.304	9.079	10.281	10.423
90Pct	10.912	11.011	11.051	11.357	10.745	9.991	10.892	10.728
95Pct	11.332	11.484	11.164	11.444	10.816	10.090	11.507	11.046
99Pct	11.940	11.923	11.651	12.372	11.330	10.178	11.966	11.974

Figure 10 depicts DO data by stream order. The median DO levels for all but the fourth order streams remain in the low probability stressor category. Fourth order streams fall into the no probability of stress category with a median value of 10.1 mg/L. Stream order does not appear to produce a trend in median DO levels. Resultant percentiles associated with Figure 10 are shown in Table 6.

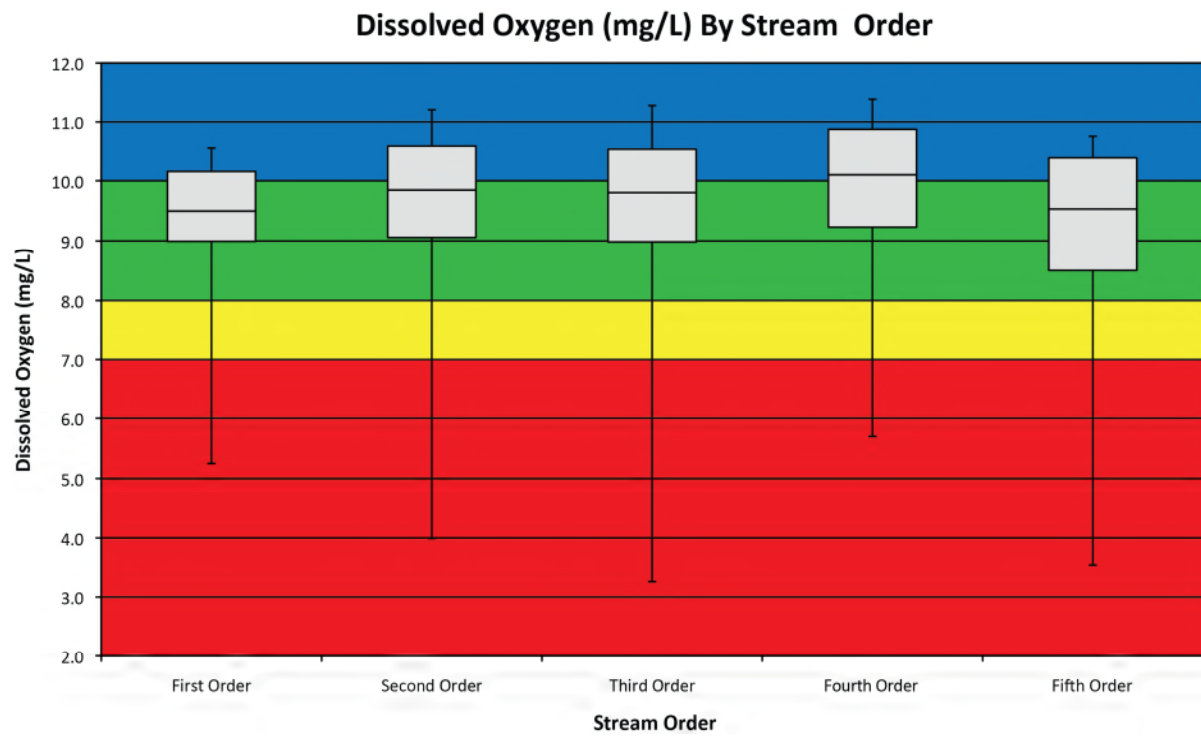


Figure10. Boxplots of Dissolved Oxygen by stream order (n = 471).

Table 6. Percentile tables of Dissolved Oxygen by stream order (n = 471).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	5.250	3.993	3.257	5.700	3.550
5Pct	7.075	7.273	6.621	7.178	4.071
10Pct	7.510	8.035	7.659	7.970	7.314
25Pct	8.994	9.058	8.985	9.230	8.500
50Pct	9.498	9.846	9.803	10.100	9.530
75Pct	10.155	10.596	10.544	10.878	10.400
90Pct	10.563	11.203	11.274	11.380	10.760
95Pct	10.953	11.378	11.651	11.980	11.360
99Pct	11.545	12.071	11.923	12.706	11.616

Figure 11 explains Dissolved Oxygen variations by EPA Level III Ecoregions. The Southeastern Plains contrast most significantly with other regions as nearly 75% of sites fall below the lower 25% of streams from other regions. The Ridge and Valley region assumes the highest median DO levels with the upper half of the dataset meeting the no stress threshold. Table 7 follows with details on percentiles associated with Figure 11.

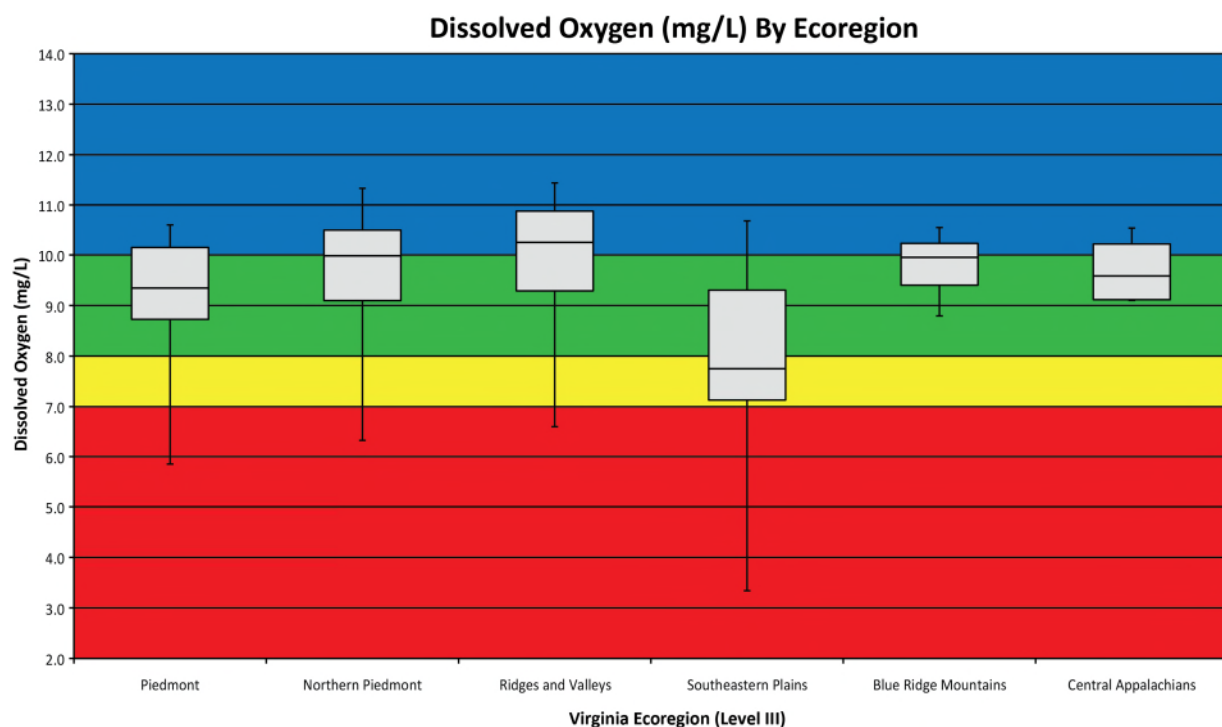


Figure 11. Boxplots of Dissolved Oxygen by Virginia Ecoregion (Level III).

Table 7. Percentile tables of Dissolved Oxygen by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	5.851	6.325	6.600	3.340	8.795	9.100
5Pct	6.951	7.614	8.122	4.432	8.795	9.100
10Pct	7.691	8.677	8.430	5.094	8.994	9.100
25Pct	8.728	9.097	9.290	7.131	9.401	9.115
50Pct	9.346	9.985	10.252	7.749	9.954	9.586
75Pct	10.149	10.497	10.878	9.304	10.232	10.220
90Pct	10.601	11.332	11.440	10.681	10.549	10.538
95Pct	11.106	11.874	11.708	10.775	10.752	11.349
99Pct	11.603	12.267	12.240	11.081	11.070	11.721

### Dissolved Oxygen Recommendations for Aquatic Life

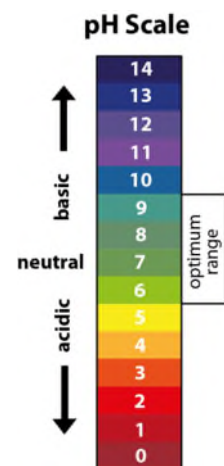
VSCI scores are not likely to be depressed from average Dissolved Oxygen concentrations above 8 mg/L (Table 4). Average DO below 7 mg/L may not support healthy benthic communities and average DO below 8 mg/L warrants an evaluation by TMDL and monitoring staff of the need for a diurnal oxygen study during a low flow high temperature period. The DO probability of stress categories presented in Table 4 applies to non-tidal, or non-coastal, streams. In order to fully understand the effect of DO in the coastal plain areas of Virginia, a natural conditions evaluation needs to be performed.

## pH

pH is a measure of the hydrogen ion ( $H^+$ ) concentration in an aqueous solution. The pH scale expresses a solution's hydrogen ion activity, ranging from zero to 14, with acids encompassing lower pH measures ( $pH < 7$ ) and bases or alkalis including the higher end of the scale ( $pH > 7$ ). A neutral solution has a pH of 7. Because the pH scale is logarithmic, pH measures increase tenfold with each whole number (e.g. a solution of pH 6 is 10 times more acidic than one of pH 7, just as a solution of pH 8 is 10 times more alkaline than one of pH 7). The combination of acids and bases results in neutralization and salt formation.

pH levels control the solubility of chemicals in water, thus pH has great bearing on nutrient availability. Aquatic organisms tolerate a relatively small pH range (6 - 9) with waters near neutral providing the least amount of stress (9-VAC25-260-140). Extreme pH values irritate fish and amphibian skin and membranes, reduce hatchery success, and impair general life functions. pH varies with photosynthesis/respiration rates, regional geology, vegetation, and precipitation, among other natural forcing mechanisms:

- Photosynthesis/respiration: Photosynthesis utilizes dissolved carbon dioxide ( $CO_2$ ) and lowers carbonic acid ( $H_2CO_3$ ), decreasing the hydrogen ion concentration of water and thus raising pH. Because the balance of photosynthesis-respiration cycles daily and seasonally with available sunlight, so too does pH, rising throughout the day and in summer months and lowering at night and in winter, respectively (Figure 12).
- Regional geology: As water erodes rock and passes through interstitial spaces below ground, minerals are incorporated as chemical constituents into streams and groundwater, affecting pH levels. Waters dominated by limestone, a calcium carbonate-rich ( $CaCO_3$ ) rock are naturally more alkaline. Alternatively, granites and shales do not contain minerals that actively react with hydrogen ions in water, so waters flowing through these rock sources are naturally less alkaline.
- Vegetation: As leaf and organic litter decomposes in water,  $CO_2$  is released, raising carbonic acid levels and thus lowering pH within a water body. This process can have significant effects in the late summer and fall months as vegetation drops leaves in preparation for winter. Forest composition also influences stream pH by affecting soil chemistry. For example, pine forests naturally generate more acidic soils, which lower pH in adjacent streams through runoff and needle deposition.
- Precipitation: Rain and snow are typically slightly acidic ( $pH = 5-6$ ) and



can influence water pH in tropical regions that experience “wet” seasons or after heavy precipitation events.

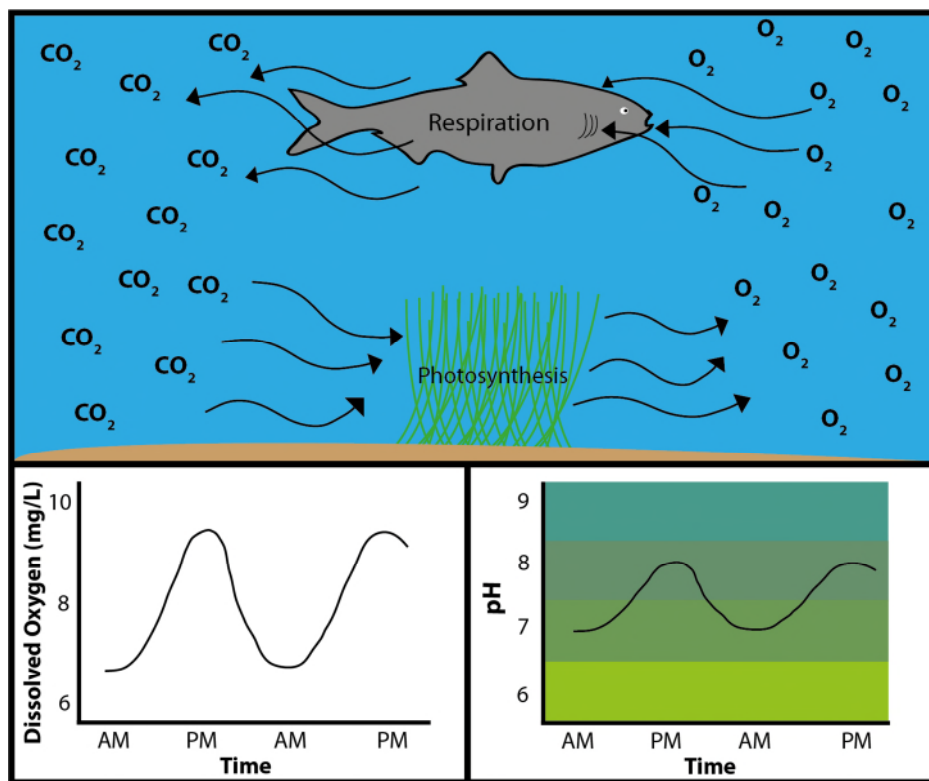


Figure12. Photosynthesis/respiration influences on Dissolved Oxygen and pH.

Humans affect water pH by polluting the waterways and atmosphere. Rapid pH changes stress aquatic organisms, so the ability of water to resist such changes, or its buffering capacity, is very important when considering aquatic health. Alkaline waters neutralize acids as they are added through natural or anthropogenic sources. Sites with low pH values in non-coastal ecoregions may indicate influence from either acid rain or acid mine drainage. VDEQ can collect additional parameters, including Acid Neutralizing Capacity (ANC) and sulfate data at monitoring sites as appropriate. High sulfate values with normal ANC in low pH streams are indicative of acid mine drainage whereas streams with low sulfate and low ANC values are susceptible to episodic acidification from acid rain (USEPA 2000).

Point source pollutants often originate from industrial waste dumps and mine runoff. Regulations necessitate wastes comply with acceptable pH ranges prior to emission; however, even small changes in pH can be detrimental to sensitive aquatic environments. Acid rain is a major nonpoint source contributor to anthropogenic pH adjustments. Vehicle engines and industry release excess  $\text{CO}_2$  into the atmosphere, which combines with rain as it condenses in

the troposphere. This acidified precipitation falls over large areas, augmenting natural pH levels in streams and lakes, impairing vegetation and soils, causing public health issues, and damaging crucial infrastructure over time. Additionally, though nutrient loading does not directly change pH, it remains a serious contributor to pH levels because it stimulates aquatic plant growth, causing larger daily swings in pH with the photosynthesis/respiration cycle.

#### pH in Virginia

The following graphics are presented to establish a baseline for pH concentrations, offer a variety of approaches to interpreting pH data, and provide some perspective on pH concentrations relative to its impacts on aquatic life. The first section shows pH distributions statewide by basin, stream order, and ecoregion. The pH appendix section contains statistical distribution information for pH. The pH water quality standard should be used to determine if pH exceeds the recommended stressor threshold levels.

pH stressor thresholds depicted in Table 8 derive from probability of stress to aquatic life. VSCI scores are not likely to be depressed from average pH concentrations that are within Virginia water quality standards (Table 8). The water quality standards for pH are protective such that excursions of the standards indicate a water quality problem that warrants further investigation.

Table 8. pH concentration ranges and associated probability of stress to aquatic life (based on Virginia's water quality standards).

pH	
Probability of Stress to Aquatic Life	Concentration (unitless)
Medium	< 6
Low	6 to 9
Medium	> 9

Figure 13 presents box-and-whisker plots of pH statewide and by basin. Median scores, 25<sup>th</sup> percentiles, and 75<sup>th</sup> percentiles fall within the low stress range for all basins and statewide. The shading in Figure 13 corresponds to the probability of stress categories in Table 8.

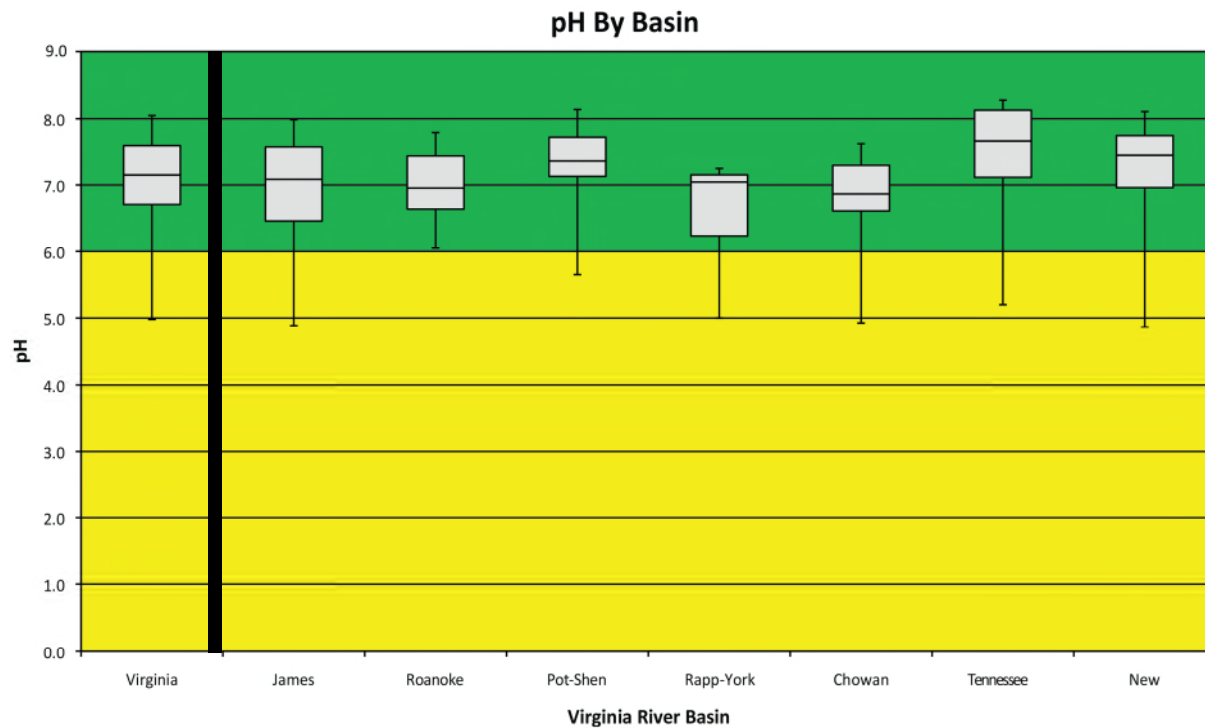


Figure 13. Boxplots of pH statewide and by basin (n = 473).

The percentiles associated with Figure 13 are shown in Table 9. Note that the quartile ranges (the top and bottom of the boxes in the box-and-whisker plot) correspond to the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively. The Tennessee and New River basins are among the highest median pH ranges in the state.

Table 9. Percentile tables of pH statewide and by basin (n = 473).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	4.98	4.88	6.05	5.65	5.00	4.93	5.20	4.86
5Pct	6.02	5.94	6.21	6.56	5.00	5.66	5.20	5.64
10Pct	6.23	6.20	6.29	6.73	5.68	6.22	6.31	6.76
25Pct	6.71	6.46	6.64	7.13	6.24	6.61	7.11	6.96
50Pct	7.15	7.08	6.95	7.37	7.05	6.86	7.67	7.45
75Pct	7.60	7.58	7.44	7.72	7.15	7.30	8.13	7.75
90Pct	8.05	7.98	7.79	8.14	7.25	7.63	8.28	8.11
95Pct	8.20	8.18	7.86	8.19	7.45	7.68	8.47	8.13
99Pct	8.47	8.37	8.31	8.38	7.59	7.71	8.60	8.43



Figure 13 depicts pH data by stream order. The median pHs for first order and second order streams are the lowest. It appears that median pH increases with increasing stream order.

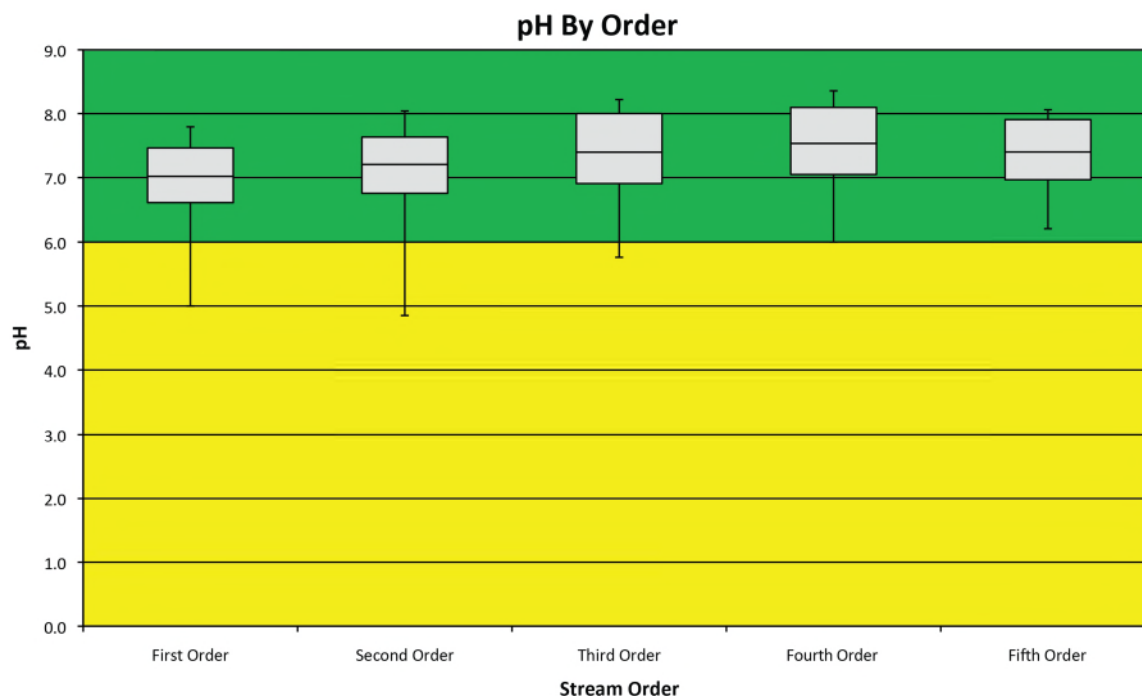


Figure 14. Boxplots of pH by stream order (n = 473).

Table 10 displays the percentiles depicted in Figure 14 with the associated colors matching stress categories explained in Table 8.

Table 10. Percentile tables of pH by stream order (n = 473).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	5.00	4.85	5.77	6.00	6.21
5Pct	5.77	5.76	6.34	6.32	6.39
10Pct	6.19	6.18	6.55	6.69	6.62
25Pct	6.61	6.75	6.90	7.05	6.97
50Pct	7.02	7.21	7.40	7.54	7.40
75Pct	7.46	7.63	8.00	8.10	7.91
90Pct	7.79	8.04	8.22	8.36	8.06
95Pct	8.05	8.24	8.38	8.44	8.26
99Pct	8.16	8.39	8.64	8.65	8.58

Figure 14 demonstrates pH variations by Virginia Ecoregions (Level III). All median values are within the low stress range with the 25<sup>th</sup> percentile of the Southeastern Plains dipping slightly into the median stress range.

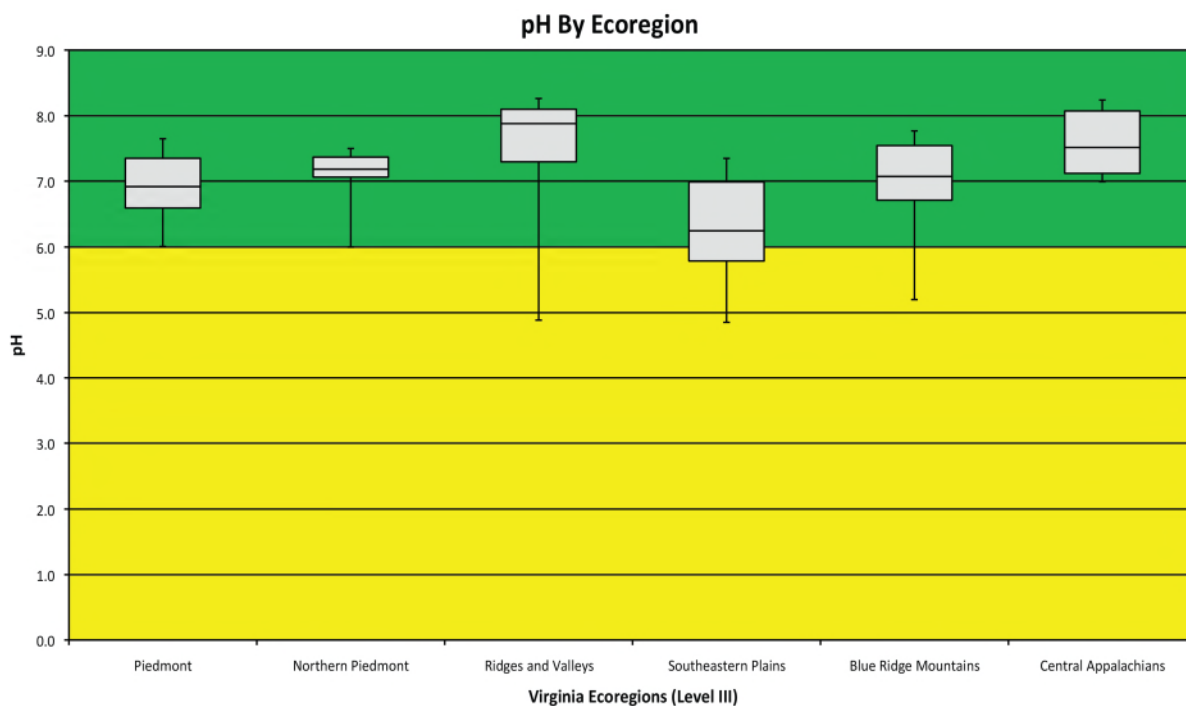


Figure15. Boxplots of pH by Virginia Ecoregion (Level III).

Percentiles reported in Figure 15 are expressed explicitly in Table 11 using the same background shading scheme from Table 8.

Table 11. Percentile tables of pH by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	6.01	6.00	4.88	4.85	5.20	6.99
5Pct	6.21	6.08	6.12	4.94	5.20	6.99
10Pct	6.25	6.41	6.69	4.98	6.26	6.99
25Pct	6.59	7.06	7.30	5.79	6.71	7.12
50Pct	6.92	7.18	7.88	6.25	7.07	7.51
75Pct	7.35	7.37	8.10	6.99	7.54	8.07
90Pct	7.65	7.50	8.26	7.35	7.77	8.24
95Pct	7.75	7.66	8.39	7.37	7.91	8.43
99Pct	7.88	8.11	8.63	7.49	8.17	8.71

#### pH Recommendations for Aquatic Life

VSCI scores are not likely to be depressed from average pH concentrations that are within Virginia water quality standards (Table 8). If pH levels are above 9 or below 6, it is important to make sure pH levels are not altered due to natural conditions (i.e. low pH values are natural in many swamps in eastern Virginia).

### ***Total Phosphorus***

Phosphorus is vital for energy transfer in photosynthesis, thus it is an essential macronutrient required for plant growth. The limited availability of phosphorus in nature restricts primary productivity and subsequently controls aquatic ecosystem health. Uninhibited plant growth promoted by excess phosphorus leads to algal blooms, eutrophication, and anoxia, all of which are detrimental to macroinvertebrate and fish communities.

Phosphorus availability is controlled by local geology and soil profiles (Figure 15). Inorganic phosphorus erodes from rock and soil minerals as phosphate ( $\text{PO}_4^{3-}$ ) and is converted to organic phosphate by aquatic plants. Organic phosphate travels upwards through trophic levels until it is lost as waste or organism death occurs. Bacterial decomposition converts organic phosphate back into inorganic phosphate where it reenters the water column to be used again by plants. However, inorganic phosphate readily attaches to sediments and is more likely deposited onto the substrate and eventually transformed back into rock than become available for plant utilization (Figure 15). Thus, phosphorus loads are naturally low in most aquatic systems.

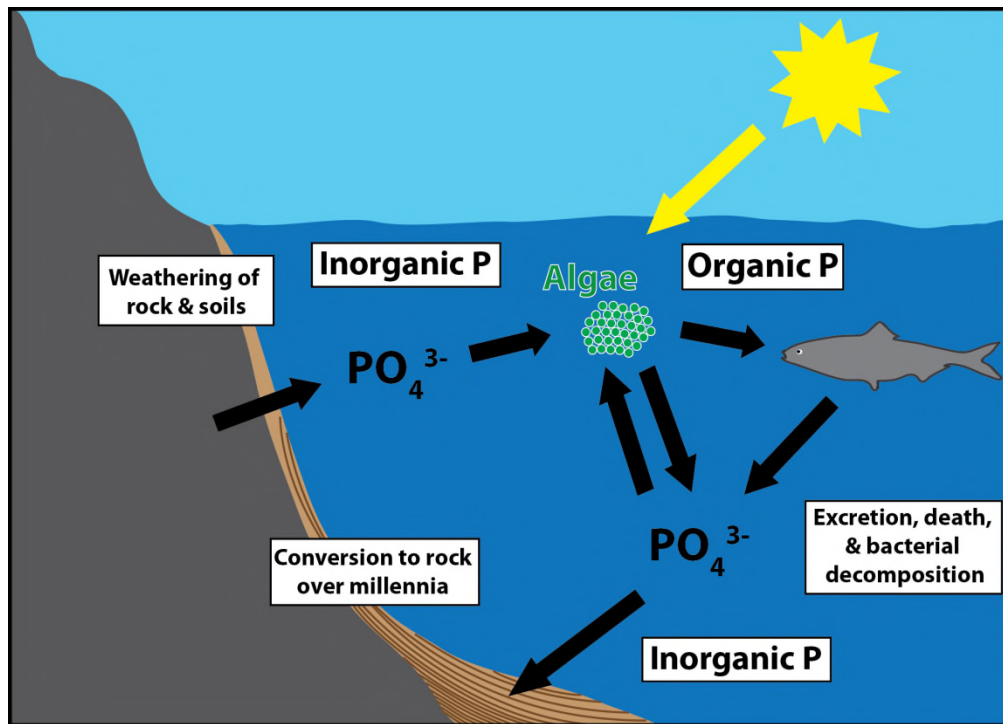


Figure 16. Phosphorus cycle.

Total Phosphorus is the quantity of organic and inorganic phosphorus (suspended and dissolved) measured in milligrams of phosphorus per liter of water (mg/L). Total Phosphorus levels exceeding 0.05 mg/L in freshwater environments contribute to shifts in biological communities and degrade aquatic health.

Because the phosphorus cycle is heavily dependent upon erosion occurring on geologic timescales, humans accelerate the process to increase availability of this limited nutrient. Industrial phosphorus mining operations generate fertilizers that are used extensively in modern agricultural practices. Excess fertilizer applied to residential and agricultural land enters the water column through runoff. Additional phosphorus inputs include poorly treated sewage effluent, municipal and industrial discharge, and improperly contained livestock waste. Artificially increased phosphorus loads in both fresh and saltwater ecosystems promote surplus plant growth. Eutrophication often ensues as plants and/or algal blooms die and bacteria deplete dissolved oxygen levels to decompose organic matter, leading to fish kills and poor aesthetics.

#### Total Phosphorus in Virginia

The following series of graphics are presented to establish a baseline for TP concentrations, offering a variety of approaches to interpret TP data in addition to perspective on TP

concentrations relative to impacts on aquatic life. Table 12 summarizes TP thresholds based on predicted probability of stress to aquatic life. TP concentrations less than 0.02 mg/L are considered to be a non-stressor to aquatic life. Concentrations between 0.02 and 0.05 are considered to have a low probability of stress to aquatic life. TP concentrations above 0.05 mg/L, but below 0.1 mg/L mean that there is a medium probability of stress to aquatic life. When TP concentrations are greater than 0.1 mg/L, there is a high probability of stress to aquatic life.

Table 12. Total Phosphorus (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Probability of Stress to Aquatic Life	Total Phosphorus (mg/L)
High	> 0.1
Medium	> 0.05, < 0.1
Low	> 0.02, < 0.05
None	< 0.02

Subsequent graphics depict Total Phosphorus (mg/L) distributions statewide, by ecoregion, by stream order, and by basin. The Total Phosphorus appendix section links the stressor to aquatic health and contains the statistical information for the recommended stressor threshold levels.

Figure 17 presents box-and-whisker plots of TP statewide and by basin. The Rappahannock-York Basin has the highest median TP. Median TP for the James, Roanoke, Tennessee, and New basins are between 0.000 mg/L and 0.020 mg/L, within the range presenting no stress to aquatic life. Note that the median TP for Virginia is just barely under 0.020 mg/L and medians for both the Roanoke and James Basins are nearly identical to the median for Virginia. The shading in Figure 17 corresponds to the probability of stress categories in Table 12.

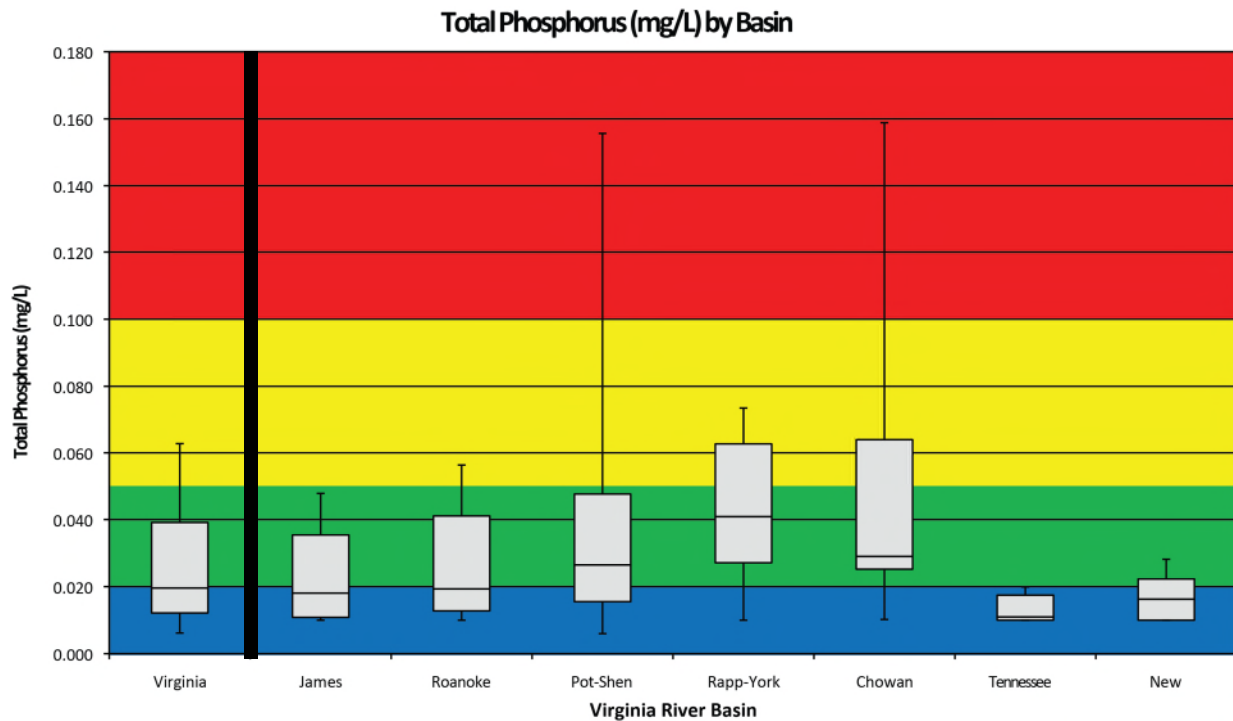


Figure 17. Boxplots of Total Phosphorus statewide and by basin (n = 471).

The percentiles associated with Figure 17 are shown in Table 13. Note that the quartile ranges (the top and bottom of the boxes in the box-and-whisker plot) correspond to the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively. Aside from the Potomac-Shenandoah, Rappahannock-York, and Chowan basins, most TP values are within the no to low probability of stress to aquatic life ranges.

Table 13. Percentile tables of Total Phosphorus statewide and by basin (n = 471).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	0.006	0.010	0.010	0.006	0.010	0.010	0.010	0.010
5Pct	0.007	0.010	0.010	0.007	0.015	0.012	0.010	0.010
10Pct	0.008	0.010	0.010	0.008	0.017	0.014	0.010	0.010
25Pct	0.012	0.011	0.013	0.016	0.027	0.025	0.010	0.010
50Pct	0.020	0.018	0.019	0.026	0.041	0.029	0.011	0.016
75Pct	0.039	0.035	0.041	0.048	0.063	0.064	0.017	0.022
90Pct	0.063	0.048	0.056	0.156	0.073	0.159	0.020	0.028
95Pct	0.097	0.049	0.076	0.172	0.122	0.282	0.024	0.030
99Pct	0.273	0.070	0.141	0.335	0.217	0.316	0.070	0.034

Figure 18 depicts TP data by stream order. The median values show some variability in TP by stream order but no significant differences.

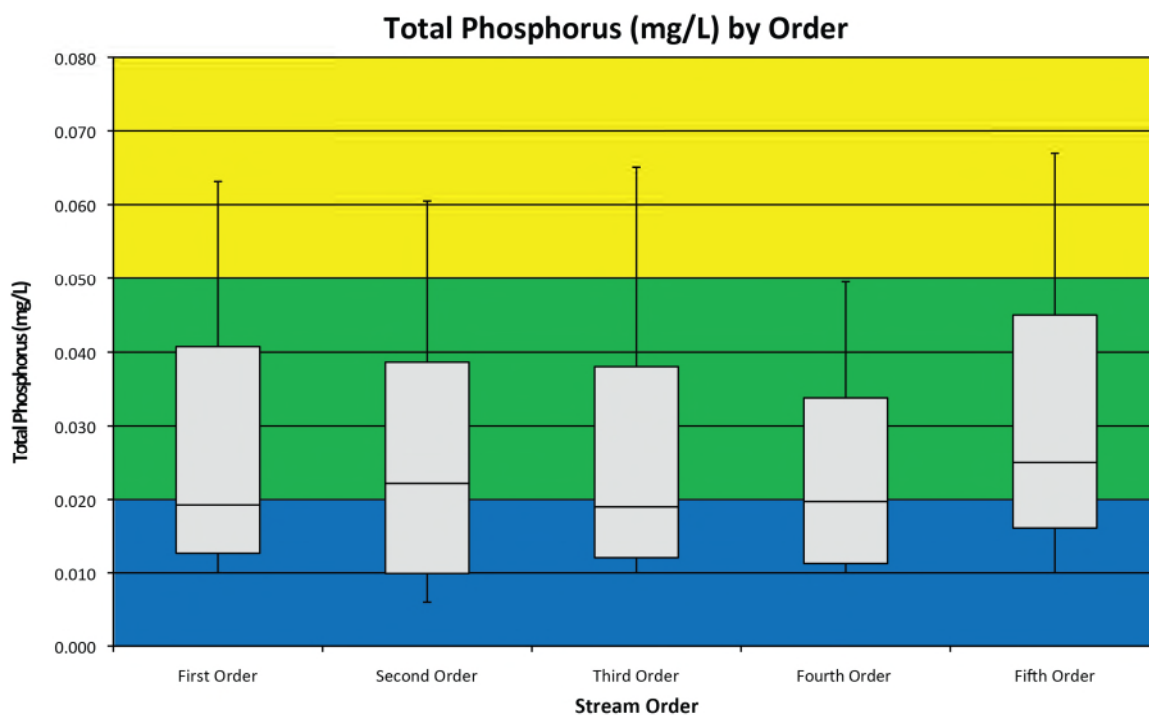


Figure 18. Boxplots of Total Phosphorus by stream order (n = 471).

Table 14 states the percentiles associated with Figure 17. Though no significant differences were noted between stream orders, fifth order streams report the highest overall TP levels.

Table 14. Percentile tables of Total Phosphorus by stream order (n = 471).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	0.010	0.006	0.010	0.010	0.010
5Pct	0.010	0.007	0.010	0.010	0.010
10Pct	0.010	0.007	0.010	0.010	0.010
25Pct	0.013	0.010	0.012	0.011	0.016
50Pct	0.019	0.022	0.019	0.020	0.025
75Pct	0.041	0.039	0.038	0.034	0.045
90Pct	0.063	0.061	0.065	0.050	0.067
95Pct	0.083	0.126	0.088	0.076	0.137
99Pct	0.210	0.187	0.341	0.107	0.473

Figure 19 illustrates TP by Virginia Ecoregion (Level III). The Southeastern Plains median value lies within the medium probability of stress range. Median TP values from all other regions remain within the low probability of stress to no stress range.



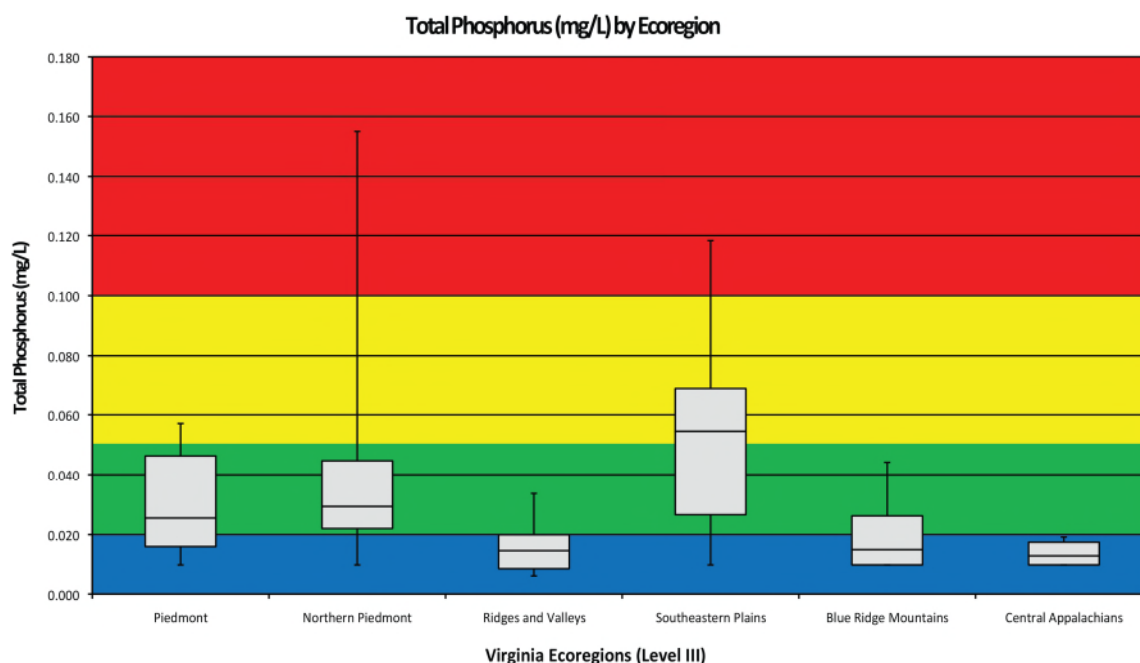


Figure 19. Boxplots of Total Phosphorus by Virginia Ecoregion (Level III).

Table 15 presents the percentiles shown in Figure 19. Note that the quartile ranges (the top and bottom of the boxes in the box-and-whisker plot) correspond to the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively.

Table 15. Percentile tables of Total Phosphorus by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	0.010	0.010	0.006	0.010	0.010	0.010
5Pct	0.010	0.012	0.006	0.010	0.010	0.010
10Pct	0.010	0.015	0.007	0.016	0.010	0.010
25Pct	0.016	0.022	0.009	0.027	0.010	0.010
50Pct	0.025	0.029	0.015	0.054	0.015	0.013
75Pct	0.046	0.045	0.020	0.069	0.026	0.017
90Pct	0.057	0.155	0.034	0.118	0.044	0.019
95Pct	0.079	0.173	0.054	0.202	0.066	0.020
99Pct	0.147	0.494	0.159	0.300	0.073	0.023

#### Total Phosphorus and Probability of Stress to Aquatic Life

VSCI scores are not likely to be depressed from average Total Phosphorus concentrations less than 0.05 mg/L. Average TP levels above 0.05 mg/L are probable stressors especially in combination with degraded Total Habitat Scores. When average TP concentrations exceed 0.1

mg/L there is a high probability of stress to aquatic life and that the VSCI will not pass the minimum attainment threshold of 60.

## ***Total Nitrogen***

Nitrogen is an essential nutrient for aquatic plants and animals, but it is only available in limited quantities throughout freshwater environments. Though the majority of ambient air is composed of nitrogen ( $N_2$ ), this reservoir is unavailable to most organisms because they lack the necessary chemical processing mechanisms. Thus, specialized cyanobacteria are required to convert or “fix”  $N_2$  into compounds readily useable by aquatic and terrestrial organisms. Of the three forms of inorganic nitrogen naturally occurring in water, nitrate ( $NO_3^-$ ) is most easily utilized by plants for protein production, opposed to nitrite ( $NO_2^-$ ) or ammonium ( $NH_4^+$ ). Nitrogen travels up trophic levels until it is lost as waste ( $NH_4^+$ ) or organism death occurs. Nitrifying bacteria convert ammonium to nitrate, yielding nitrogen available for plant use again. Figure 20 summarizes the nitrogen cycle from nitrogen fixation through nitrification, nitrogen utilization by organisms, and denitrification.

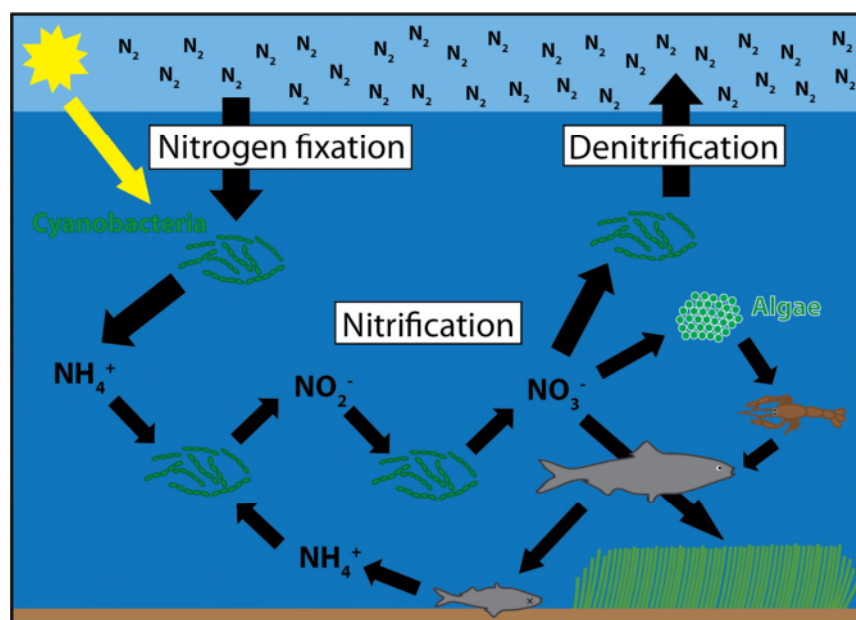


Figure 20. Nitrogen Cycle.

Total Nitrogen is the amount of all nitrogen compounds in a water sample measured in milligrams per liter (mg/L). Consequences of excess TN include the eutrophication of streams and lakes through the overfertilization of algae, which leads to algal blooms, altering not only

the chemistry and biology of a waterway, but also the aesthetics as nuisance algae visually detract from natural ecosystems. Daily swings in dissolved oxygen and pH levels stress aquatic organisms and ultimately trigger shifts in aquatic communities or complete habitat destruction with the onset of hypoxia and anoxia.

Humans may alter natural nitrogen levels through poor agricultural practices, municipal waste disposal, and fossil fuel combustion. Overfertilization and the application of fertilizers outside growing seasons inadvertently stimulate aquatic primary producers when surplus nitrogen enters the waterways through runoff. Mismanagement of agricultural waste (e.g. livestock manure) can also elevate ammonia ( $\text{NH}_3$ ) levels. Technological and regulatory advances in municipal waste disposal denitrify wastewaters to comply with state ordinances; however, treatment plant overflows and failures still occur, releasing point source nutrient pollutants into streams and rivers. Heavy precipitation events can overwhelm stormwater treatment efforts and emit excess nutrients into waterways. Fossil fuel combustion contributes excess nitrogen into the atmosphere, that precipitate out of the troposphere as acid rain/snow causing harm to aquatic environments, vegetation, and infrastructure.

#### Total Nitrogen in Virginia

The following graphics are presented in order to establish a baseline for TN concentrations, offering a variety of approaches for the interpretation of TN data as well as perspective on TN concentrations relative to affects on aquatic life. Total Nitrogen (mg/L) distributions are presented statewide, by ecoregion, stream order, and basin. All graphics use a similar shading structure, outlined in Table 16, based on probability of stress to aquatic life. TN measurements over 2 mg/L are among the highest in the Commonwealth and may result in impacts to the benthic community. The medium probability of stress to aquatic life category includes the 1 to 2 mg/L TN range. TN levels between 0.5 to 1 mg/L present low probability of stress to aquatic life. TN measurements below 0.5 mg/L are considered unlikely to cause stress to aquatic life. The Total Nitrogen appendix section links the stressor thresholds to aquatic health and contains the statistical information for the recommended stressor threshold levels.

Table 16. Total Nitrogen (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Total Nitrogen	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 2
Medium	> 1, < 2
Low	> 0.5, < 1
None	< 0.5

Figure 21 presents box-and-whisker plots of TN statewide and by basin. The Potomac-Shenandoah Basin has the highest median TN followed by the Rappahannock-York Basin. Both lie within the low probability of stress to aquatic life realm. Median TNs for both the Roanoke and James Basins are between 0.0 mg/L and 0.5 mg/L. Note that the median TN for Virginia is under 0.5 mg/L and medians for both the Roanoke and James basins are less than the median for Virginia.

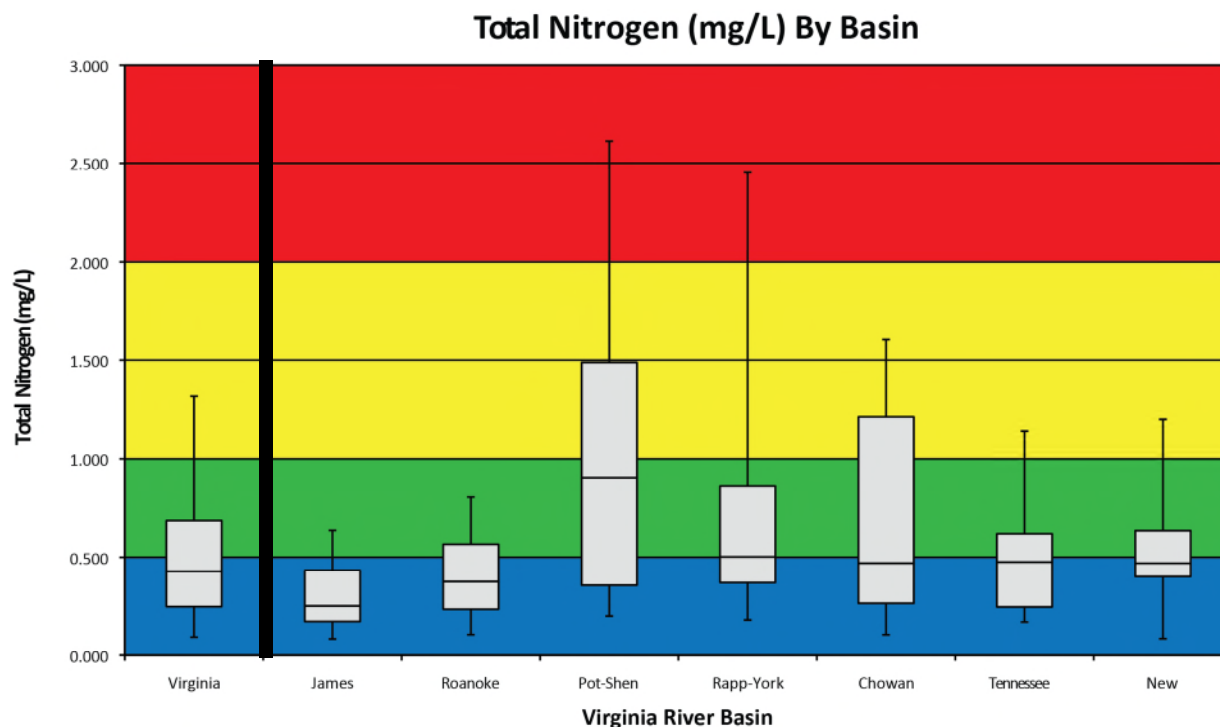


Figure 21. Boxplots of Total Nitrogen statewide and by basin (n = 471).

The percentiles associated with Figure 20 are shown in Table 17. Aside from the Potomac-Shenandoah and Chowan basins, most TN values are within the no to low probability of stress to aquatic life ranges.

Table 17. Percentile tables of Total Nitrogen statewide and by basin (n = 471).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	0.093	0.084	0.106	0.200	0.180	0.105	0.170	0.085
5Pct	0.130	0.096	0.141	0.221	0.216	0.105	0.177	0.096
10Pct	0.160	0.109	0.172	0.247	0.262	0.130	0.180	0.099
25Pct	0.248	0.172	0.235	0.357	0.370	0.265	0.246	0.401
50Pct	0.428	0.252	0.376	0.905	0.503	0.470	0.476	0.469
75Pct	0.687	0.433	0.566	1.488	0.864	1.210	0.620	0.636
90Pct	1.317	0.637	0.806	2.612	2.453	1.604	1.139	1.197
95Pct	1.883	1.015	1.041	3.441	3.193	2.279	1.361	1.381
99Pct	3.497	1.975	1.174	7.189	4.007	2.872	1.929	1.630

Figure 22 depicts TN data by stream order. The median TN for first order streams is the lowest at 0.399 mg/L. It appears that median TN values increase with increasing stream order.

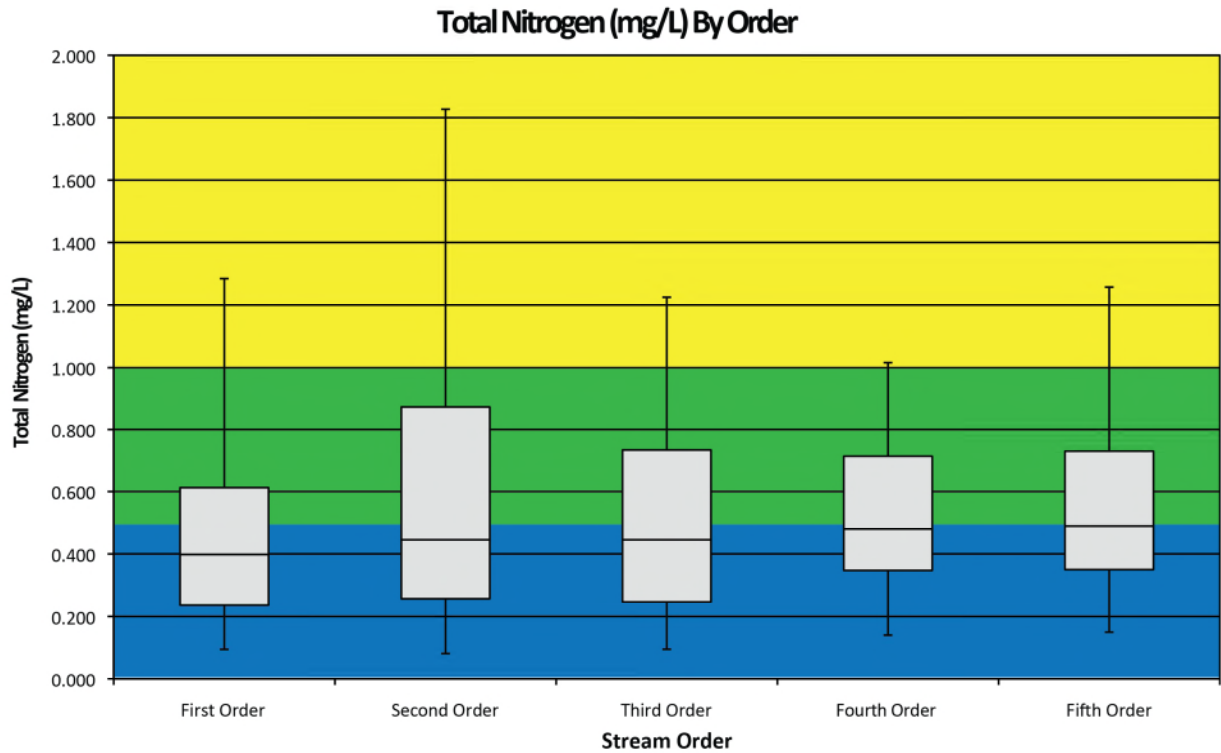


Figure 22. Boxplots of Total Nitrogen by stream order (n = 471).

Table 18 presents the percentiles illustrated in Figure 22. The 75<sup>th</sup> percentile for all orders is considered to be a low probability of stress to aquatic life.

Table 18. Percentile tables of Total Nitrogen by stream order (n = 471).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	0.095	0.081	0.095	0.140	0.150
5Pct	0.105	0.105	0.125	0.159	0.166
10Pct	0.157	0.149	0.150	0.235	0.218
25Pct	0.236	0.257	0.247	0.348	0.350
50Pct	0.399	0.445	0.445	0.480	0.490
75Pct	0.613	0.873	0.734	0.713	0.730
90Pct	1.285	1.827	1.226	1.016	1.258
95Pct	1.855	2.483	1.481	1.161	1.932
99Pct	3.402	4.582	3.766	2.251	5.360

Figure 23 denotes TN by Virginia Level III ecoregions. Median values of the Piedmont, Ridges and Valleys, Blue Ridge Mountains, and Central Appalachians fall into the no stress to aquatic life category below 0.5 mg/L while median values of the Northern Piedmont and Southeastern Plains remain in the low probability of stress threshold.

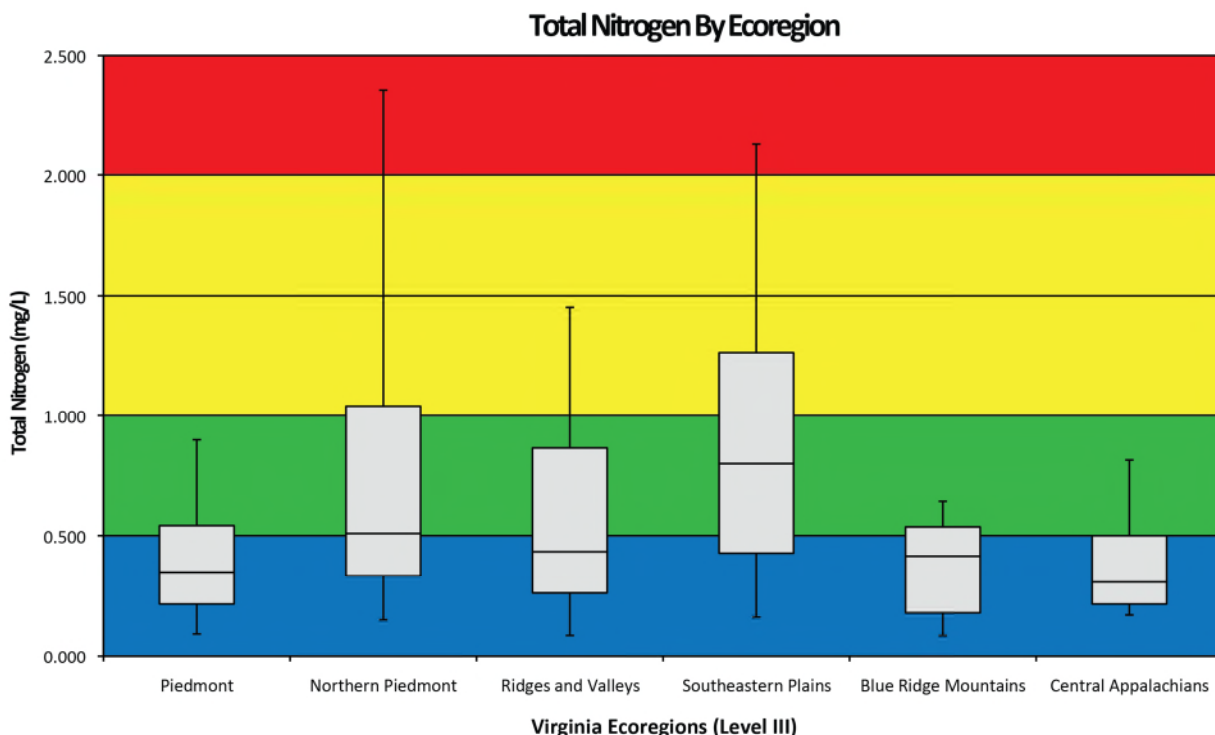


Figure 23. Boxplots of Total Nitrogen by Virginia Ecoregion (Level III).

Table 19 further describes the percentiles indicated in Figure 23 with the corresponding shading pattern.

Table 19. Percentile tables of Total Nitrogen by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	0.091	0.150	0.085	0.161	0.085	0.170
5Pct	0.102	0.226	0.111	0.216	0.094	0.175
10Pct	0.138	0.242	0.149	0.265	0.114	0.183
25Pct	0.215	0.332	0.261	0.427	0.179	0.215
50Pct	0.347	0.509	0.433	0.802	0.415	0.306
75Pct	0.542	1.040	0.866	1.263	0.536	0.500
90Pct	0.900	2.355	1.453	2.131	0.643	0.816
95Pct	1.169	3.839	1.664	2.758	0.725	0.842
99Pct	2.509	7.188	2.891	3.248	1.345	1.068

## Total Nitrogen and Probability of Stress to Aquatic Life

VSCI scores are not likely to be depressed from average Total Nitrogen concentrations less than 1 mg/L (Table 16). Average Total Nitrogen levels above 2 mg/L make TN a probable stressor especially in combination with degraded Total Habitat Scores. When average Total Nitrogen concentrations exceed 3 mg/L there is a high probability that the VSCI will not pass the minimum attainment threshold of 60.

## *Ionic Strength*

Ionic strength refers to the concentration of ions in solution. Water readily dissolves chemical compounds, imparting different chemical compositions that can benefit or harm aquatic communities. To measure ionic strength and compare waters with differing chemical composition, we measure conductivity and total dissolved solids (TDS). The ability of water to transmit electrical current is known as conductivity while TDS measures the total amount of ions, salts, metals, and minerals dissolved in a water body.

Ionic constituents and temperature primarily control conductivity within a water body. Dissolved inorganic solids promote electron transfer, thus the anions: nitrate ( $\text{NO}_3^-$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{PO}_4^{3-}$ ), and sulfate ( $\text{SO}_4^{2-}$ ) and cations: iron ( $\text{Fe}^{2+/3+}$ ), sodium ( $\text{Na}^+$ ), magnesium ( $\text{Mg}^{2+}$ ), calcium ( $\text{Ca}^{2+}$ ), potassium ( $\text{K}^+$ ), and aluminum ( $\text{Al}^{3+}$ ) are commonly found in waters reporting higher conductivity levels. Organic compounds (including oils, sugars, and alcohols) do not readily conduct electrical current; consequently, their presence in a water body lowers conductivity. Temperature controls ionic motion, so chemically identical waters report higher conductivity measures at higher temperatures and lower conductivity at lower temperatures. Hence, conductivity is recorded at a uniform 25°C and referred to as specific conductivity. VDEQ measures specific conductivity in units of microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ).

TDS measures the milligrams of dissolved constituents (that pass through a 2  $\mu\text{m}$  filter) per liter of water (mg/L). Explicitly measuring TDS concentrations is a fairly tedious laboratory process that involves evaporating all liquids from a water sample to find the mass of the remaining constituents. However, TDS is based on ionic strength, which is related to the electrical conductivity of water. Thus, easily obtainable specific conductivity measurements (from a water quality meter) can be converted to an approximate TDS measure (Figure 24).



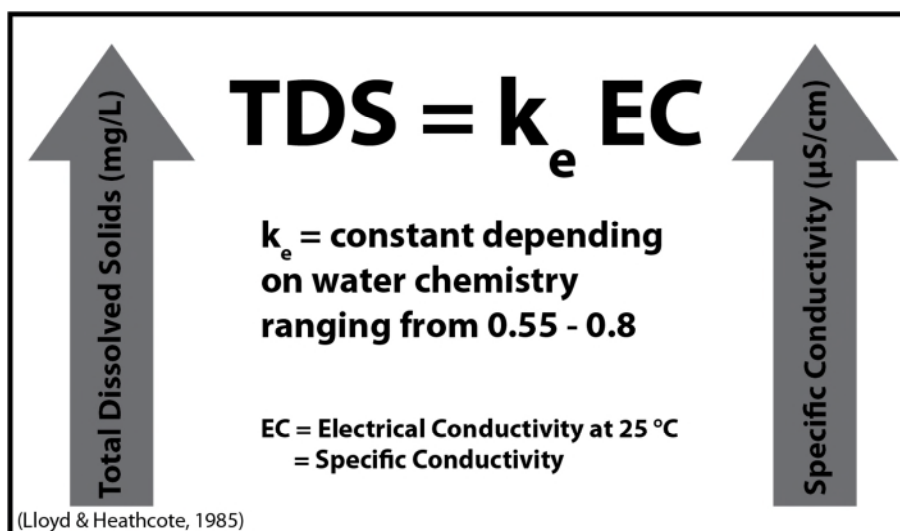


Figure 24. Specific Conductivity to Total Dissolved Solids conversion.

Regional geology has great bearing on the ionic strength of a water body. Water flowing through materials that easily dissolve into their ionic constituents (i.e. clays) has higher conductivity. Inert substrates that resist erosion and ionization (i.e. granites) do not impart additional ions to the water column, so lower conductivity values are expected in these environments.

Conductivity within freshwater environments differs considerably from saline waters. Over 90 percent of freshwater ecosystems in Virginia have a specific conductance below 350  $\mu\text{S/cm}$  while ocean water is typically 50,000  $\mu\text{S/cm}$  (Figure 25). High conductivity indicates increased dissolved ion concentrations in the water column. This increase in ionic strength often accompanies stressed aquatic communities, suggesting macroinvertebrate species intolerant to pollution might be responding to unnatural pollution in the water column.

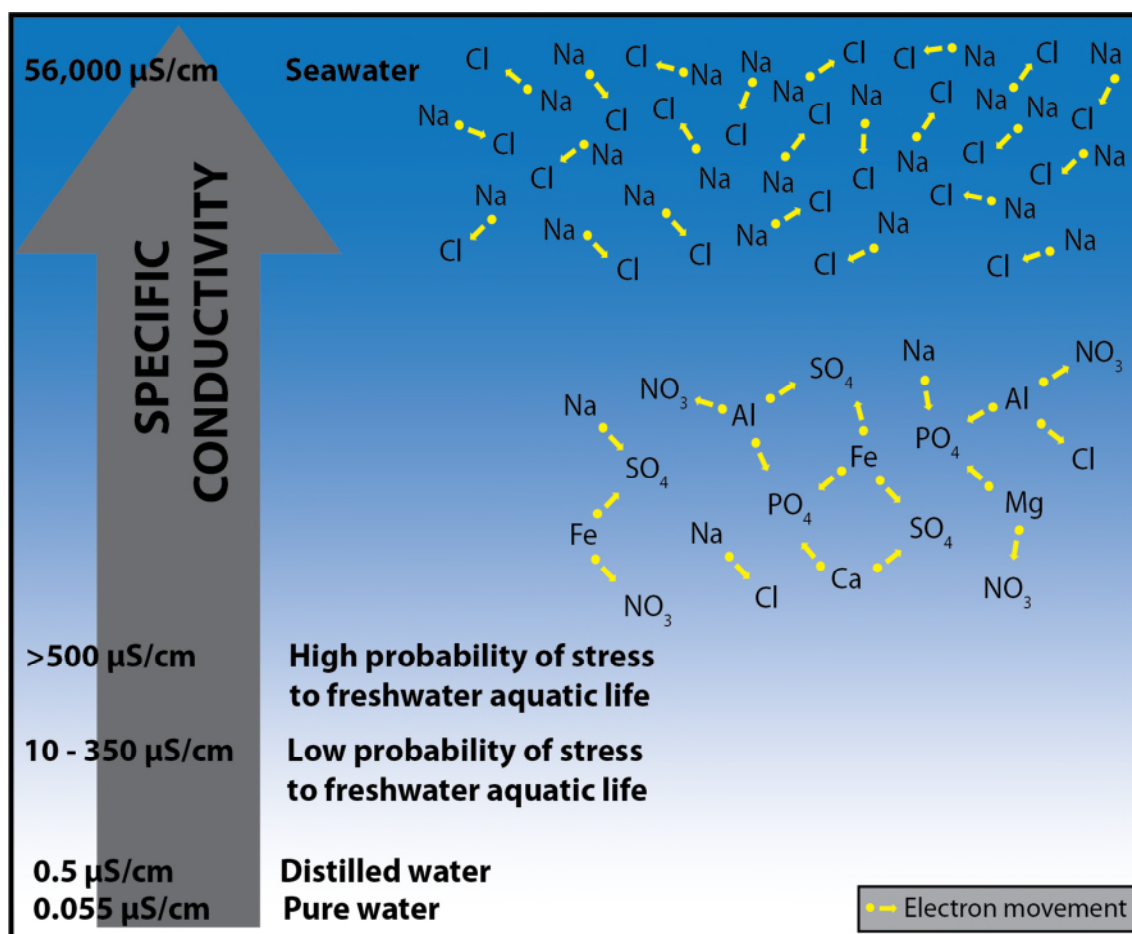


Figure 25. Specific Conductivity scale.

Virginia does not have a water quality standard in place for conductivity or TDS, though it is still used as an indicator of aquatic health. EPA Secondary Regulations establish a (non-enforceable) TDS limit of 500 mg/L for aesthetic purposes including water taste and smell as well as corrosion prevention.

Anthropogenic activities such as runoff from urban, agricultural, and surface mining as well as other sewage and industrial discharges increase ionic strength. Prime contributors to TDS through runoff include salts applied to roadways, fertilizers from residential and agricultural land, and acid mine drainage from both operating and abandoned mines.

Given that conductivity levels increase with the presence of dissolved inorganic solids, elevated conductivity levels indicate the need for additional sampling to identify specific stressors to a water body. Source tracking efforts conducted during pollution investigations benefit from stream conductivity changes that accompany particular pollutants. For example, failing sewage

systems increase conductivity levels in stream water due to the presence of nitrate, chloride, and phosphate while oil spills lower conductivity values because of the nature of their organic compounds.

The correlation of specific conductivity and total dissolved solids are integral to the definition of stressor thresholds for invertebrate communities. While specific conductivity and total dissolved solids cannot explicitly identify the stressor, or stressors, affecting a water body, they can identify the need for further analysis. This document identifies a few primary ions to consider when high conductivity or TDS concentrations are encountered. These ions include sulfate, chlorine, sodium, and potassium, collectively termed SoClNaK (pronounced 'sock-I-nak'), and are discriminated from other ions because of their increased impact on benthic communities in Virginia.

#### Ionic Strength in Virginia

The following graphics establish a baseline for specific conductivity levels, present a variety of approaches to interpreting conductivity data, and offer perspective on conductivity levels relative to its impacts on aquatic life. VDEQ presents probability of stress to aquatic life related to specific conductance in Table 20 and TDS in Table 21. VDEQ found the dissolved ions that have the most impact on aquatic communities in Virginia are sulfate, chloride, sodium, and potassium. Stressor thresholds for those dissolved ions are found in Tables 22-25. Appendices G-J present greater detail on the individual ions and links concentrations to aquatic community effects.

Table 20. Specific Conductivity ( $\mu\text{S}/\text{cm}$ ) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Specific Conductivity	
Probability of Stress to Aquatic Life	Electrical Conductivity ( $\mu\text{S}/\text{cm}$ )
High	> 500
Medium	> 350, < 500
Low	> 250, < 350
None	< 250

Table 21. Total dissolved solids (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Total Dissolved Solids	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 350
Medium	> 250 , < 350
Low	> 100, < 250
None	< 100

Table 22. Dissolved sulfate (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Dissolved Sulfate	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 75
Medium	> 25, < 75
Low	> 10, < 25
None	< 10

Table 23. Dissolved chloride (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Dissolved Chloride	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 50
Medium	> 25 , < 50
Low	> 10, < 25
None	< 10

Table 24. Dissolved sodium (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Dissolved Sodium	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 20
Medium	> 10, < 20
Low	> 7, < 10
None	< 7

Table 25. Dissolved potassium (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI scores).

Dissolved Potassium	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 10
Medium	> 2, < 10
Low	> 1, < 2
None	< 1

Percentiles for specific conductivity in Virginia statewide, and by ecoregion, stream order, and basin are included as this data is commonly available for stressor evaluation. If elevated specific conductivity values are found, TDS and other major ions (sulfate, chlorides, sodium, potassium) should be collected. Detailed analyses related to TDS, dissolved sulfate, chloride, sodium, and potassium can be found in the appendices.

Figure 26 presents box-and-whisker plots of specific conductivity statewide and by basin. The shading in Figure 26 corresponds to the probability of stress categories in Table 20.

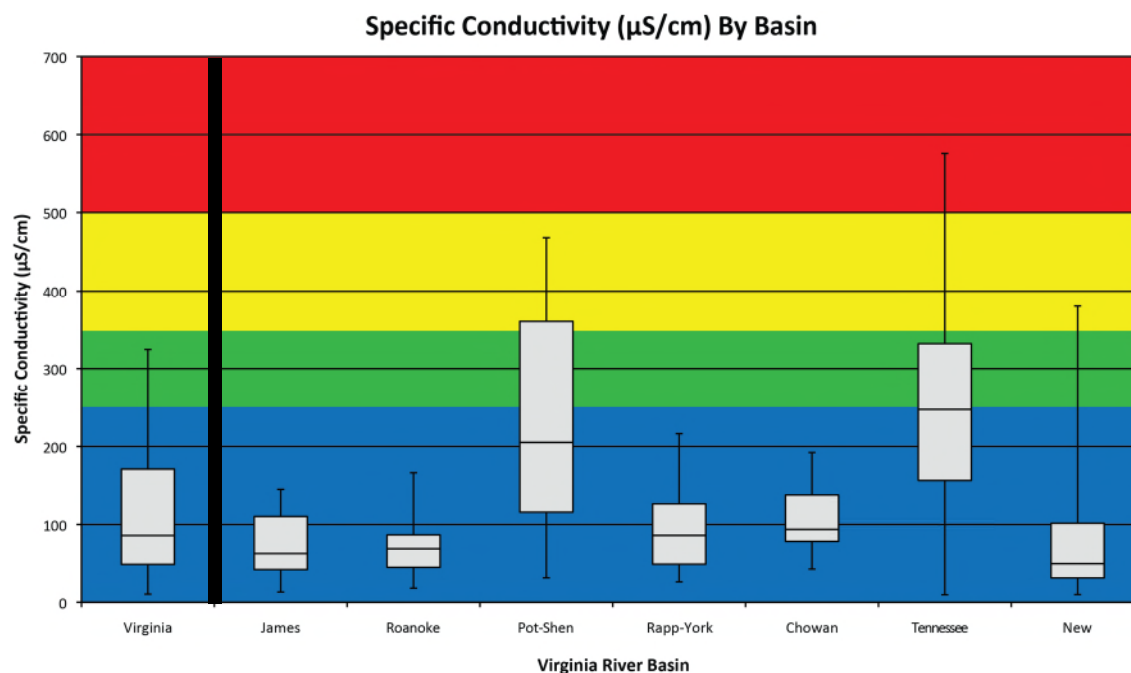


Figure 26. Boxplots of Specific Conductivity statewide and by basin (n = 473).

All basins have median Specific Conductivity values below 250  $\mu\text{S}/\text{cm}$ , which is within the no probability of stress to aquatic life threshold. The James, Roanoke, Rappahannock-York, and Chowan basins plot nearly entirely within the no probability of stress category. The Tennessee and Potomac-Shenandoah basins express the highest specific conductivity measures with upper quartiles plotting in the low and medium probability of stress to aquatic life thresholds, respectively. Table 26 explicitly states percentiles illustrated in Figure 26.

Table 26. Percentile tables of Specific Conductivity statewide and by basin (n = 473).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	10.244	13.000	18.000	32.500	26.000	43.500	9.550	9.800
5Pct	22.325	16.695	19.245	33.029	26.000	48.386	9.550	15.970
10Pct	31.766	29.854	25.257	33.844	43.002	49.635	30.848	24.059
25Pct	49.378	42.837	45.662	115.560	49.665	78.572	156.881	32.298
50Pct	85.949	63.209	69.250	205.172	86.192	93.722	247.102	50.244
75Pct	171.443	110.123	86.772	360.710	126.117	137.342	332.104	101.518
90Pct	324.635	144.452	166.650	468.071	216.249	192.304	576.016	380.372
95Pct	438.070	233.236	424.844	485.555	296.088	219.172	838.490	564.059
99Pct	769.389	433.387	485.480	704.449	303.789	311.643	1166.662	730.812

Figure 27 depicts Specific Conductivity data by stream order. Rising median values from first to fifth order streams illustrate that specific conductivity levels generally increase with increasing stream order. Third and fourth order streams show the widest spread in data with 75<sup>th</sup> percentiles creeping into the low probability of stress category slightly above 250  $\mu\text{S}/\text{cm}$ . Table 27 presents percentile data corresponding to Figure 27.

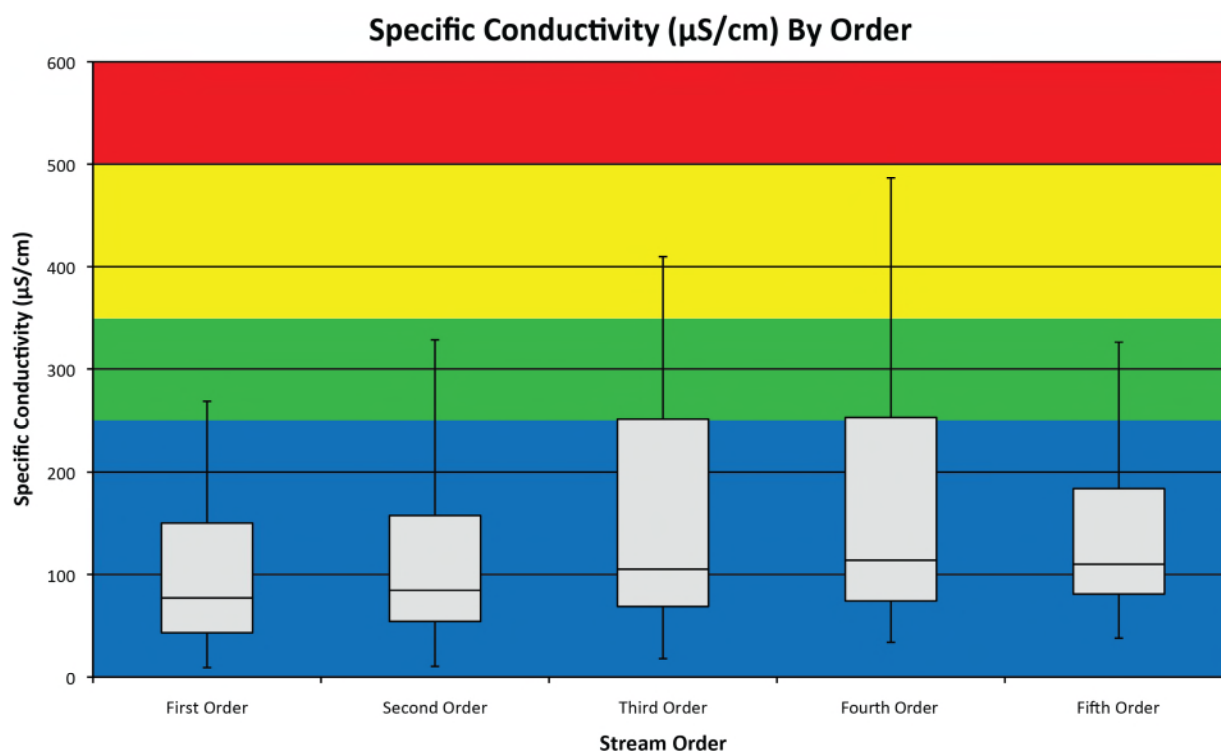


Figure 27. Boxplots of Specific Conductivity by stream order (n = 473).

Table 27. Percentile tables of Specific Conductivity by Stream Order (n=473).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	9.550	10.728	18.193	34.000	38.000
5Pct	17.875	27.432	35.113	46.915	51.000
10Pct	25.800	32.450	42.450	53.043	59.490
25Pct	43.175	54.125	68.549	73.948	80.550
50Pct	76.925	84.525	105.175	114.000	110.000
75Pct	150.250	157.675	251.563	253.175	184.050
90Pct	268.800	328.550	410.130	486.200	326.100
95Pct	337.600	447.573	575.875	676.300	448.800
99Pct	550.905	530.130	1127.470	1013.310	684.032

Specific Conductivity analyzed by Virginia Level III Ecoregion is shown in Figure 28. The Piedmont and Blue Ridge Mountains plot entirely within the no stress to aquatic life category (below 250 µS/cm). All other regions, besides the Central Appalachians, exhibit median specific conductivity values with no probability of stress to aquatic life. The Central Appalachians have a median value that is considered to exhibit low probability of stress to aquatic life. Table 28 details percentiles associated with Figure 28.

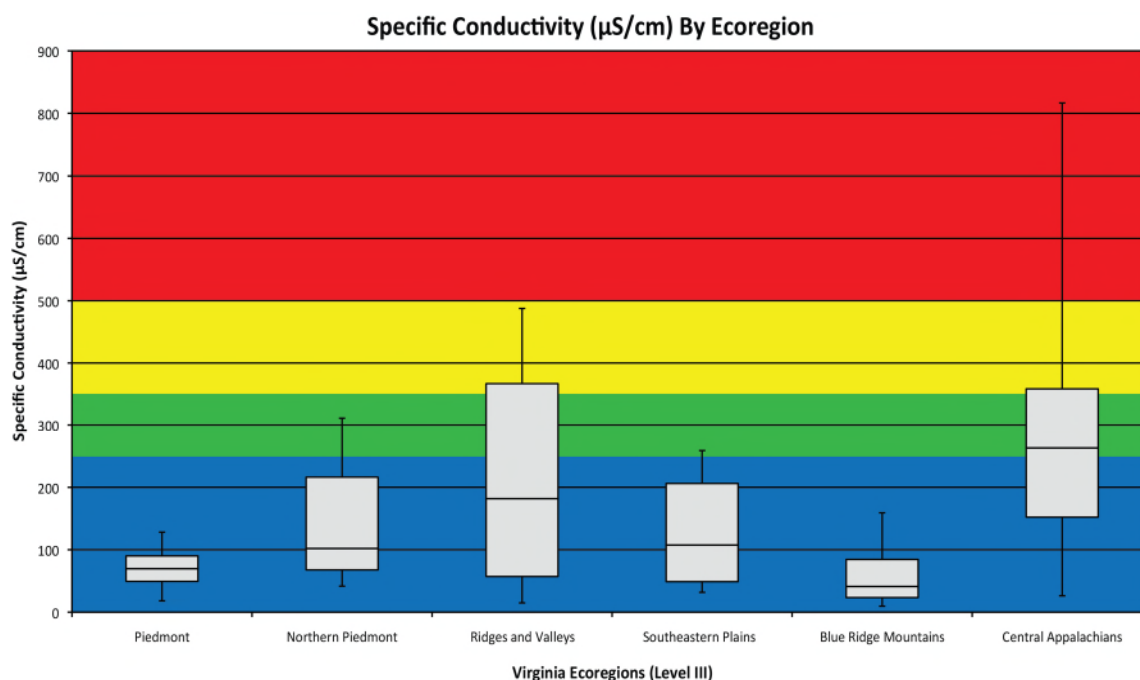


Figure 28. Boxplots of Specific Conductivity by Virginia Ecoregion (Level III).

Table 28. Percentile tables of Specific Conductivity by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	18.000	42.000	14.736	32.000	9.550	26.500
5Pct	21.055	43.311	31.504	43.020	9.550	28.470
10Pct	31.936	47.941	32.852	45.040	12.011	32.451
25Pct	49.562	67.811	57.340	49.047	23.736	151.818
50Pct	69.914	101.993	181.981	107.437	41.510	262.841
75Pct	90.118	216.173	366.596	206.203	84.570	358.353
90Pct	128.068	310.993	487.826	258.713	159.494	816.421
95Pct	138.459	393.029	527.691	280.899	174.795	1005.712
99Pct	177.567	477.417	764.881	298.555	195.950	1496.732

### Specific Conductivity and Probability of Stress to Aquatic Life

VSCI scores are not likely to be depressed due to specific conductivity levels below 250 µS/cm in all regions in Virginia. Measurements over 500 µS/cm are uncommon background levels in Virginia. Levels over 250 µS /cm are uncommon in the Piedmont and Coastal Plain, but limestone valleys in western Virginia commonly have naturally elevated conductivity. It is important to be aware of local geology when performing stressor analysis. If elevated specific conductivity values are suspected, additional monitoring for TDS and other major ions (sulfate, chlorides, sodium, potassium) should be conducted.



## ***Total Habitat***

Habitat is the area or environment where an organism resides, encompassing living and non-living components in the stream itself and throughout the surrounding riparian (stream bank) zone. Habitat determines the types of aquatic communities that can reside in a stream. Habitat plays a critical role in a stream's ability to attenuate pollution in that excellent instream and bank habitat can protect aquatic communities from the negative effects of excess sedimentation or nutrients. The reverse is true in that if habitat is degraded, aquatic communities are more exposed to pollution. This important concept is further explored later in this section and in the document appendices.

Since different organisms have diverse habitat requirements, a variety of available habitat types in a stream or river support diverse aquatic communities. Depending on whether a stream is high gradient or low gradient, expectations for habitat conditions vary. A variety of substrate is key to a diverse community of benthic macroinvertebrates. Large woody debris is another important component of both low and high gradient streams as it provides habitat diversity. Streamside vegetation is critical for shading and temperature regulation of instream habitats in both high gradient and low gradient streams. In addition, seasonal inputs of leaves from streamside trees help support the benthic families that thrive when there is vegetation available for shredding and consumption. Native streamside vegetation provides bank stability because root systems provide structure to keep soils from eroding. Non-native vegetation provides some stability but typically root systems aren't as extensive. Vegetation also serves to take up nutrients and other constituents that travel to streams via groundwater and/or surface runoff; thus, riparian vegetation attenuates pollutants and protects instream water quality. Sedimentation is evaluated in both high and low gradient streams as is channel alteration and channel flow status. By design, methods used in Virginia evaluate the main habitat components discussed briefly above. The Rapid Bioassessment protocols (Barbour, 1999) were developed to account for these habitat components and their combined ability to support desirable aquatic communities.

Habitat is examined through the qualitative evaluation of ten habitat parameters observed in conjunction with the biomonitoring sample collection process. Table 29 provides each parameter and a description. Note that three of the ten parameters evaluated differ depending on whether the stream being scored is considered low gradient or high gradient. Each parameter is scored 0 to 20 based on categorical descriptors of parameter conditions identified as optimal, suboptimal, marginal, and poor. A Total Habitat score is assigned through the combination of evaluated habitat parameters, ranging between 0 to 200.

Table 29. Rapid Bioassessment Protocol II Habitat Parameters.

Habitat Parameter	Description
Epifaunal substrate/ available cover	Amount of naturally occurring structures suitable for organism inhabitation; higher diversity of habitats increase biological diversity
Sediment deposition	Measures sediment accumulation on bottom substrate and in pools; indicates sediment movement issues
Channel flow status	Amount of channel filled with water and thus available habitat for diverse species colonization
Channel alteration	Human modifications to natural stream condition- channelization, artificial bank stabilization, dams, etc.
Bank stability (Score left and right bank separately)	Measures degree of erosion (or erosion potential) persistent on stream banks; indicates stability of habitat, sediment transport dynamics, and vegetative cover
Bank vegetative protection (Score left and right bank separately)	Measures stream bank vegetation cover; indicates bank stability and offers stream shading, among other habitat controls
Riparian vegetative zone width (Score left and right bank separately)	Measures vegetation cover width from stream bank through riparian zone; diminishes runoff nutrient input, mitigates stream bank erosion, and increases instream habitat diversity
<b>HIGH GRADIENT STREAMS</b>	
Embeddedness	Degree larger rocks are surrounded by smaller sediments; increased imbeddedness reduces macroinvertebrate habitat & indicates sediment movement problems
Velocity/depth combinations	Characterizes water flow patterns; multiple regimes promote habitat and biologic diversity
Frequency of riffles (or bends)	Numerous riffles/bends provides diverse habitats and dissipates flood power
<b>LOW GRADIENT STREAMS</b>	
Pool substrate characterization	Identifies pool sediment type; uniform substrates reduce biologic diversity
Pool variability	Characterizes pool patterns; multiple pool types promote habitat and biologic diversity
Channel sinuosity	Increased sinuosity increases habitat diversity and moderates flooding conditions

Habitat scores above 150 indicate favorable habitat conditions that support a healthy aquatic community and are subsequently considered optimal. Total Habitat scores less than 120 increase the likelihood of low VSCI scores (VSCI score less than 60 indicates an aquatic life use impairment). When Total Habitat scores fall below 130, protections from the deleterious impacts of nutrients are reduced.



*Bannister River photo by L. Willis depicts desirable riparian vegetation.*



*Back Creek in Pulaski County illustrates lack of riparian vegetation and eroding banks.*

#### Total Habitat in Virginia

The following series of graphics establish a baseline for total habitat scores, include a variety of approaches to interpreting total habitat data and offer context on total habitat scores relative to predicted effects on benthic macroinvertebrate communities (based on VSCI scores). Table 30 summarizes the stressor thresholds for total habitat. Total habitat scores less than 100 indicate a high probability of stress to aquatic life. Scores above 130 mean that there is a low probability of stress that impaired benthic community will result due to total habitat. The figures that follow show Total Habitat distributions statewide, by ecoregion, by stream order, and by basin. The Total Habitat appendix section links the stressor to aquatic health and contains the statistical information for the recommended stressor threshold levels.

Table 30. Total Habitat Scores ranges and associated probability of stress to aquatic life (based on VSCI scores).

Total Habitat - Qualitative	
Probability of Stress to Aquatic Life	Total Habitat (unitless)
High	< 100
Medium	> 100 , < 130
Low	> 130, < 150
None	< 150

Figure 29 shows box-and-whisker plots of total habitat scores by basin in Virginia. All basins have median values associated with low probability of stress to aquatic life. Total habitat scores are the highest overall in the James River basin.

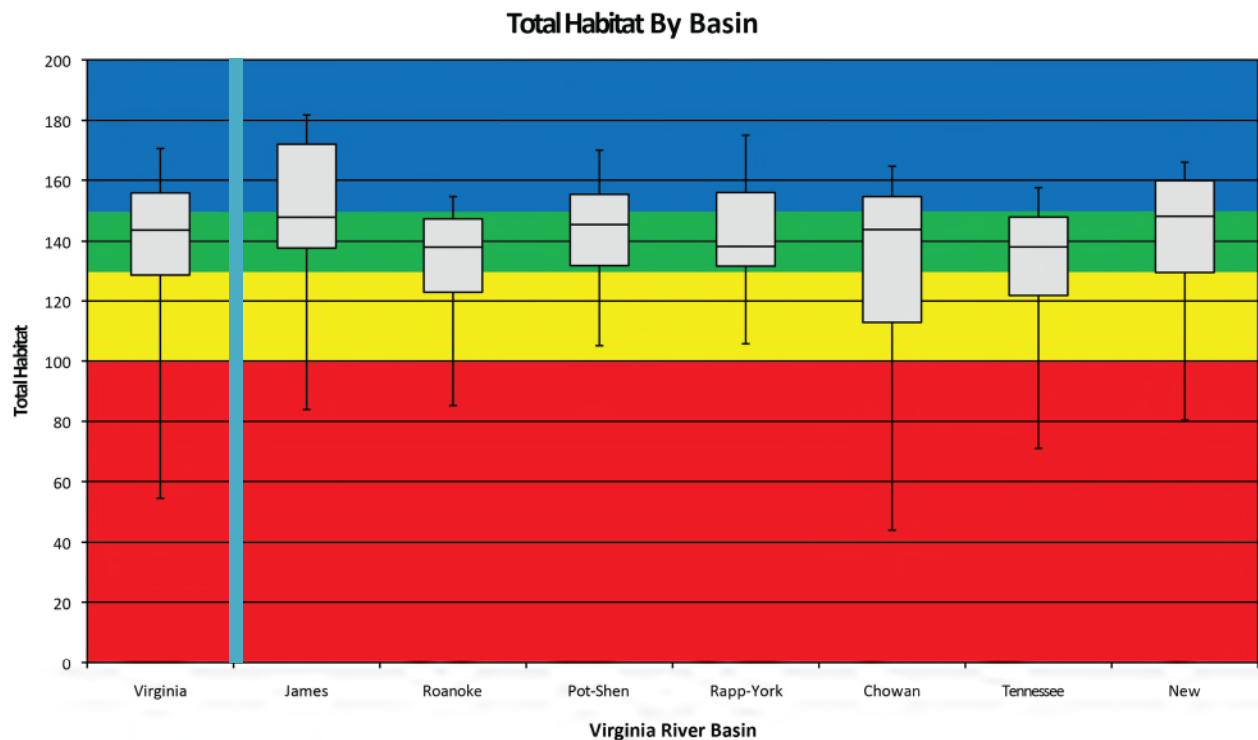


Figure 29. Boxplots of Total Habitat Statewide and by Basin (n=470).

The percentiles associated with Figure 28 are shown in Table 31.

Table 31. Percentile Tables of Total Habitat Statewide and by Basin (n=470).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	55	84	85	105	106	44	71	80
5Pct	100	94	103	113	108	44	71	85
10Pct	113	119	110	126	110	53	108	97
25Pct	129	138	123	132	132	113	122	129
50Pct	144	148	138	145	138	144	138	148
75Pct	156	172	147	155	156	155	148	160
90Pct	171	182	155	170	175	165	158	166
95Pct	180	187	163	174	189	170	159	172
99Pct	190	190	174	185	190	173	164	180

Figure 30 depicts Total Habitat data by stream order. Median values remain fairly stable as stream order increases. Table 32 shows the values that correspond to Figure 30.

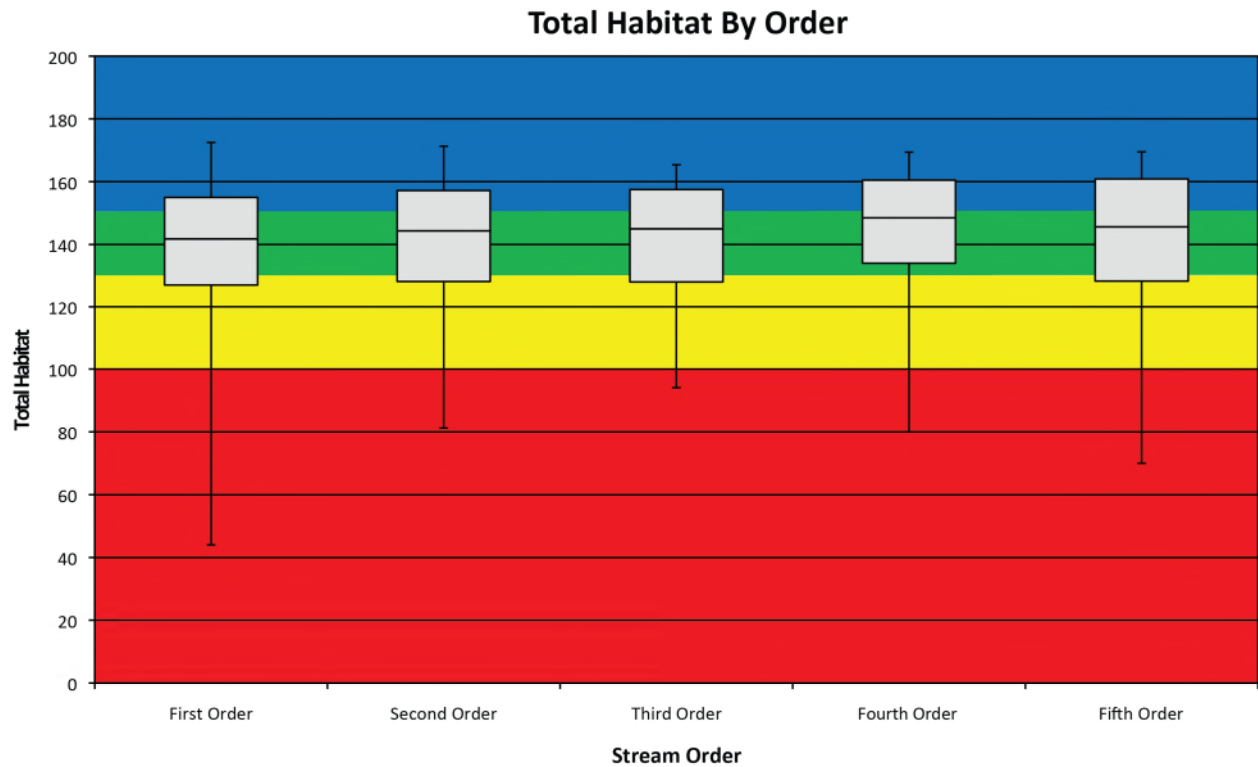


Figure 30. Boxplots of Total Habitat data by stream order (n=470).

Table 32. Percentile Tables of Total Habitat by Stream Order (n=470).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	44	81	94	80	70
5Pct	87	105	106	100	82
10Pct	110	116	110	118	92
25Pct	127	128	128	134	128
50Pct	142	144	145	149	146
75Pct	155	157	158	161	161
90Pct	173	171	165	169	170
95Pct	180	182	170	179	183
99Pct	187	188	186	186	188

Figure 31 presents box-and-whisker plots by ecoregion. The Blue Ridge Mountain and Ridges and Valleys ecoregions have median total habitat scores in the no stress to aquatic life category. All other ecoregion medians are around 140 in the low probability of stress to aquatic life category. Table 33 contains the percentiles that correspond to Figure 31.

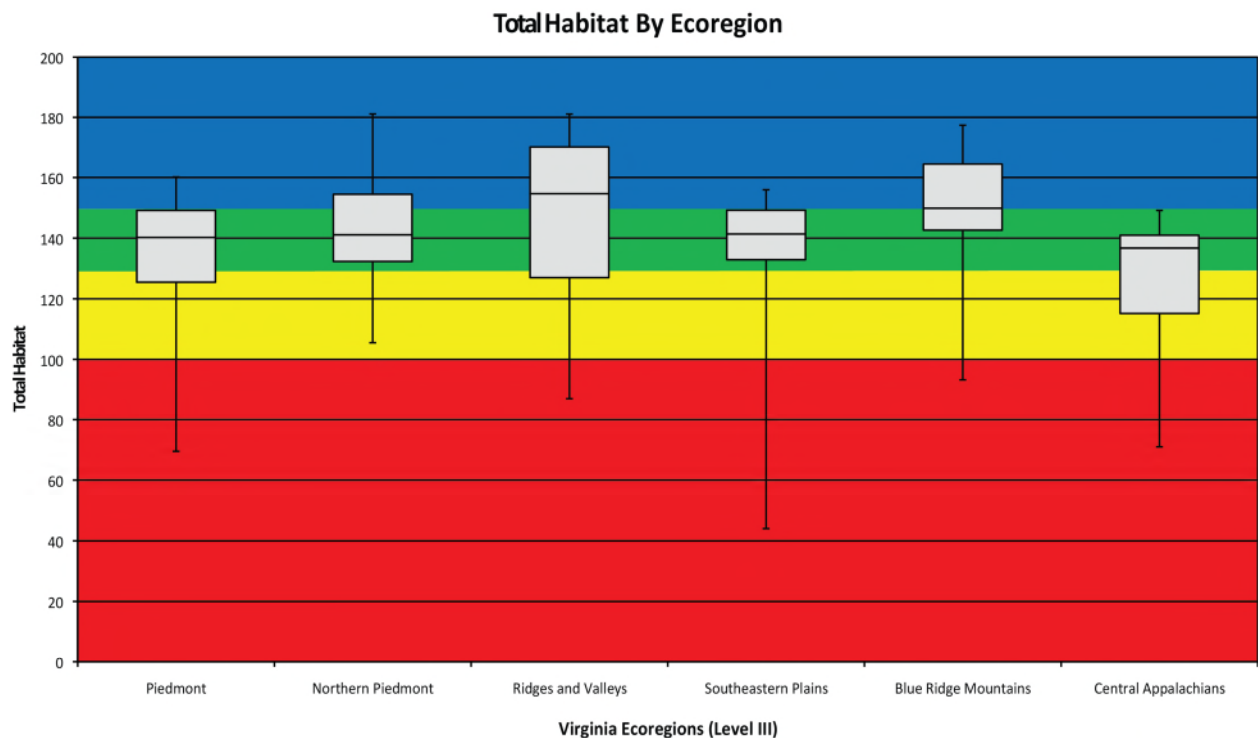


Figure 31. Boxplots of Total Habitat by Virginia Ecoregion (Level III).

Table 33. Percentile Tables of Total Habitat by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	70	106	87	44	93	71
5Pct	92	107	107	44	118	71
10Pct	106	115	113	106	127	71
25Pct	125	132	127	133	143	115
50Pct	140	141	155	141	150	137
75Pct	149	154	170	149	165	141
90Pct	160	181	181	156	177	149
95Pct	167	189	187	159	179	155
99Pct	179	190	190	168	184	163

### Total Habitat and Probability of Stress to Aquatic Life

Decreases in Total Habitat scores have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Total Habitat scores less than 100 increase the likelihood of having a low VSCI score. When Total Habitat scores fall below 130 protections from impacts of other stressors, such as nutrients, are reduced.

### *Relative Bed Stability*

Instream substrate varies naturally across the Commonwealth based on slope, local geology, flow, and channel morphology. A variety of instream substrate supports a diverse population of benthic macroinvertebrates by providing spaces in between and underneath rocks, or substrate, for organisms to inhabit. Larger substrate particles require more energy to move and benthic macroinvertebrates utilize their surfaces for feeding and undersides for refuge. If smaller particles fill the interstitial spaces between larger particles, benthic macroinvertebrate habitat is diminished (Figure 32). The influx of small particles creates a more transient and unstable stream bottom which can be detrimental to aquatic life.



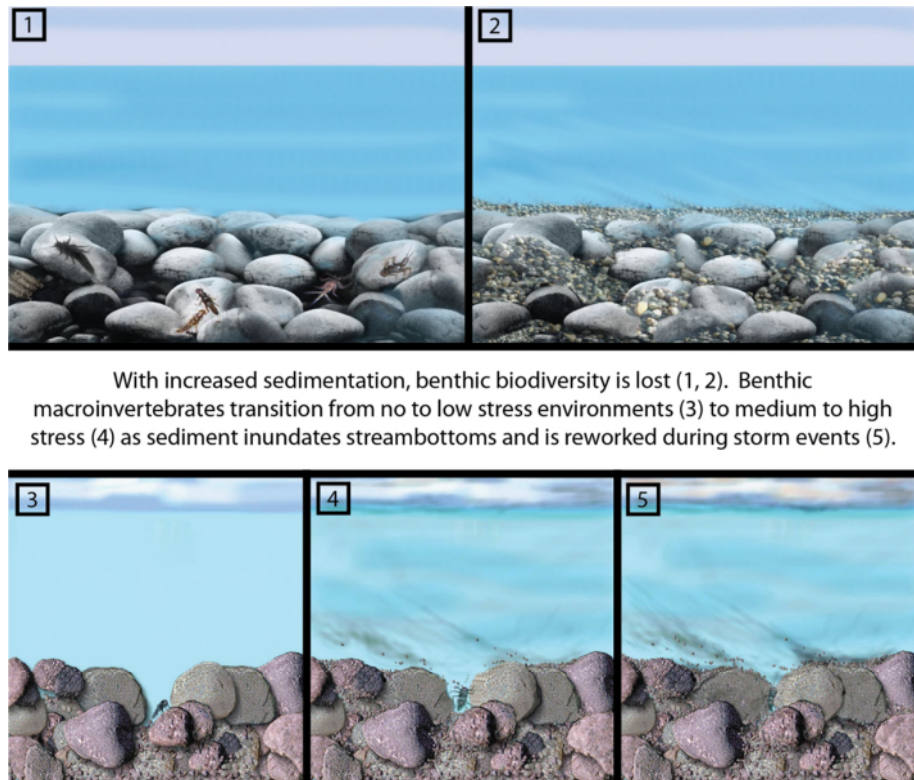


Figure 32. Streambed sedimentation example (graphic courtesy of L. Willis).

Developed land consisting of impervious surfaces like pavement increases runoff to streams, carrying with it small particles that add to the natural sediment loads. Channelization and increased flow to streams increases in stream erosion, incising banks, downcutting streambeds, and moving sediment downstream at rates that exceed a natural system. Constant reworking of natural streambed environments stresses benthic macroinvertebrates and high trophic levels that depend upon a system that remains in a dynamic equilibrium.

Relative Bed Stability calculations enable the differentiation of natural sediment deposition from anthropogenic sediment deposition. To make this distinction, the average sediment particle size of a stream is compared to an expected particle size that is determined based on the stream's size, slope, channel shape, and other geomorphologic factors (Kaufmann 1999 and 2008). Taking the logarithm of the ratio of these two numbers creates an index where 0 indicates a stable environment. In Virginia streams, a Log Relative Bed Stability (LRBS) value below -1.0 implies an unstable streambed consisting of smaller particles than expected.



## Relative Bed Stability in Virginia

Subsequent graphics offer a foundation for understanding and interpreting Relative Bed Stability (log transformed; LRBS) data and offer perspective on aquatic life impacts

A statewide analysis of LRBS is presented followed by ecoregion, stream order, and basin analyses of Virginia streams. All graphics utilize a standardized color format for showing probability of stress relative to benthic macroinvertebrate communities (Table 34). LRBS values less than -1.5 and above 0.5 are observed when natural systems become unstable either from excessive unnatural sedimentation or hardened and devoid of sediment from extremely flashy flows. LRBS values between -0.5 and 0.5 are considered stable and pose no stress to aquatic life. Figure 33 utilizes the color scheme and the probability of stress to aquatic life thresholds from Table 34 and presents them in a continuum diagram. The LRBS appendix section provides additional statistical evidence for the ranges presented in Table 34.

Table 34. LRBS values and associated probability of stress to aquatic life (based on VSCI scores).

Relative Bed Stability (RBS) Quantitative Habitat	
Probability of Stress to Aquatic Life	Relative Bed Stability (unitless)
High	$LRBS < -1.5$
Medium	$-1.5 < LRBS < -1.0$
Low	$-1.0 < LRBS < -0.5$
None	$-0.5 < LRBS < 0.5$
Medium	$LRBS > 0.5$

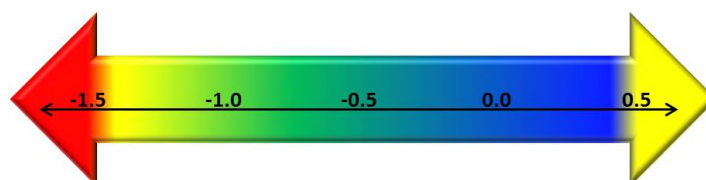


Figure 33. LRBS values and associated probability of stress to aquatic life continuum diagram.

Figure 34 presents box-and-whisker plots of LRBS statewide and by basin. The shading in Figure 32 corresponds to the probability of stress categories in Table 34. Virginia has a statewide median LRBS within the low stress category. The Tennessee Basin is the only basin in Virginia where over 50% of the data falls into the no stress to aquatic life category for LRBS. The Chowan Basin has the lowest median LRBS falling in the medium probability of stress category and nearly half of sites reporting high probability of stress LRBS category.

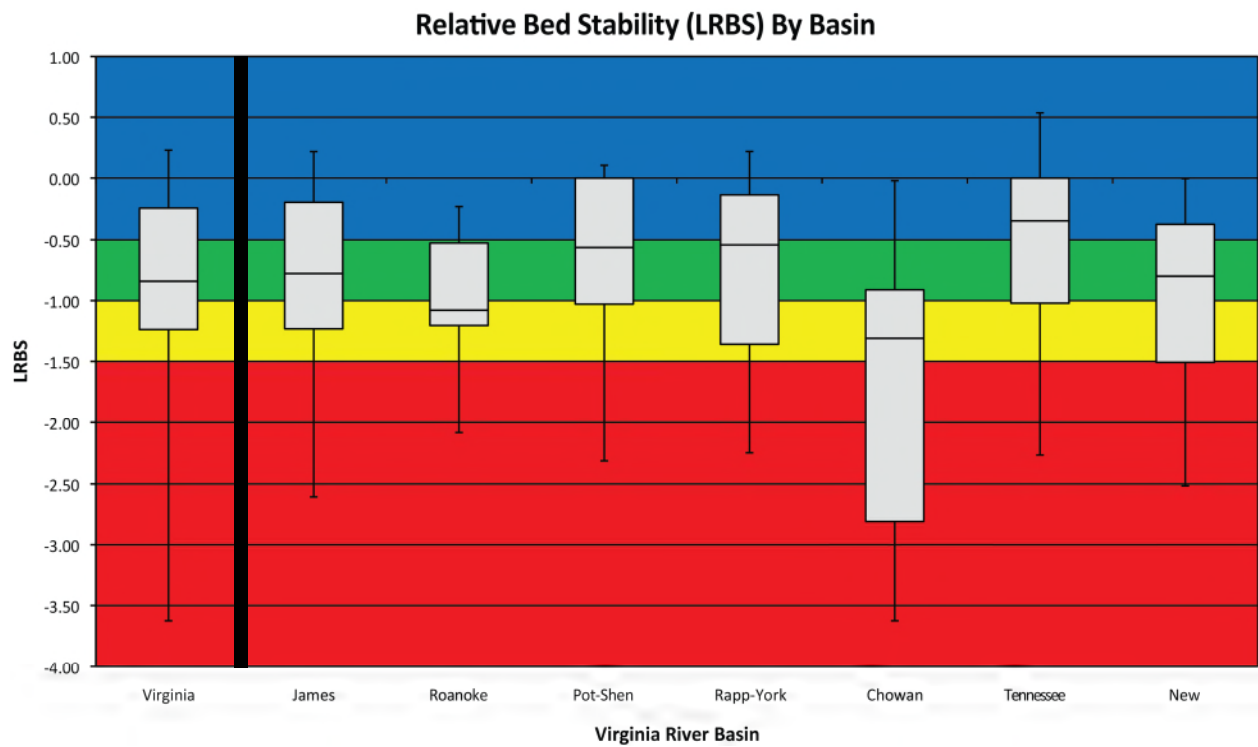


Figure 34. Boxplots of LRBS statewide and by basin (n=270).

Percentiles associated with Figure 34 are shown in Table 35. Most basins in Virginia fall within the low probability of stress to aquatic life category.

Table 35. Percentile tables of LRBS statewide and by basin (n=270).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	-3.623	-2.605	-2.083	-2.252	-2.247	-3.623	-2.265	-2.515
5Pct	-1.931	-2.057	-1.702	-2.043	-2.170	-3.623	-2.118	-2.515
10Pct	-1.768	-1.538	-1.496	-1.373	-1.920	-3.623	-1.838	-2.515
25Pct	-1.234	-1.228	-1.201	-0.968	-1.361	-2.811	-1.020	-1.508
50Pct	-0.843	-0.781	-1.078	-0.502	-0.541	-1.313	-0.346	-0.803
75Pct	-0.243	-0.196	-0.526	0.060	-0.136	-0.912	0.144	-0.374
90Pct	0.234	0.222	-0.230	0.111	0.223	-0.021	0.536	-0.004
95Pct	0.498	0.295	0.023	0.566	0.310	0.239	0.584	0.324
99Pct	0.703	1.100	0.363	0.871	0.528	0.448	0.622	0.593

Figure 35 shows LRBS by stream order and the corresponding percentiles for each stream order are shown in Table 36. A rise in median LRBS values from first to third order streams is noted as they shift from low to no probability of stress to aquatic life. However, the trend does not continue into fourth and fifth order streams as their medians progress from the lower end of no stress into low probability of stress. Overall, these are fairly stable systems with first order streams experiencing the highest variability and only the top 25% of data plotting in the no stress category.

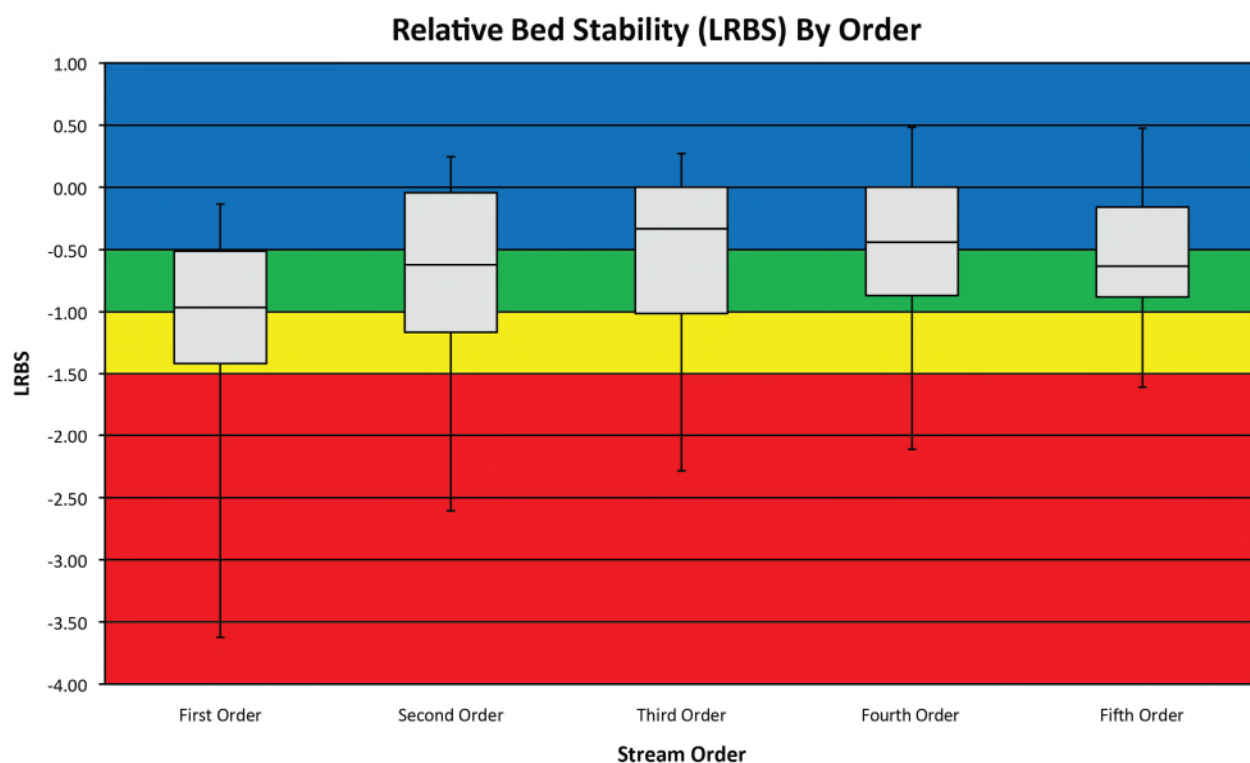


Figure 35. Boxplots of LRBS by stream order (n= 270).

Table 36. Percentile tables of LRBS by stream order (n= 270).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	-3.623	-2.605	-2.247	-2.113	-1.609
5Pct	-2.358	-2.252	-1.846	-1.557	-1.609
10Pct	-1.820	-1.754	-1.424	-1.337	-1.481
25Pct	-1.418	-1.163	-0.974	-0.870	-0.881
50Pct	-0.965	-0.623	-0.293	-0.441	-0.635
75Pct	-0.511	-0.044	0.039	0.143	-0.159
90Pct	-0.133	0.246	0.273	0.482	0.475
95Pct	0.272	0.466	0.445	0.587	0.750
99Pct	0.573	0.950	0.646	1.082	1.076

Finally, Figure 36 shows LRBS by ecoregion. The associated percentiles by ecoregion are shown in Table 37. The Ridges and Valleys ecoregion has the highest median LRBS value. Median values from the Northern Piedmont, Blue Ridge Mountains, and Central Appalachians remain in the low probability of stress category with the Piedmont median slightly lower and falling into the medium probability of stress to aquatic life zone. The Southeastern Plains have over 50% of

collected data in the high probability of stress to aquatic life category, indicating a very unstable benthic environment.

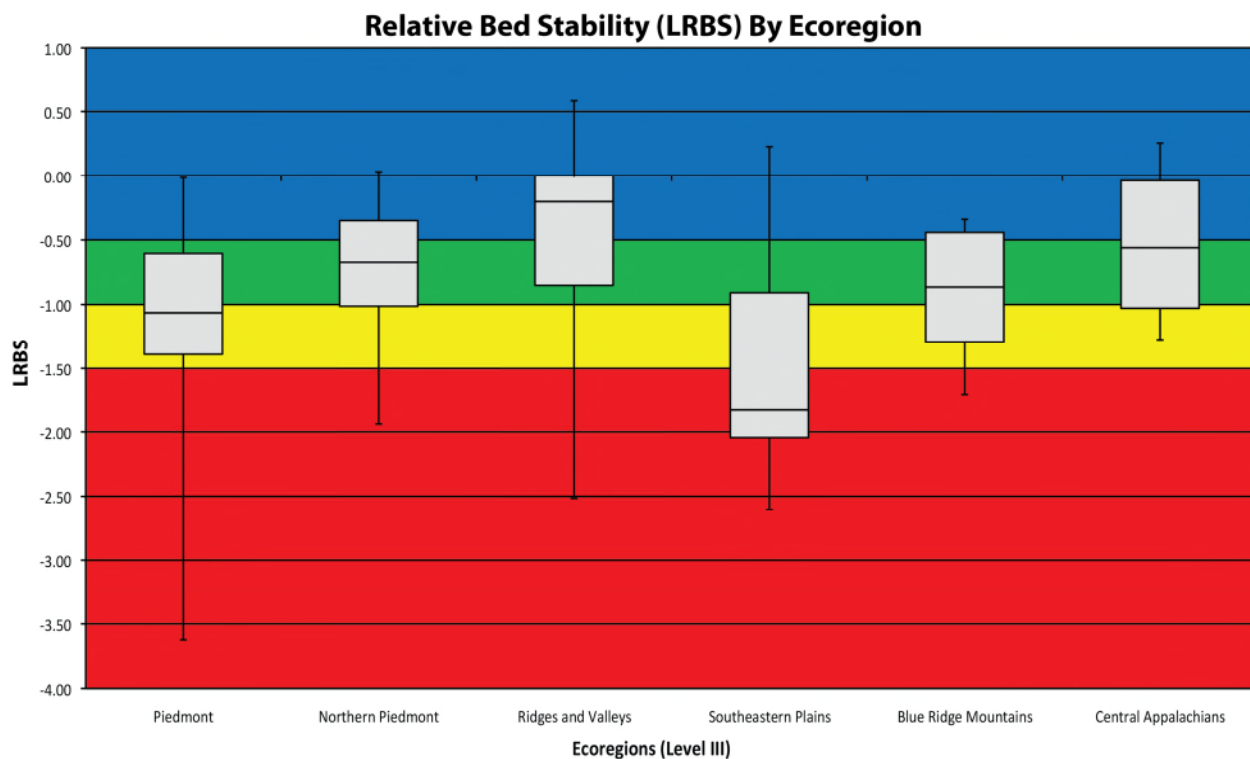


Figure 36. Boxplot of LRBS by ecoregion (n= 270).

Table 37. Percentile tables of LRBS by Level III Ecoregion.

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	-3.623	-1.931	-2.515	-2.605	-1.704	-1.275
5Pct	-1.923	-1.452	-2.515	-2.557	-1.704	-1.249
10Pct	-1.789	-1.133	-1.698	-2.333	-1.532	-1.194
25Pct	-1.391	-1.014	-0.851	-2.045	-1.291	-1.029
50Pct	-1.065	-0.673	-0.202	-1.822	-0.865	-0.561
75Pct	-0.605	-0.350	0.172	-0.909	-0.442	-0.038
90Pct	-0.016	0.032	0.584	0.227	-0.341	0.255
95Pct	0.252	0.407	0.624	0.284	-0.152	0.335
99Pct	0.569	0.833	1.093	0.330	0.146	0.482

#### LRBS Recommendations for Aquatic Life

VSCI scores decline as excess sedimentation fills interstitial spaces as reflected which correspond to lower LRBS values. Of note are LRBS values above 0.5 which may indicate

unnatural hardening of stream bottom. The LRBS appendix (L) provides additional statistical analyses to support stressor thresholds.

### ***Dissolved Metals Cumulative Criterion Unit (Metals CCU)***

Heavy metals are high density, metallic elements that are harmful to the environment at low concentrations. Though trace amounts of heavy metals are unavoidable and even essential to certain metabolic functions, however exceeding said quantities can prove toxic to organisms. Aquatic insects are especially sensitive to the presence of dissolved mercury, chromium, cadmium, arsenic, and lead in streams and rivers. These metals tend to accumulate in the gills and muscles of aquatic organisms and are subsequently transferred up the food chain, biomagnifying and risking the health of organisms at higher trophic levels. Metals can also decrease overall abundances of benthic macroinvertebrates and shift communities towards a composition dominated by organisms that are tolerant of metals. Mayflies, specifically, tend to be particularly susceptible to metals (Iwasaka, 2009).

Dissolved metals have been identified as important predictors of stream health. In the context of water quality criteria, dissolved metals are typically treated independently; however there is strong evidence that metals have a cumulative effect (Clements, 2000). Cumulative Criterion Units (CCU) account for this additive effect by standardizing each dissolved metal's concentration with chronic criterion values established by VDEQ. The metals are summed together resulting in the CCU Metals Index score (Figure 37).

$$\text{Metals CCU} = \sum \frac{\text{Dissolved metal concentration}}{\text{VDEQ criterion value}}$$

Arsenic (chronic) =	$\frac{\text{measured concentration}}{150.00}$	=	Arsenic ratio
			+
Chromium (chronic) =	$\frac{\text{measured concentration}}{[e^{0.8190 [\ln (\text{HARDNESS})] + 0.6848}] (0.860)}$	=	Chromium ratio
			+
Copper (chronic) =	$\frac{\text{measured concentration}}{[e^{0.8545 [\ln (\text{HARDNESS})] - 1.702}] (0.960)}$	=	Copper ratio
			+
Lead (chronic) =	$\frac{\text{measured concentration}}{[e^{1.273 [\ln (\text{HARDNESS})] - 3.259}]}$	=	Lead ratio
			+
Nickel (chronic) =	$\frac{\text{measured concentration}}{[e^{0.8460 [\ln (\text{HARDNESS})] - 0.8840}] (0.997)}$	=	Nickel ratio
			+
Zinc (chronic) =	$\frac{\text{measured concentration}}{[e^{0.8473 [\ln (\text{HARDNESS})] + 0.8841}] (0.986)}$	=	Zinc ratio
			<hr/>
			<b>Metals CCU</b>

(Clements, 2000)

Figure 37. Metals Cumulative Criterion Unit calculation.

Toxicity of many metals is dependent on water hardness warranting calculations of site specific water quality criteria from hardness values. Chromium, copper, lead, nickel, and zinc all rely upon a hardness factor when calculating the EPA criterion value. Only arsenic is has a constant 150.00 (µg/L) criterion.

#### Metals CCU Scores in Virginia

The following series of tables and graphics are presented in order to establish a baseline for Metal CCU levels, illustrating a variety of approaches to interpreting Metals CCU data and offering some perspective on Metal CCU scores relative to its impacts on aquatic life.

Table 38 shows that in Virginia Metals CCU scores less than 0.75 pose no risk to aquatic life (based on VSCI scores). Metals CCU scores between 0.75 and 1.5 are considered low probability of stress to aquatic life. Scores greater than 1.5 but less than 2.0 indicate that dissolved metals are a possible stressor. A high probability of stress to aquatic life exists when Metals CCU scores are above 2.0.

Table 38. Metals CCU Scores ranges and associated probability of stress to aquatic life (based on VSCI scores) (n=368).

Dissolved Metals Cumulative Criterion Unit (CCU)	
Probability of Stress to Aquatic Life	Metals CCU (unitless)
High	> 2.0
Medium	> 1.5, < 2.0
Low	> 0.75, < 1.5
No	< 0.75

The next series of graphics and tables show Metals CCU distributions statewide by ecoregion, stream order, and basin. The Metals CCU Appendix M links the stressor to aquatic health and contains the statistical information for the recommended stressor threshold levels.

Figure 38 presents box-and-whisker plots of Metals CCU statewide and by basin. The Rappahannock-York Basin has the highest median Metals CCU. Median Metals CCU scores for all basins are within the low to no probability of stress ranges. Note that the median Metals CCU for Virginia is under 1.0 and medians for both the Roanoke and James Basins are commensurate to the median for Virginia. The shading in Figure 38 corresponds to the probability of stress categories in Table 38.



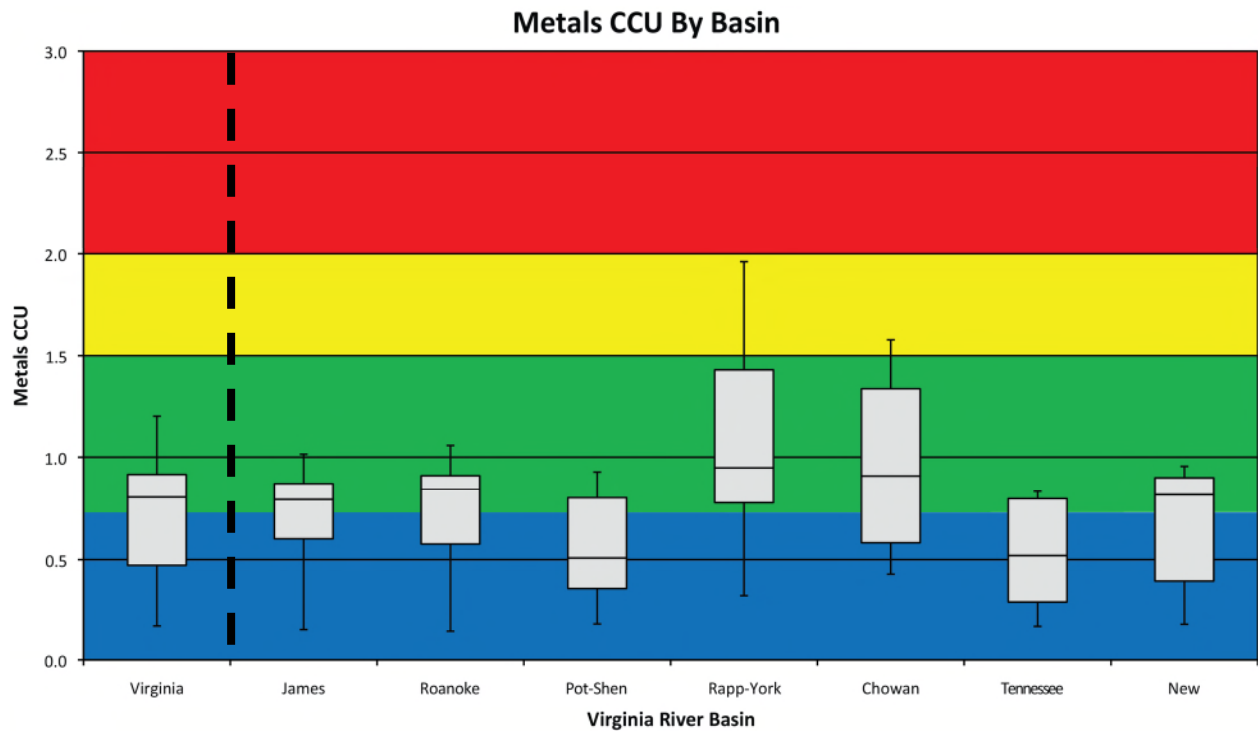


Figure 38. Boxplots of Metals CCU statewide and by basin (n = 368).

The percentiles associated with Figure 38 are shown in Table 39. Note that the quartile ranges (the top and bottom of the boxes in the box-and-whisker plot) correspond to the 25<sup>th</sup> and 75<sup>th</sup> percentiles, respectively. Metals CCU quartile ranges statewide and within each individual basin straddle the extent exhibiting no to low probability of stress to aquatic life.

Table 39. Percentile tables of Metals CCU statewide and by basin (n = 368).

Statistic	Virginia	James	Roanoke	Pot-Shen	Rapp-York	Chowan	Tennessee	New
1Pct	0.171	0.153	0.145	0.181	0.319	0.425	0.169	0.179
5Pct	0.206	0.220	0.203	0.190	0.392	0.429	0.187	0.179
10Pct	0.283	0.296	0.287	0.202	0.575	0.437	0.219	0.238
25Pct	0.472	0.601	0.575	0.354	0.777	0.582	0.288	0.391
50Pct	0.803	0.792	0.843	0.508	0.948	0.909	0.520	0.816
75Pct	0.916	0.871	0.910	0.800	1.431	1.338	0.796	0.900
90Pct	1.199	1.015	1.057	0.928	1.961	1.578	0.832	0.956
95Pct	1.436	1.432	1.149	1.047	2.407	1.662	0.882	1.144
99Pct	2.506	1.528	1.302	1.320	2.795	1.729	0.929	1.322

Figure 39 illustrates Metals CCU data by stream order. Median Metals CCU values appear fairly stable as stream order increases, indicating little downstream transport of heavy metal constituents. Table 40 states the percentiles associated with Figure 39.

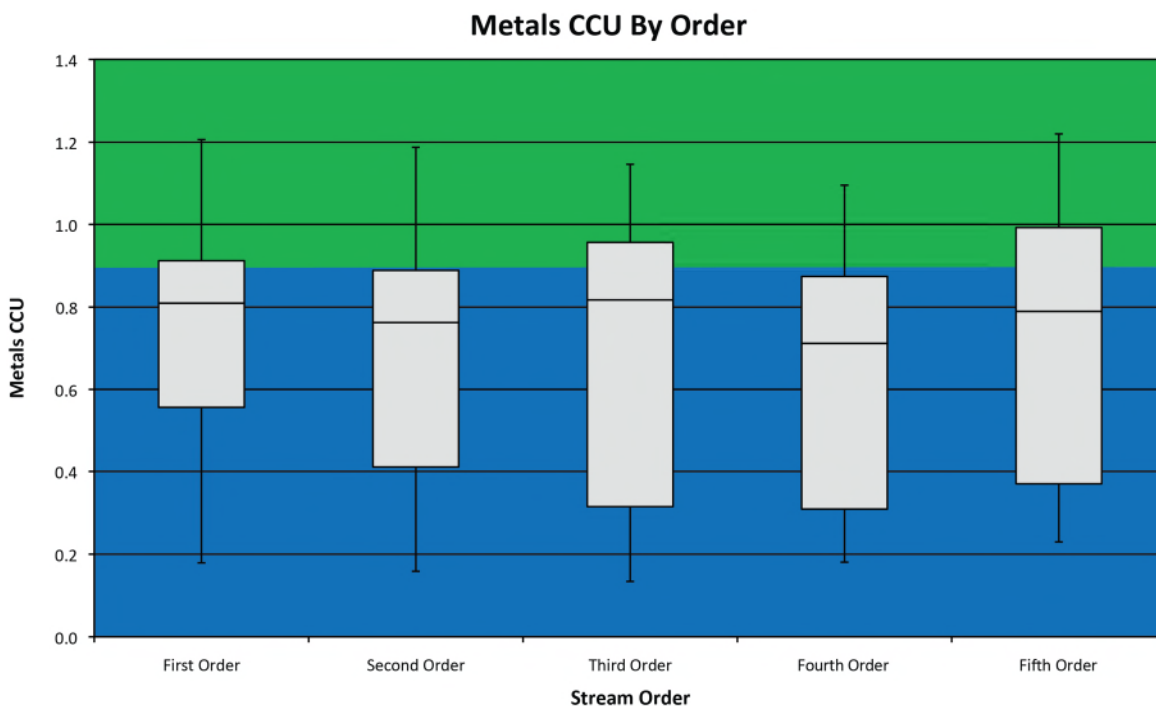


Figure 39. Boxplots of Metals CCU by stream order (n = 368).

Table 40. Percentile tables of Metals CCU by stream order (n = 368).

Statistic	First Order	Second Order	Third Order	Fourth Order	Fifth Order
1Pct	0.179	0.159	0.134	0.181	0.229
5Pct	0.209	0.199	0.186	0.200	0.232
10Pct	0.312	0.245	0.219	0.256	0.257
25Pct	0.556	0.411	0.315	0.309	0.370
50Pct	0.809	0.763	0.817	0.713	0.790
75Pct	0.913	0.889	0.957	0.874	0.993
90Pct	1.206	1.188	1.146	1.094	1.220
95Pct	1.451	1.364	1.332	1.196	1.340
99Pct	2.193	1.885	1.542	1.594	1.458

Figure 40 demonstrates Metals CCU data by Virginia Ecoregion (Level III). The Southeastern Plains ecoregion exhibits the highest median Metals CCU value at nearly 1.0 and 75<sup>th</sup> percentile extending into medium stress range. Median Metals CCU levels in all other ecoregions fall into the low to no probability of stress range with the Central Appalachian and Ridge and Valley ecoregions reporting the greatest percentages of sites in the no stress zone. Table 41 expresses percentiles presented in Figure 40.

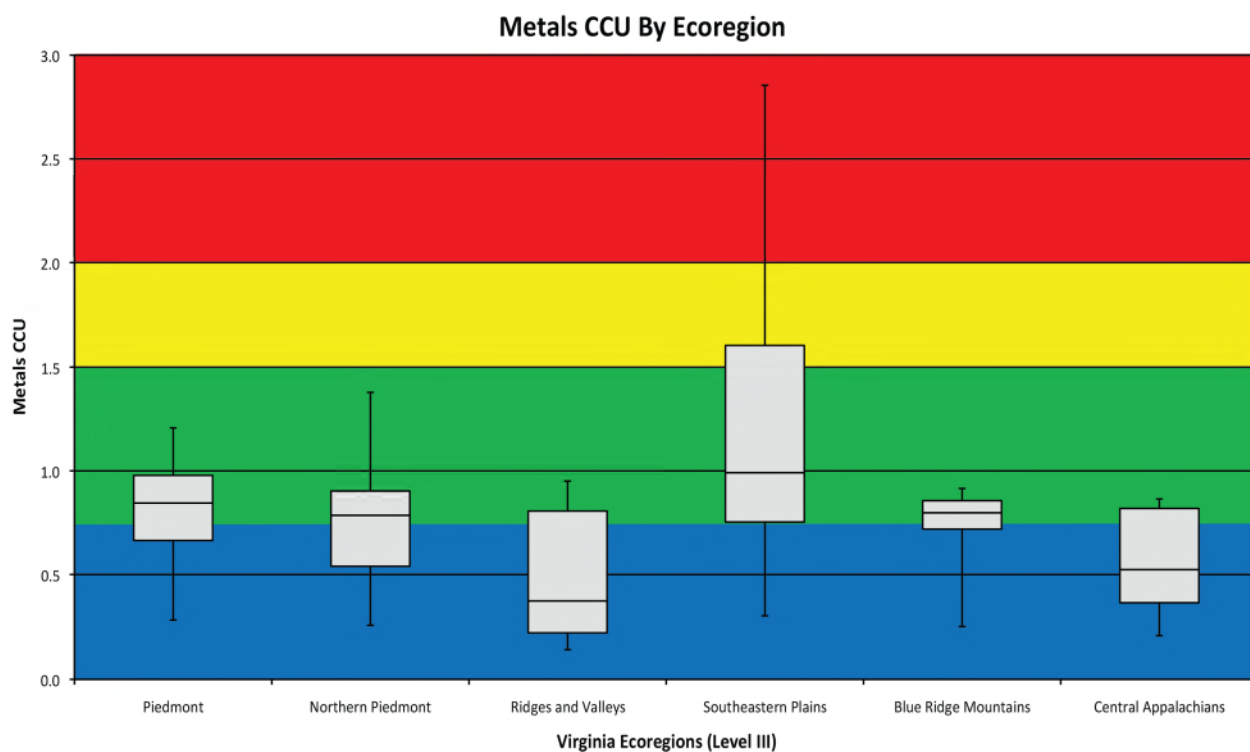


Figure 40. Boxplot of Metals CCU by Virginia Ecoregion (Level III).

Table 41. Percentile tables of Metals CCU by Virginia Ecoregion (Level III).

Statistic	Piedmont	Northern Piedmont	Ridges and Valleys	Southeastern Plains	Blue Ridge Mountains	Central Appalachians
1Pct	0.282	0.257	0.141	0.302	0.251	0.208
5Pct	0.379	0.354	0.172	0.302	0.270	0.250
10Pct	0.434	0.356	0.186	0.302	0.301	0.290
25Pct	0.664	0.540	0.221	0.753	0.719	0.364
50Pct	0.845	0.786	0.374	0.991	0.798	0.524
75Pct	0.978	0.903	0.806	1.605	0.856	0.818
90Pct	1.207	1.378	0.951	2.855	0.915	0.864
95Pct	1.340	1.467	0.987	2.874	0.919	0.892
99Pct	1.532	1.698	1.271	2.889	1.074	0.914

#### Metals CCU and Probability of Stress to Aquatic Life

High levels of dissolved metals have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Metals CCU levels above 2 increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). This probability increases significantly once the Metal CCU increases above 1.5.

## 5. Toxics and Benthic Macroinvertebrate Community Stressor Analysis

### Background

A requirement of the TMDL process is to identify the stressor(s) causing the impairment, which in this case is a suppressed macroinvertebrate community. The process involves the identification of individual stressor(s), including physical, nutrient based or chemical, followed by developing a weight-of-evidence linkage between the cause and effect to the benthic community. The real difficulty is identifying potential stressors as they can be numerous and do not always act alone. Although VDEQ currently identifies benthic macroinvertebrate samples to the Family level, preliminary analysis of Probabilistic Monitoring data shows that Family level data does not correlate well with toxic substances. While tolerance values exist for many benthic macroinvertebrate families, there is limited information on organism tolerance with respect to toxic contaminants. Not only is the identification of toxic stressors difficult but it is also hard to neatly tie in with the TMDL framework.

Upon ruling out the more common benthic stressors such as sedimentation and nutrients, the most likely stressor(s) are chemical. Examples of chemical or toxic stressors known to impact benthic communities include Polycyclic Aromatic Hydrocarbons (PAHs), pesticides, and metals. PAHs are most often found in the environment as a group of contaminants and act in an additive way whereas individual pesticides or metals can directly lead to the impairment or be significant contributors. Although very prevalent in the environment, there is little evidence to support that Total Polychlorinated Biphenyls (tPCBs) trigger benthic macroinvertebrate community shifts at typical sediment concentrations observed in Virginia when compared to Sediment Quality Guidelines (SQGs, >0.4 mg/kg or ppm where toxicity is predicted; MacDonald, 2000). Other stressors, not considered “toxic” in the traditional sense, can impact the benthic fauna as well. Examples include chloride or Total Dissolved Solids (TDS). Both stressors lead to uninhabitable conditions by causing osmotic in-balances within the internal fluids of benthic organisms.

The myriad of potential sources for upland contaminants must also be considered in this process. Land based activity in the area can provide an obvious sign as to the type of toxicants that should be targeted. Available sediment chemistry results can be very useful in determining potential sources provided the data set is fairly recent. While aging data may provide some insight and direction, chances are current land uses have changed. If upstream land use is

associated with activities that could release toxicant(s) on a pulsed basis, this should be considered. Examples of pulsed contaminants can include pesticides or herbicides especially following their seasonal applications. PAHs may be steadily released from nearby combustion activity or pulsed from application of tar based asphalt sealants. The possibility also exists that toxicant(s) not analyzed could be a cause of the impairment as thousands of anthropogenic chemicals have been developed but only a small percentage chemically analyzed.

Several programs existed in the past that provided crucial information in determining potential causes to aquatic life impairments. Historically, VDEQ operated a laboratory capable of performing effluent and/or ambient toxicity tests. The toxicity testing laboratory provided a service within VDEQ to evaluate potential toxic sources in a relatively short timeframe. However, due to budget shortfalls the lab was taken out of service. To fill the void left by the closure of VDEQ's lab, and to assist in TMDL development for benthic impairments, EPA agreed to perform the water column toxicity testing service in their laboratory located in Wheeling, West Virginia. Unfortunately, the EPA lab also discontinued the service. Another source of ambient toxics information used in the development of TMDLs included VDEQ's Fish Tissue and Sediment Program. Under this program, annual monitoring that targeted toxic contaminants in fish tissue and sediment was performed. The program was temporarily discontinued in 2009 due to budgetary reasons. It is unknown if/when the program will rematerialize. Presently, VDEQ's Probabilistic Monitoring program facilitates collection of a short list of toxicants (i.e., sediment metals).

Looking to the future, it appears funding from grants or obtaining funds directly from EPA are the most viable options for performing TMDL toxicity studies in stressor determination. While VDEQ has limited resources to invest in toxic stressor evaluations, this chapter presents various methods, cost estimates and the positive and negative attributes associated with each approach. This information should assist VDEQ staff in making decisions about stressor identification as it relates to impaired benthic communities. As such, it is imperative that the appropriate sampling approaches be utilized in a way in that allows contaminants to be ruled in or out as stressor(s) while keeping costs to a minimum.

## **Stressor Analysis Tools**

The intent of ambient toxics monitoring is to perform a quick screen of the medium of interest to determine if there is potential for toxics pollutants that negatively impact aquatic life. An excellent tool used to screen for adverse biological effects including survival, growth and

reproduction of surrogate species, consists of water and/or sediment toxicity tests. Chemical monitoring can also provide evidence of potential toxicants although one must keep in mind that targeted analytes reflect only a few of the available chemical contaminants that may be contributing to or causing the observed impairment. The selection of the medium to test is also important in these studies. Although extremely transient, ambient water can be the focus of these efforts if there is a suspected nearby source. To eliminate the transient nature of waterborne contaminants, there are tools available to sequester these contaminants such as passive samplers also known as Semi-permeable membrane devices (SPMDs). Due to the ease of collection, the medium that is most often collected and analyzed is sediment. The prime reason for sediment collection is non-polar chemical contaminants have a great affinity for suspended particles that ultimately settle to the bottom of these water bodies. Unless depositional areas are targeted, the disadvantage for collecting sediment may be the difficulty in locating representative samples as stream beds in many Virginia non-tidal streams and rivers are largely comprised of bedrock and/or cobble with sand.

Toxic contaminants can be evaluated in a variety of matrices including effluent, surface water, SPMDs, or sediment. Different approaches are available to hone in on the possible causes of the impaired community. The following sections provide options that should help contribute to the weight of evidence in determining the potential for impacts caused by this category of stressors.

### ***Effluent Toxicity***

The Virginia Pollution Discharge Elimination System (VPDES) permitting program has a component known as the Toxics Management Program that is designed to evaluate applicable effluents for toxicity. The process requires effluents be screened for a list of chemical contaminants as well as Whole Effluent Toxicity (WET). The chemical analysis targets priority pollutants that are included in 40 CFR Part 136 which can be compared to Virginia's water quality criteria (WQC). The downside to a chemical approach, which was discussed earlier, is the targeting of a relatively small fraction of available chemicals that may be present. Additionally, chemicals are often present as mixtures and may act toxicologically in an additive or synergistic way. Recognizing the complexity associated with chemical mixtures, EPA developed standardized methods for acute and chronic WET tests (EPA, 2002). The main advantage of this approach is a complete integration of test organism exposure to the full spectrum of chemical contaminants present in an effluent. Chronic WET tests, which are the more common of the two methods, use surrogate test organisms including a vertebrate

commonly known as the fathead minnow (*Pimephales promelas*) and an invertebrate known as a water flea (*Ceriodaphnia dubia*). Chronic toxicity is measured over a seven day period using multi-concentrations of effluent. As such, the tests are designed to provide a dose-response expressed as a percent effluent indicating the highest concentration that has no statistically observed effect on survival, growth or reproduction. When a toxic effect is observed in effluent, it can be very difficult to determine causality by comparing the available chemical results with biological results. However, important insight is obtained indicating the effluent is toxic. Under the VPDES Program, the permittee has the ultimate responsibility in determining causality through a Toxics Reduction Evaluation (TRE).

As part of the TMDL stressor analysis study, it is important to evaluate all available VPDES toxics data. This includes both historical and more recent chemical and WET test data. If the character of the effluent has changed due to a process change at an industrial site, or for example a municipality began accepting new industrial wastewater(s), these changes would not be reflected in the historic VPDES WET results. In all likelihood the original testing was performed several years ago with the current requirement of an annual WET test. The permit specifies that the more sensitive of the two surrogate test organisms be used in annual monitoring. If the character of the effluent has changed, the “more sensitive species” used for the annual WET monitoring may no longer be the appropriate test organism. When evidence supports this occurrence, re-evaluating the effluent with new toxicity tests using two species may be necessary. As an important step in a toxicity stressor analysis, it is strongly suggested that evaluation and collection of all permit related toxics information be a collaborative effort between TMDL staff and the permit writer.

#### Advantages

- WET test results provide insight on the potential for toxicity from effluents.
- Exposure of biota with the full integration of all available chemical contaminants.
- The permittee has the financial responsibility for performing up to date testing if deemed necessary.

#### Disadvantages

- The cause of the toxicity is not always readily apparent and typically requires additional investigation.



## ***Surface Water Toxicity***

Ambient toxicity tests provide the means to evaluate the potential for adverse biological effects from chemical contaminants directly to indigenous biota. The monitoring objective is to capture impacts to survival and growth of the fathead minnow (*P. promelas*) or survival and reproduction to *C. dubia* following exposure to ambient water collected at one or more stations. Similar to chronic effluent WET tests and adhering to EPA methods (EPA 2002), surrogate test organisms are exposed to ambient surface water for a seven day period. A major difference between the effluent WET test and ambient water test is no dilution of samples occurs as a dose-response is not necessary. Rather, each ambient station is statistically compared to a laboratory test control. These tests can determine if there is an on-going water quality impact from water borne toxic pollutants that are continuously available or derived from pulsed inputs. Chronic tests are generally preferred over acute tests because 1) acute effects can be obtained from chronic tests and 2) toxicants are present at ambient levels that typically do not illicit an acute effect.

Water column samples for chronic toxicity tests are typically collected over a period of a week and require that at least three new samples be collected. Samples are then shipped to a toxicity testing lab. It is imperative that sample collection and shipment be coordinated with the toxicity testing lab as water samples have a short holding time (36 hrs prior to first use). As discussed previously, results do not isolate a contaminant that causes adverse effects to the organisms; it is a screening tool that indicates presence or absence of toxicity and the degree to which the toxicity affects test organisms.

### **Advantages**

- Excellent screening tool in the determination of presence or absence of toxicity. Can be an important element in developing a weight-of-evidence.
- Exposure of biota with the full integration of all available chemical contaminants.

### **Disadvantages**

- The cause of the toxicity will not be readily apparent.
- Ambient samples collected as grabs represent a “snap-shot” in time. Pulses of contamination can be missed
- Significant field effort for sample collection is required as a minimum of three samples are necessary to comply with the test procedures.
- Laboratory tests have inherent limitations in predicting ecological effects

## ***Passive Sampling***

Passive samplers are useful when chronic toxicity is suspected. Passive samplers provide several advantages over traditional tissue residue analysis, conventional grab samples and short term composite sampling.

Passive samplers can be deployed in a manner that they remain stationary during sample collection unlike fish. The samplers do not depurate or metabolize target analytes as do biota. The samplers are deployed ultra clean and do not contain interfering substances that can complicate analytical workup as with tissue analysis.

Passive samplers are integrative samplers in that they sequester compounds during the entire deployment. In this way they are very useful in determining the average concentration over weeks to several months. Grab and composite samples offer only a short snapshot of contaminant concentration which can result in misleading data. Depending on the compounds of interest and the types of membranes being deployed samplers can be deployed for several weeks to several months.

There are a variety of passive samplers available the choice of which depends on the analytes of interest. There are passive samplers that are specific to metals that may be ionic in solution. Other samplers can be divided into two general categories, 1) those that sequester hydrophobic organics with high octanol to water partitioning coefficients, KOWs and 2) those that capture organics with low KOWs.

When conducting studies trying to determine the cause of some measured toxicity whether in the benthic community or via conventional toxicity exposure tests use of multiple membranes that cover the widest possible number of analytes based on their KOWs is important. The use of high resolution gas chromatography and high resolution mass spectrometry (HRGC/MS) is recommended to aid in unknown compound identification. HRGC/MS has the advantage of providing exact mass measurements of unknown compounds detected in sample fractions.

A further advantage of using long term integrative samplers is that they are generally not encumbered by censorship of data at the method detection limit. The equivalent of hundreds to thousands of liters of sample, based on deployment time, are analyzed so the actual water column concentration is easily detected to the large mass sequestered.

Given the large number of analytes that are typically detected, determining the specific chemical that is causing toxicity can be daunting. The use of Microtox, Mutatox and the Yeast Estrogen Screening assay may be of use. Exposure of the passive samplers extracts in the least sensitive Microtox assay will determine if there is any toxicity in the whole sample. If exposure reveals toxicity the sample extract can be fractionated by High Performance Liquid Chromatography into multiple subsamples based on KOWs. Each of the subsample extracts can then be exposed to each of the three test assays to identify the compound. These subsamples in turn can be analyzed by HRGC/MS resulting in a much smaller and easier to identify compound list. Additional information is available through the U.S. Geological Survey website.

### ***Whole Sediment Toxicity***

Sediment provides habitat for many aquatic organisms while at the same time acting as a sink for many persistent chemicals. Most anthropogenic chemicals including toxic organic and inorganic contaminants eventually accumulate in sediment. However, the mere presence of elevated chemicals does not automatically imply the sediment is toxic. This is due to bioavailability of contaminants, or partitioning between sediment and water, which may depend on many factors including pH, redox potential, affinity for sediment organic carbon and dissolved organic carbon, grain size of the sediment and the quantity of acid volatile sulfides. For these reasons, sediment is an important medium to evaluate using sediment toxicity tests.

Similar to water toxicity tests, methods have been developed to obtain a direct measure of sediment toxicity by exposing surrogate organisms to sediments under controlled conditions. The objective of a sediment test is to determine whether chemicals in sediment are harmful and bioavailable to benthic organisms. The tests are used to measure interactive toxic effects of complex chemical mixtures in sediment. Furthermore, they have evolved into effective tools that provide direct, quantifiable evidence of biological consequences of sediment contamination that can only be inferred from chemical or benthic community analysis. Toxicity methods are outlined in “Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates” (EPA, 2000). The surrogate test organisms include the amphipod *Hyaella azteca* and the midge *Chironomus tentans*. The test methodology requires that each be exposed to a laboratory control as well as reference and test site sediments for a period of 10 days in a static test system. The test endpoints are survival and growth. Procedures are primarily described for testing freshwater sediments;

however, estuarine sediments (up to 15‰ salinity) can also be tested in 10-d sediment toxicity tests with *H. azteca*.

#### Advantages

- Excellent screening tool in the determination of presence or absence of toxicity. Can be an important element in developing a weight-of-evidence.
- Measures interactive toxic effects of complex chemical mixtures in sediments as well as their bioavailability.
- Ten-day toxicity test methods are rapid and inexpensive relative to other approaches.

#### Disadvantages

- The collection of representative sediments in many freshwater streams and rivers may be difficult to locate.
- Sediment collection, handling, and storage may alter bioavailability
- Laboratory tests have inherent limitations in predicting ecological effects.
- Specific toxicant causing observed effect can be difficult to identify without a Toxicity Identification Evaluation (TIE).

### ***Sediment Screening Values***

Virginia does not have regulatory criteria or standards for contaminated sediments. Extremely variable sediment characteristics affect the toxicity potential of contaminants yielding inaccurate predictions of toxic effects on benthic communities. These inherent issues necessitate an adoption of broadly applicable guidelines for sediments. Instead of regulatory criteria or standards, VDEQ reviews sediment concentrations of toxic chemicals using screening values to estimate the potential for adverse effects of contaminants. These screening values are neither legally enforceable nor default cleanup goals. However, they may prove useful refining lists of potential chemicals of concern at a site, thus guiding decisions regarding the need for and focus of site-specific investigations of ecological risk.

VDEQ reviews toxic contaminant concentrations in sediment throughout the 305(b) assessment using sediment screening values. If sediments are below the screening value concentration, the sediment is considered to have low potential for causing adverse effects on aquatic life. Thus, the sediment in the water body is considered to meet the “aquatic life use” (as long as other water quality indicators are also met and support that assessment). Water bodies where the sediment concentration exceeds sediment screening values (SVs) are considered to

have “observed effects”, but are not listed as “impaired” due to an exceedance of the sediment screening value.

For freshwater sediments above the fall line, and tidal freshwater, sediments can be assessed by using the Consensus Based Probable Effects Concentrations (PEC as derived in MacDonald, 2000). In marine and estuarine waters, concentrations of toxic contaminants can be compared to “effect-range-medium” values (ER-M) screening values for sediment developed by the National Oceanic and Atmospheric Administration (NOAA *Screening Quick Reference Tables* (SQuiRT) Buchman, 1999).

The usefulness of either the ER-M or PEC values in predicting actual adverse toxic effects on the benthic organisms can be limited for a variety of reasons, including the type of sediment present, especially the percent of organic carbon present in the sediment. Exceedance of these screening values does not constitute a finding that the benthic community has been adversely affected by the toxic contaminant. It does however act as evidence that there is an increased potential for toxicity caused by the toxic compound, whose PEC or ER-M value has been exceeded.

Both freshwater PEC and marine water ER-M sediment screening values used by VDEQ can be found in Appendix F of Virginia’s “Water Quality Assessment Guidance Manual for 2012, 305(b)/303(d) Integrated Report” (VDEQ, 2012). This is available from the following website; <http://www.VDEQ.virginia.gov/waterguidance/pdf/112007.pdf>

### ***Sediment Toxicity Identification Evaluation (TIE)***

A sediment Toxicity Identification Evaluation (TIE) is applicable at locations where sediments have demonstrated chronic toxicity to surrogate test species through whole sediment toxicity tests, as well as adverse ecological effects such as benthic population declines or changes in community structure. Simply knowing that sediment from specific sites is toxic has limited use. For this reason, EPA developed a guidance document entitled “Sediment Toxicity Identification Evaluation (TIE) Phases I, II, and III Guidance Document” (EPA, 2007). Without going into great detail, TIE methods allow for the identification of toxic chemicals or chemical classes causing observed toxicity. The identification of pollutants responsible for toxicity of contaminated sediments has broad application in a number of EPA programs including the TMDL framework, where it could be feasible to link sediment toxicity to specific dischargers or contaminated sites.

The EPA Guidance document contains Phase I TIE (characterization) methods for interstitial waters and whole sediments. There is specific guidance on when to use whole sediment or interstitial water methods, the collection of interstitial waters for testing, and test volume considerations. Interstitial water methods include the following manipulations: graduated pH, aeration, filtration, C18 reverse phase chromatography extraction, EDTA addition, and cation exchange solid phase extraction. Whole sediment methods include general procedures and considerations for whole sediment testing and the following manipulations: *Ulva lactuca*, zeolite, cation exchange resin, anion exchange resin, acid volatile sulfide, Ambersorb, and powdered coconut charcoal additions and base metal substitution. Existing guidance for Phases II and III methods have been tailored for chemical classes normally found in sediments.

## **6 Existing Resources and Standing Workgroup Goals**

### **West Virginia's Dirty Reference Model**

West Virginia's Department of Environmental Protection (WVDEP) utilizes weight-of-evidence and best professional judgment to identify possible stressors to benthic macroinvertebrate communities. Prior to TMDL development, monthly water chemistry data is compared to water quality standards. Biological data collected is evaluated and contrasted with developed biological thresholds. Considerations of the potential impacts from other sources as well as habitat limitations are assigned a numerical rating in order to better evaluate the stream quantitatively.

WVDEP relies on the "dirty reference model" for statistical classification of potential stressors to benthic macroinvertebrate communities. The null model references assemblages impacted by a sole stressor. Dirty references or stressed communities are compared to unknown assemblages in regard to statistical similarity and probability. Organic enrichment, ionic stress, sedimentation, and acidic pH/dissolved metals are categories of biological stress designated through this weight-of-evidence approach.

VDEQ Biologist/ TMDL Staff workgroup established a chapter sub group to evaluate the utility of the dirty reference model in Virginia. The group concluded that a full evaluation of the model would require reviewing the associated documents and inner workings of the model (primary and secondary matrices, file structure, statistics package used, etc.). A copy of the draft manuscript and a case study was acquired from Tetra Tech and is available on VDEQ's T: drive. It was also determined that VDEQ would need to boost the number of stress sites and completely recalibrate this tool for VA streams. The decision was made to table the chapter group at this time and place it on the agenda for the standing workgroup.

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# Appendices

# Appendices

## Appendix Introduction

The following sections present statistical analyses for each of the parameters discussed in the main document. The intent of the appendices is to present support for the stressor threshold linkages to benthic macroinvertebrate community VSCI scores. Peer-reviewed statistical techniques are presented in the following appendices and were employed to explore the extent of the relationships between parameters and benthic community responses. Scatterplots, cumulative distribution functions, conditional probability, and quantile regression were part of the analyses that led to the stressor thresholds for dissolved oxygen, total phosphorus, total nitrogen, specific conductivity, ionic strength, total habitat, relative bed stability, and metals cumulative criterion unit. The aforementioned statistical approaches will be discussed in general terms in this section and shown in context to the applicable stressor parameters in appendices A through M.

Scatterplots are widely used to graphically represent data relationships. Scatterplots were initially used to highlight the parameters that at certain concentrations or values impact benthic macroinvertebrate communities. Willis (2012) applied scatterplot and regression plots to identify the most common stressors to Virginia's benthic macroinvertebrate communities. The parameters that best explained Virginia Stream Condition Index (VSCI) scores were confirmed using a generalized linear model (GLM). This approach narrowed the list of candidate parameters to those discussed in this document. Jason Hill performed additional statistical analyses that were used to identify thresholds that caused a shift in the benthic communities. The following appendices detail the development of the stressor thresholds.

Since Virginia's probabilistic stations were randomly selected, the resulting datasets allowed VDEQ to estimate the values of a water quality parameter over the entire state with known confidence using cumulative distribution functions. Cumulative distribution function (CDF) curves display the probability of data observed at or below a particular value. Probability of an event is presented on the y-axis while the range of values of a certain variable is shown on the x-axis. Cumulative Distribution Functions (CDFs) were employed by VDEQ to show statistically accurate estimates (Diaz-Ramos et al. 1996) for each stressor parameter presented statewide, by major basin, major ecoregion (level III), and by stream order. This graphical depiction plots the observed data for a given parameter over 100% of stream miles so that the full distribution can be evaluated. The example CDF below (Figure 1) shows various probabilities corresponding to specific conductance occurrence (x-axis) in a hypothesized dataset of 100% of stream miles (y-axis). Using the example CDF, 50% of stream miles have a specific conductance less than 250 uS/cm and 10% of streams have a specific conductance less than 375 uS/cm. Knowing the distribution of values allow VDEQ to understand if a parameter is within the range of

background concentrations or if the impaired reach has elevated concentrations based on where on the distribution a concentration or average of observed concentrations falls.

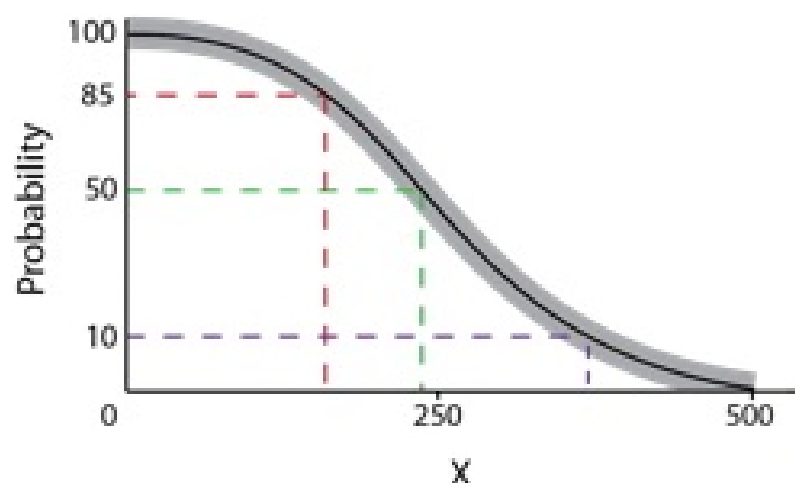


Figure 1. Hypothesized Specific Conductance CDF curve. The shading depicts hypothesized confidence intervals.

Stressor extent and relative risk are presented for select parameters in the following appendices along with associated confidence intervals. Calculation of relative risk first required classification of water quality responses (e.g. the benthic macroinvertebrate indices) and the water quality stressors into ‘optimal’ and ‘suboptimal’ categories. Relative or stressor extent shows how prevalent a stressor is in Virginia streams. In other words, stressor extent represents the percent of stream miles for a given stressor parameter that are categorized as ‘suboptimal’. Relative risk (Van Sickle, et al. 2006 and 2008) is a term borrowed from the medical field and applied here to communicate the severity of impact a stressor has on an aquatic environment. In order to fully appreciate relative risk in the ecological realm, it is first discussed in medical terms. For example, it is widely accepted that an individual with total cholesterol above 240 mg/dl is at greater risk for heart disease than an individual whose cholesterol is below 200 mg/dl; thus, the individual with cholesterol level above 240 has a higher relative risk of having heart disease than the individual with cholesterol level below 200. The relative risks for aquatic stressors can be interpreted in a manner similar to the heart disease example. Table A.1 shows the following relative risk categories for dissolved oxygen (DO) based on Figure A.2: the optimal range is greater than 9 mg/L and suboptimal is less than 7 mg/L. According to Figure A.3, an estimated 4.2% of streams have suboptimal DO concentrations (< 7 mg/L) and when DO is suboptimal, a stream is four times more likely to have a VSCI score below the impairment threshold of 60. Stressor extent and relative risk can be powerful tools in justifying and evaluating stressors and these analyses are presented in the following appendices for the parameters with adequate datasets.

Conditional probability (Paul and McDonald 2005) is a statistical analysis tool that allows for exploration relationships between a given stressor and response. This technique explores the

probability of an event (B) occurring given the knowledge that event A has already occurred. Conditional Probability is presented for select parameters and shows the likelihood that a stream will be considered impaired (i.e. VSCI score < 60) at a given parameter value (i.e. parameter concentration). For example, Figure 2 below shows probability of VSCI scores being less than 60 (e.g. impaired) on the y-axis relative to DO concentration on the x-axis. The optimal and suboptimal categories introduced in the previous paragraph are applied here (> 9 mg/L and < 7 mg/L, respectively), thus the probability of having VSCI score less than 60 when the DO is under 7 mg/L is 90%. Conditional probability is presented for stressor parameters where applicable datasets exist.

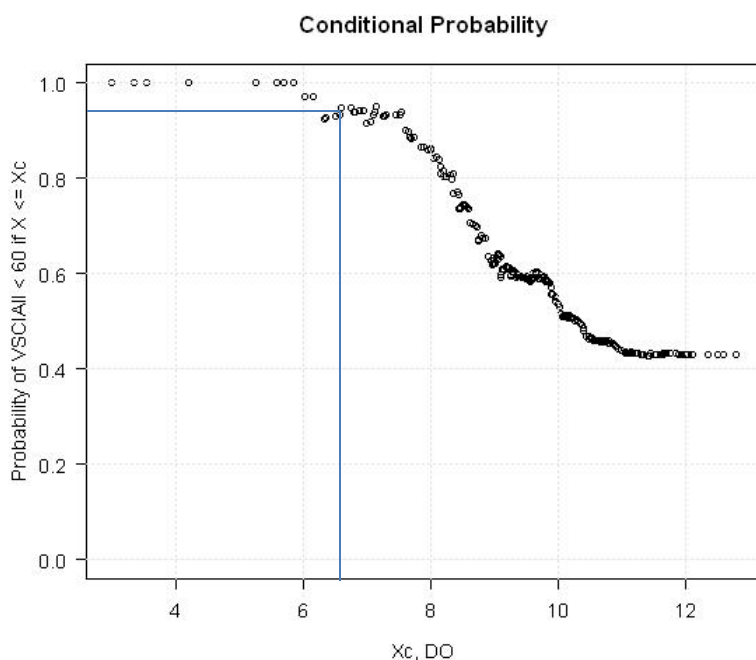


Figure 2. Dissolved oxygen conditional probability graphic.

Quantile regression (Cade and Noon 2003) techniques are used to describe the relationship between stressors and responses in a manner that aids in teasing out the effects of other stressors. The approach fits a 90<sup>th</sup> percentile line and carries the assumption that separation of the upper quartile between of under the premise is that fit a regression to the 90<sup>th</sup> quantile in order to remove the effects of other stressor variables to biological metrics. The stressor parameters with datasets conducive to quantile regression in the following appendices show the VSCI scores (y-axis) by parameter concentration (x-axis). The 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> percentile lines are also identified on the quantile regression graphs. However, only the 90<sup>th</sup> percentile regression equations were used to estimate stressor thresholds.

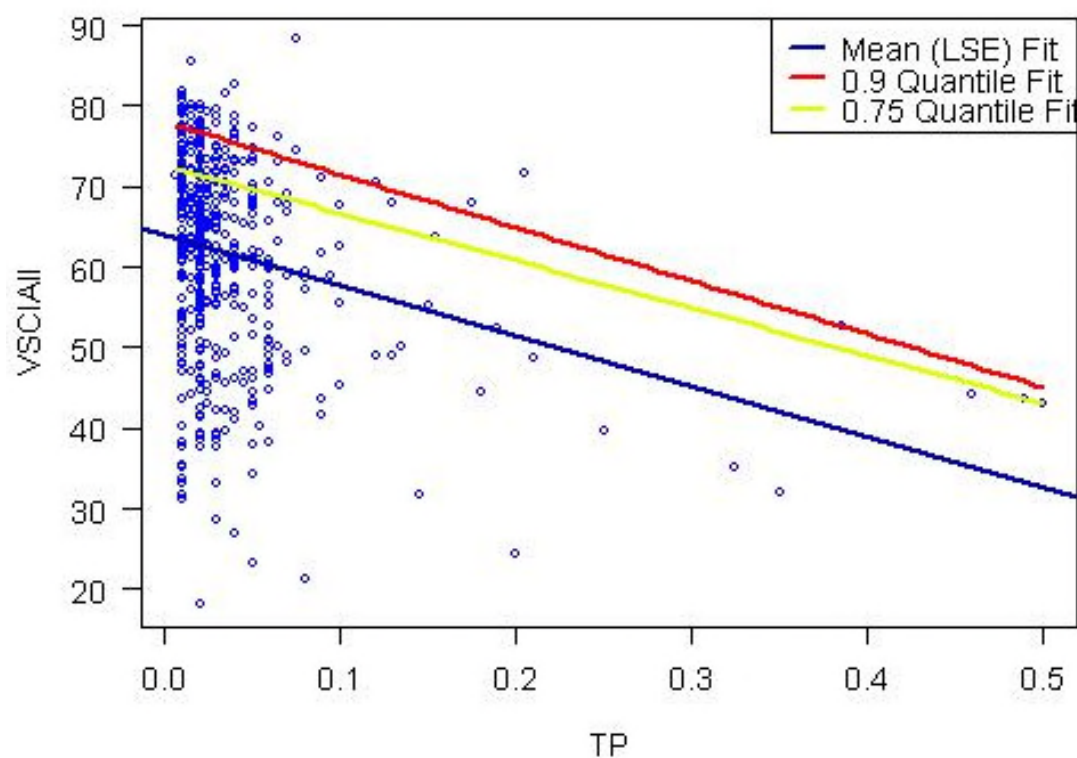


Figure 3. Quantile regression of VSCI by total phosphorus concentration.

The following sections include statistical analyses supporting stressor linkages for DO, pH, total phosphorus, total nitrogen, specific conductivity, total dissolved solids, individual ions, total habitat, Relative Bed Stability, and metals CCU.

## Appendix A: Dissolved Oxygen Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Aquatic health is measured by VDEQ with a multimetric biomonitoring tool known as the Virginia Stream Condition Index (VSCI) as described in the *Biological Monitoring* section. Statistical results show that dissolved oxygen levels under 7 mg/L increase the likelihood of having a low VSCI score (VSCI scores less than 60 indicate aquatic life use impairment). Note that the Virginia freshwater DO standard is 4.0 mg/L (Class II – IV, 9VAC25-260-50 Virginia Water Quality Standards), but high stress conditions for benthic macroinvertebrate communities most likely occur when DO values fall below 7.0 mg/L. This discrepancy derives from VDEQ's monitoring of DO conditions during daylight hours when measured oxygen levels are higher due to algal photosynthesis. When oxygen levels are observed in the field that fall in the medium and high probability of stress categories (Table 2) during daylight hours, it is highly recommended that a diurnal DO study take place during a low flow, high temperature time of year to determine if oxygen levels are meeting water quality standards. The DO probability of stress categories presented in Table 2 apply to non-tidal, or non-coastal, streams. In order to fully understand the effect of DO in the coastal plain areas of Virginia, a natural conditions evaluation needs to be performed. Figure 4 displays a scatterplot of DO and VSCI scores. The following figures and tables in Appendix A further explore the relationship of DO to benthic macroinvertebrate communities.



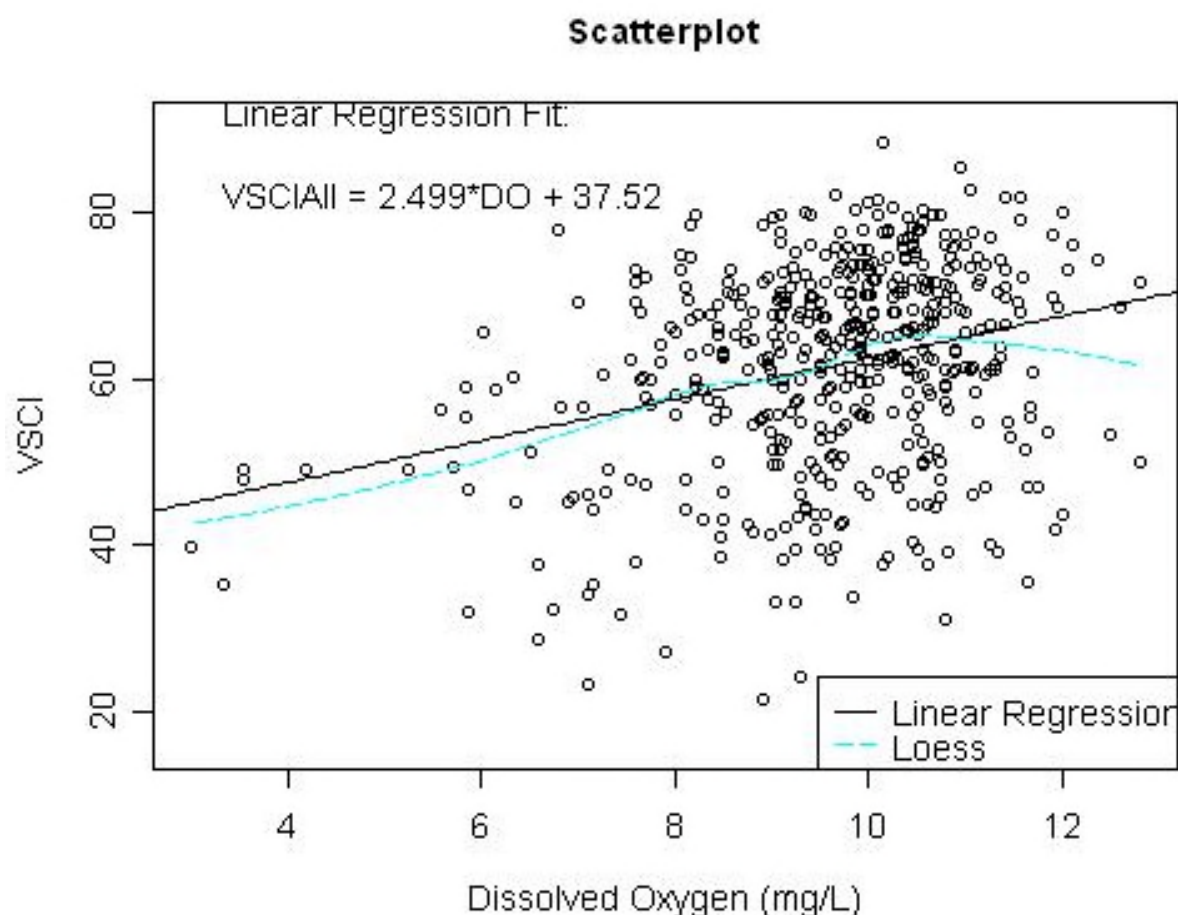


Figure 4. Stressor Gradient Scatterplot Comparing Decreasing Dissolved Oxygen (mg/L) values to Declining VSCI Scores.

### *Dissolved Oxygen Relative Risk Results*

An optimal level of greater than 9 mg/L of DO was selected based on the apparent low risk to aquatic life. VDEQ estimates 75% of Virginia streams have a DO level above 9 mg/L (Table 1). A DO under 7 mg/L was considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 5) and scatter plot graphs. An estimated 4.2% of Virginia streams have a DO under 7 mg/L (Figure 6). VDEQ relative risk calculations found that a VSCI score is 4.0 times more likely to be below 50 when the DO is below 7 mg/L than when the DO concentration is above 9 mg/L (Figure 6).

Table 1. **Dissolved Oxygen Relative Risk Categories.**

Stressor Parameter	Optimal	Suboptimal
Dissolved Oxygen (mg/L)	>9	<7

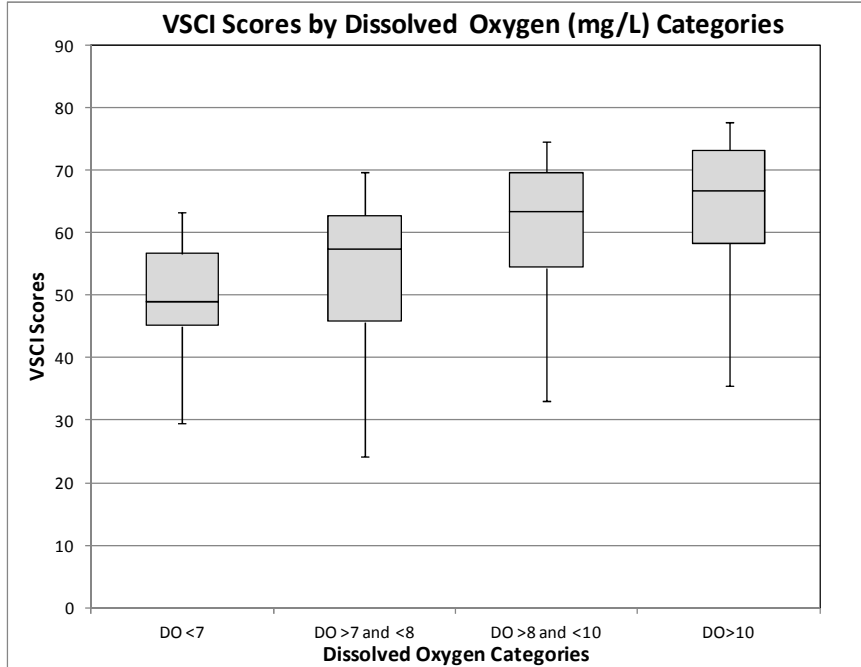
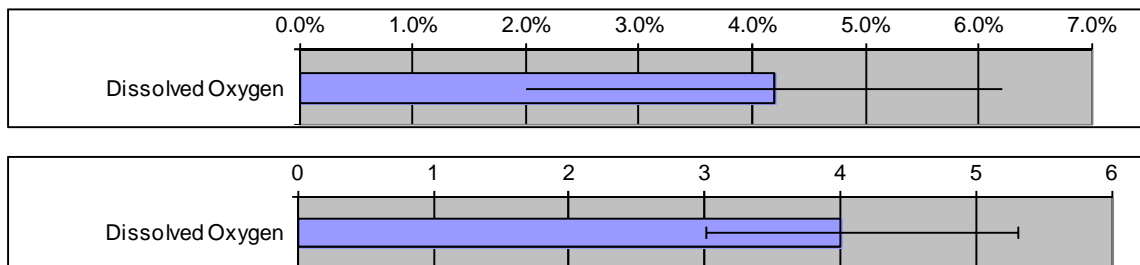


Figure 5. VSCI Scores by Dissolved Oxygen Categories.

Figure 6. Dissolved Oxygen Relative Extent (% Stream miles with DO below 7mg/L) and Risk Results.



### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis contains 25 sites with dissolved oxygen under 7 mg/L. Twenty-one of 25 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the DO is under 7 mg/L is 90% (Figure 7).

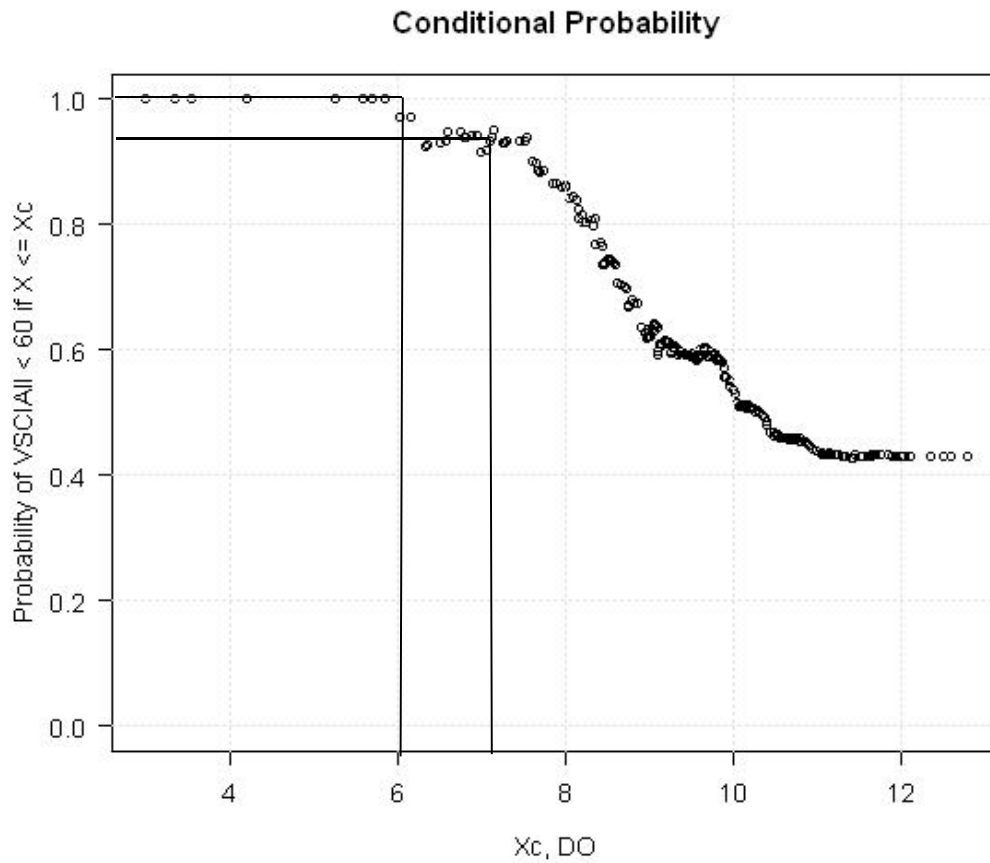


Figure 7. **Probability of VSCI less than 60 if Dissolved <6 mg/L and <7 mg/L.**

Conditional probability is shown in Figure 7. In Figure 7, the establishment of a defined situation (i.e. DO at various concentrations) is plotted against the probability of the VSCI being less than 60. At each DO “condition” on the x-axis, a VSCI<60 probability is evident on the y-axis. The probability of the VSCI score being less than 60 when the DO is under 6 mg/L is 100%.

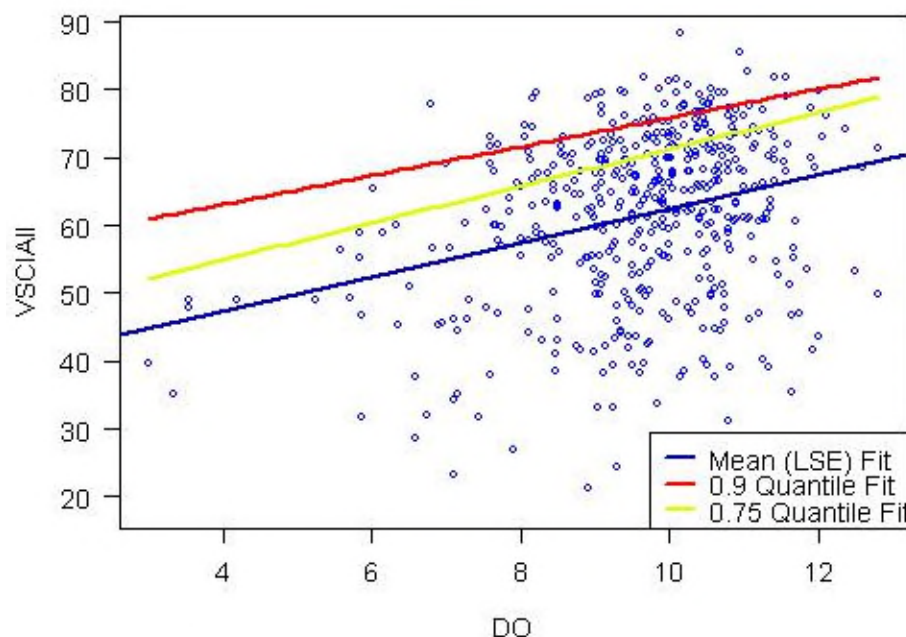


Figure 8. **Quantile Regression VSCI versus Dissolved Oxygen (mg/L).**

In Figure 8, the 0.9 quantile fit regression analysis (red line) shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to DO concentrations. The 50<sup>th</sup> percentile of reference crosses at 8.2 mg/L, 25<sup>th</sup> percentile intersects at 5.4 mg/L, and the 10<sup>th</sup> percentile is equal to 2.5 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective DO values, while the 10<sup>th</sup> percentile tends to represent values where the aquatic community is already stressed.

### *Dissolved Oxygen (mg/L) and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from average Dissolved Oxygen concentrations above 8 mg/L (Table A.2.). Average Dissolved Oxygen below 7 mg/L do not support health benthic communities and average dissolved oxygen below 8 mg/L warrant a diurnal oxygen study during a low flow, high temperature period.

Table 2. Dissolved Oxygen (mg/L) concentrations and probability of stress to aquatic life (based on VSCI Scores).

Dissolved Oxygen	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	< 7
Medium	> 7, < 8
Low	> 8, < 10
None	> 10

### *Dissolved Oxygen Cumulative Distribution Function curves*

The following figures (9-12) depict CDF curves for DO: statewide, by super basin, Level III ecoregion, and stream order. Tables 3-6 contain the DO concentration estimates and percentiles for stream basin, Level III ecoregion, and stream order.

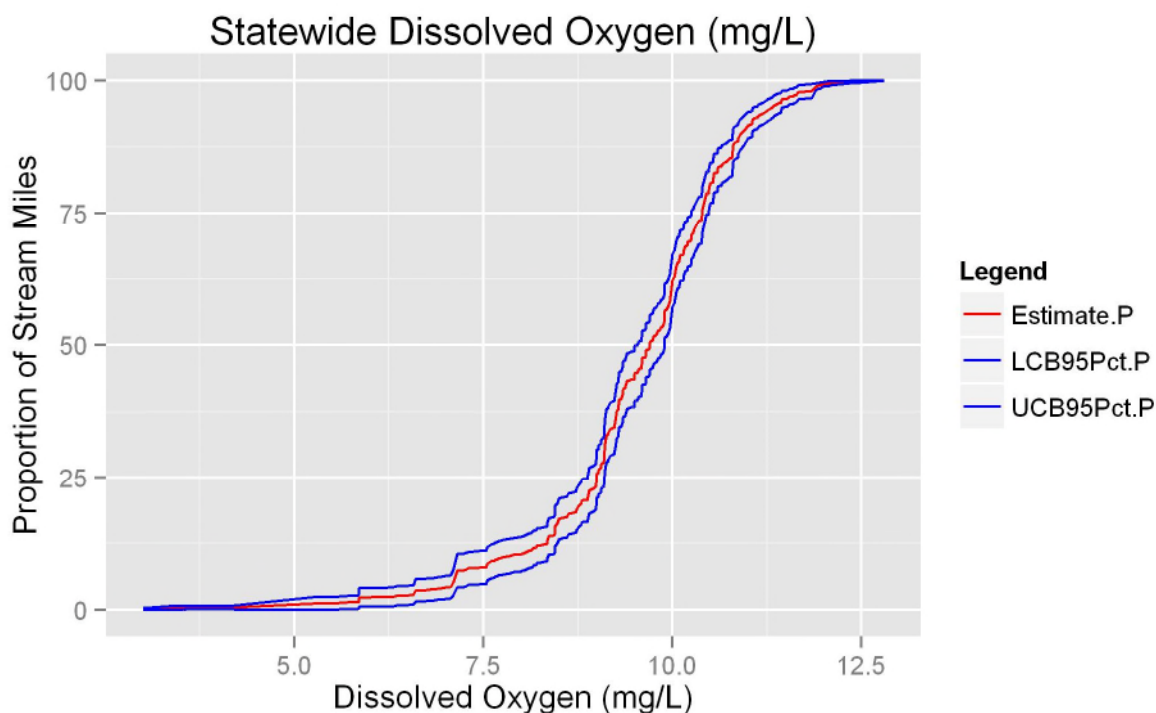


Figure 9. Dissolved Oxygen Statewide CDF graph.

Figure 9 shows the CDF curve for statewide DO bracketed by the 95% confidence intervals. Fifty percent of stream miles have DO concentrations of 9.7 mg/L (in the low probability of risk to aquatic life range). Twenty-five percent of streams have DO concentrations of 9.0 mg/L or below. Table 3 contains the DO estimates utilized to generate the CDF curve.

**Table 3. Statewide Dissolved Oxygen Estimates.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	DO	3.00	1	0.12	0.00	0.31
Virginia	DO	3.34	2	0.29	0.00	0.63
Virginia	DO	3.55	3	0.33	0.00	0.68
Virginia	DO	3.56	4	0.37	0.03	0.72
Virginia	DO	4.20	5	0.41	0.08	0.75
Virginia	DO	5.25	6	1.12	0.00	2.34
Virginia	DO	5.59	7	1.29	0.05	2.53
Virginia	DO	5.70	8	1.36	0.11	2.61
Virginia	DO	5.85	10	1.45	0.20	2.70
Virginia	DO	5.86	12	2.28	0.53	4.03
Virginia	DO	6.02	13	2.35	0.60	4.10
Virginia	DO	6.16	14	2.37	0.62	4.12
Virginia	DO	6.33	15	2.49	0.73	4.26
Virginia	DO	6.35	16	2.61	0.84	4.39
Virginia	DO	6.52	17	2.74	0.95	4.53
Virginia	DO	6.58	18	2.90	1.09	4.72
Virginia	DO	6.60	19	3.61	1.51	5.72
Virginia	DO	6.75	20	3.74	1.62	5.86
Virginia	DO	6.80	21	3.78	1.66	5.90
Virginia	DO	6.81	22	3.82	1.70	5.94
Virginia	DO	6.89	23	3.99	1.85	6.12
Virginia	DO	6.95	24	4.06	1.92	6.20
Virginia	DO	6.99	25	4.18	2.03	6.33
Virginia	DO	7.07	26	4.30	2.14	6.46
Virginia	DO	7.10	28	5.18	2.72	7.63
Virginia	DO	7.12	29	5.89	3.20	8.57
Virginia	DO	7.15	31	7.31	4.19	10.42
Virginia	DO	7.25	32	7.48	4.36	10.60
Virginia	DO	7.28	33	7.60	4.48	10.71
Virginia	DO	7.30	34	7.77	4.64	10.89
Virginia	DO	7.45	35	7.93	4.80	11.07
Virginia	DO	7.53	36	7.95	4.82	11.09
Virginia	DO	7.55	37	8.66	5.48	11.85
Virginia	DO	7.60	41	9.09	5.89	12.30
Virginia	DO	7.65	43	9.30	6.10	12.51
Virginia	DO	7.67	44	9.42	6.22	12.63
Virginia	DO	7.70	47	9.68	6.47	12.90
Virginia	DO	7.75	49	9.89	6.67	13.12
Virginia	DO	7.85	51	10.14	6.91	13.37
Virginia	DO	7.90	52	10.31	7.06	13.55
Virginia	DO	7.95	53	10.38	7.13	13.62
Virginia	DO	8.00	55	10.49	7.24	13.73
Virginia	DO	8.01	56	10.53	7.28	13.77
Virginia	DO	8.05	58	10.74	7.48	13.99
Virginia	DO	8.10	62	11.11	7.83	14.38
Virginia	DO	8.14	63	11.18	7.90	14.46
Virginia	DO	8.15	66	11.39	8.11	14.66
Virginia	DO	8.16	67	11.56	8.27	14.84
Virginia	DO	8.20	69	11.85	8.58	15.11

Virginia	DO	8.21	70	12.01	8.75	15.28
Virginia	DO	8.24	71	12.03	8.77	15.30
Virginia	DO	8.30	73	12.27	9.00	15.55
Virginia	DO	8.34	74	12.39	9.11	15.68
Virginia	DO	8.35	75	13.10	9.69	16.51
Virginia	DO	8.37	76	13.81	10.33	17.30
Virginia	DO	8.43	77	13.98	10.48	17.48
Virginia	DO	8.44	78	14.10	10.59	17.61
Virginia	DO	8.45	82	15.86	12.08	19.64
Virginia	DO	8.47	83	15.98	12.20	19.76
Virginia	DO	8.47	84	16.15	12.36	19.94
Virginia	DO	8.50	89	17.19	13.32	21.05
Virginia	DO	8.53	90	17.23	13.36	21.09
Virginia	DO	8.54	91	17.27	13.40	21.13
Virginia	DO	8.55	92	17.31	13.44	21.18
Virginia	DO	8.57	93	17.33	13.46	21.20
Virginia	DO	8.60	94	17.40	13.53	21.26
Virginia	DO	8.63	95	18.11	14.23	21.99
Virginia	DO	8.67	96	18.18	14.29	22.06
Virginia	DO	8.70	97	18.30	14.41	22.18
Virginia	DO	8.72	98	18.37	14.48	22.26
Virginia	DO	8.74	99	19.08	15.08	23.07
Virginia	DO	8.75	101	19.41	15.41	23.42
Virginia	DO	8.80	102	20.12	16.00	24.25
Virginia	DO	8.80	104	20.41	16.31	24.52
Virginia	DO	8.82	105	20.58	16.47	24.70
Virginia	DO	8.87	106	20.65	16.54	24.77
Virginia	DO	8.90	111	22.40	18.05	26.75
Virginia	DO	8.95	114	22.81	18.46	27.16
Virginia	DO	8.97	115	22.98	18.62	27.33
Virginia	DO	8.98	116	23.10	18.74	27.45
Virginia	DO	8.98	117	23.22	18.86	27.58
Virginia	DO	8.99	118	23.93	19.49	28.37
Virginia	DO	9.00	123	25.71	21.14	30.28
Virginia	DO	9.02	124	25.78	21.21	30.35
Virginia	DO	9.03	125	26.49	21.86	31.12
Virginia	DO	9.05	127	26.78	22.14	31.42
Virginia	DO	9.06	128	27.49	22.84	32.14
Virginia	DO	9.07	129	27.61	22.97	32.26
Virginia	DO	9.08	130	27.78	23.12	32.44
Virginia	DO	9.09	131	27.85	23.19	32.51
Virginia	DO	9.10	133	28.19	23.51	32.86
Virginia	DO	9.10	139	30.05	25.22	34.88
Virginia	DO	9.11	141	31.47	26.56	36.38
Virginia	DO	9.13	143	32.89	27.91	37.88
Virginia	DO	9.13	144	32.93	27.95	37.92
Virginia	DO	9.14	145	33.06	28.06	38.05
Virginia	DO	9.15	148	33.47	28.47	38.46
Virginia	DO	9.18	149	34.18	29.16	39.20
Virginia	DO	9.20	150	34.35	29.33	39.36
Virginia	DO	9.21	151	34.42	29.40	39.43
Virginia	DO	9.23	152	34.46	29.45	39.47
Virginia	DO	9.25	156	36.66	31.57	41.75

Virginia	DO	9.26	157	36.78	31.70	41.86
Virginia	DO	9.27	158	37.49	32.36	42.61
Virginia	DO	9.27	159	37.66	32.53	42.79
Virginia	DO	9.28	160	37.82	32.69	42.96
Virginia	DO	9.30	166	39.74	34.56	44.93
Virginia	DO	9.33	167	39.87	34.68	45.05
Virginia	DO	9.34	168	40.58	35.39	45.76
Virginia	DO	9.35	171	41.62	36.41	46.83
Virginia	DO	9.36	172	41.74	36.53	46.95
Virginia	DO	9.37	173	41.87	36.65	47.08
Virginia	DO	9.40	180	43.20	37.98	48.41
Virginia	DO	9.43	181	43.36	38.14	48.59
Virginia	DO	9.44	182	43.43	38.21	48.66
Virginia	DO	9.45	183	43.47	38.25	48.70
Virginia	DO	9.46	184	43.52	38.29	48.74
Virginia	DO	9.48	185	43.56	38.33	48.78
Virginia	DO	9.50	186	43.68	38.45	48.90
Virginia	DO	9.50	195	44.70	39.51	49.89
Virginia	DO	9.53	196	44.74	39.55	49.93
Virginia	DO	9.54	197	44.91	39.70	50.11
Virginia	DO	9.55	198	44.98	39.78	50.18
Virginia	DO	9.55	201	45.38	40.18	50.59
Virginia	DO	9.56	202	45.45	40.25	50.66
Virginia	DO	9.56	203	45.49	40.29	50.70
Virginia	DO	9.59	204	45.62	40.41	50.82
Virginia	DO	9.60	205	46.33	41.10	51.55
Virginia	DO	9.60	210	47.62	42.49	52.74
Virginia	DO	9.64	211	47.78	42.67	52.90
Virginia	DO	9.65	216	49.02	43.93	54.11
Virginia	DO	9.68	218	49.13	44.04	54.23
Virginia	DO	9.70	219	49.25	44.17	54.34
Virginia	DO	9.70	224	50.54	45.41	55.66
Virginia	DO	9.72	225	50.58	45.45	55.70
Virginia	DO	9.72	227	50.72	45.60	55.84
Virginia	DO	9.74	228	50.84	45.71	55.97
Virginia	DO	9.75	230	51.67	46.51	56.83
Virginia	DO	9.77	231	51.71	46.55	56.88
Virginia	DO	9.78	232	51.88	46.71	57.05
Virginia	DO	9.79	233	51.95	46.79	57.11
Virginia	DO	9.80	238	52.52	47.37	57.68
Virginia	DO	9.81	239	52.65	47.49	57.80
Virginia	DO	9.82	240	52.69	47.53	57.84
Virginia	DO	9.83	241	52.76	47.60	57.91
Virginia	DO	9.84	242	52.92	47.77	58.08
Virginia	DO	9.84	243	52.99	47.85	58.14
Virginia	DO	9.85	246	53.31	48.16	58.45
Virginia	DO	9.86	247	53.43	48.28	58.58
Virginia	DO	9.87	248	53.55	48.41	58.69
Virginia	DO	9.89	249	54.26	49.12	59.40
Virginia	DO	9.90	258	56.43	51.35	61.52
Virginia	DO	9.91	259	56.60	51.50	61.70
Virginia	DO	9.92	260	56.67	51.57	61.77
Virginia	DO	9.95	262	57.55	52.46	62.64



Virginia	DO	9.97	263	58.26	53.20	63.32
Virginia	DO	10.00	275	62.13	57.14	67.11
Virginia	DO	10.03	276	62.84	57.89	67.78
Virginia	DO	10.05	282	64.79	59.91	69.67
Virginia	DO	10.07	283	65.50	60.66	70.35
Virginia	DO	10.09	284	65.67	60.83	70.51
Virginia	DO	10.10	289	66.86	62.06	71.66
Virginia	DO	10.11	290	66.90	62.10	71.70
Virginia	DO	10.14	291	67.07	62.25	71.89
Virginia	DO	10.15	292	67.24	62.42	72.06
Virginia	DO	10.15	293	67.95	63.17	72.73
Virginia	DO	10.17	294	68.66	63.94	73.37
Virginia	DO	10.20	295	68.73	64.02	73.44
Virginia	DO	10.20	300	69.48	64.78	74.17
Virginia	DO	10.24	301	69.64	64.96	74.33
Virginia	DO	10.25	306	70.24	65.57	74.91
Virginia	DO	10.26	307	70.95	66.35	75.55
Virginia	DO	10.26	308	70.99	66.40	75.59
Virginia	DO	10.27	309	71.03	66.43	75.63
Virginia	DO	10.29	310	71.74	67.18	76.30
Virginia	DO	10.30	314	72.27	67.73	76.81
Virginia	DO	10.35	319	73.51	69.02	78.00
Virginia	DO	10.37	320	73.55	69.06	78.04
Virginia	DO	10.38	321	73.59	69.10	78.07
Virginia	DO	10.39	322	73.76	69.27	78.25
Virginia	DO	10.39	323	74.47	70.06	78.87
Virginia	DO	10.40	330	75.77	71.44	80.10
Virginia	DO	10.45	340	78.75	74.73	82.76
Virginia	DO	10.48	341	78.87	74.85	82.89
Virginia	DO	10.49	342	79.58	75.63	83.53
Virginia	DO	10.50	347	80.62	76.78	84.46
Virginia	DO	10.51	348	80.66	76.82	84.50
Virginia	DO	10.52	349	80.70	76.87	84.54
Virginia	DO	10.53	350	80.77	76.94	84.60
Virginia	DO	10.55	359	82.51	78.86	86.15
Virginia	DO	10.57	360	82.55	78.90	86.19
Virginia	DO	10.60	361	82.72	79.08	86.35
Virginia	DO	10.60	367	83.58	79.98	87.17
Virginia	DO	10.62	369	83.74	80.15	87.33
Virginia	DO	10.64	370	83.78	80.20	87.37
Virginia	DO	10.65	373	84.14	80.57	87.72
Virginia	DO	10.67	374	84.26	80.70	87.83
Virginia	DO	10.67	375	84.39	80.83	87.94
Virginia	DO	10.69	377	84.60	81.05	88.15
Virginia	DO	10.70	378	84.64	81.09	88.19
Virginia	DO	10.72	379	84.76	81.22	88.30
Virginia	DO	10.75	383	85.29	81.78	88.79
Virginia	DO	10.79	384	85.41	81.91	88.91
Virginia	DO	10.80	394	87.83	84.71	90.95
Virginia	DO	10.81	395	88.00	84.90	91.09
Virginia	DO	10.83	397	88.24	85.15	91.32
Virginia	DO	10.85	400	88.47	85.39	91.54
Virginia	DO	10.87	401	88.54	85.47	91.61

Virginia	DO	10.88	402	89.25	86.35	92.15
Virginia	DO	10.90	408	89.81	86.94	92.68
Virginia	DO	10.95	410	90.59	87.89	93.30
Virginia	DO	11.00	414	91.56	89.09	94.04
Virginia	DO	11.05	415	91.73	89.28	94.18
Virginia	DO	11.05	416	91.80	89.36	94.25
Virginia	DO	11.06	417	91.87	89.43	94.31
Virginia	DO	11.06	418	92.58	90.41	94.75
Virginia	DO	11.08	419	92.70	90.54	94.86
Virginia	DO	11.09	420	92.87	90.72	95.02
Virginia	DO	11.10	421	92.94	90.80	95.08
Virginia	DO	11.13	422	93.01	90.87	95.14
Virginia	DO	11.13	423	93.05	90.92	95.18
Virginia	DO	11.14	424	93.22	91.11	95.33
Virginia	DO	11.14	425	93.39	91.30	95.47
Virginia	DO	11.15	426	93.46	91.37	95.54
Virginia	DO	11.20	429	93.81	91.75	95.88
Virginia	DO	11.25	432	94.27	92.23	96.31
Virginia	DO	11.26	433	94.39	92.37	96.42
Virginia	DO	11.30	435	94.73	92.75	96.71
Virginia	DO	11.32	436	94.90	92.94	96.86
Virginia	DO	11.33	437	94.97	93.01	96.92
Virginia	DO	11.35	440	95.25	93.32	97.17
Virginia	DO	11.40	444	95.65	93.75	97.54
Virginia	DO	11.41	445	95.72	93.82	97.61
Virginia	DO	11.44	446	95.78	93.90	97.67
Virginia	DO	11.45	447	96.49	94.96	98.03
Virginia	DO	11.53	448	96.62	95.09	98.14
Virginia	DO	11.55	451	96.99	95.53	98.46
Virginia	DO	11.60	452	97.12	95.66	98.57
Virginia	DO	11.62	453	97.24	95.80	98.68
Virginia	DO	11.64	454	97.36	95.94	98.78
Virginia	DO	11.65	455	97.53	96.14	98.92
Virginia	DO	11.66	456	97.65	96.27	99.03
Virginia	DO	11.67	457	97.77	96.41	99.13
Virginia	DO	11.70	458	97.81	96.46	99.17
Virginia	DO	11.76	459	97.94	96.59	99.28
Virginia	DO	11.85	460	98.00	96.67	99.34
Virginia	DO	11.90	462	98.84	98.20	99.47
Virginia	DO	11.93	463	98.96	98.36	99.56
Virginia	DO	11.95	464	99.03	98.45	99.61
Virginia	DO	12.00	466	99.32	98.84	99.79
Virginia	DO	12.05	467	99.39	98.93	99.85
Virginia	DO	12.10	468	99.56	99.19	99.92
Virginia	DO	12.35	469	99.72	99.48	99.97
Virginia	DO	12.50	470	99.79	99.58	100.00
Virginia	DO	12.60	471	99.86	99.69	100.00
Virginia	DO	12.80	473	100.00	100.00	100.00

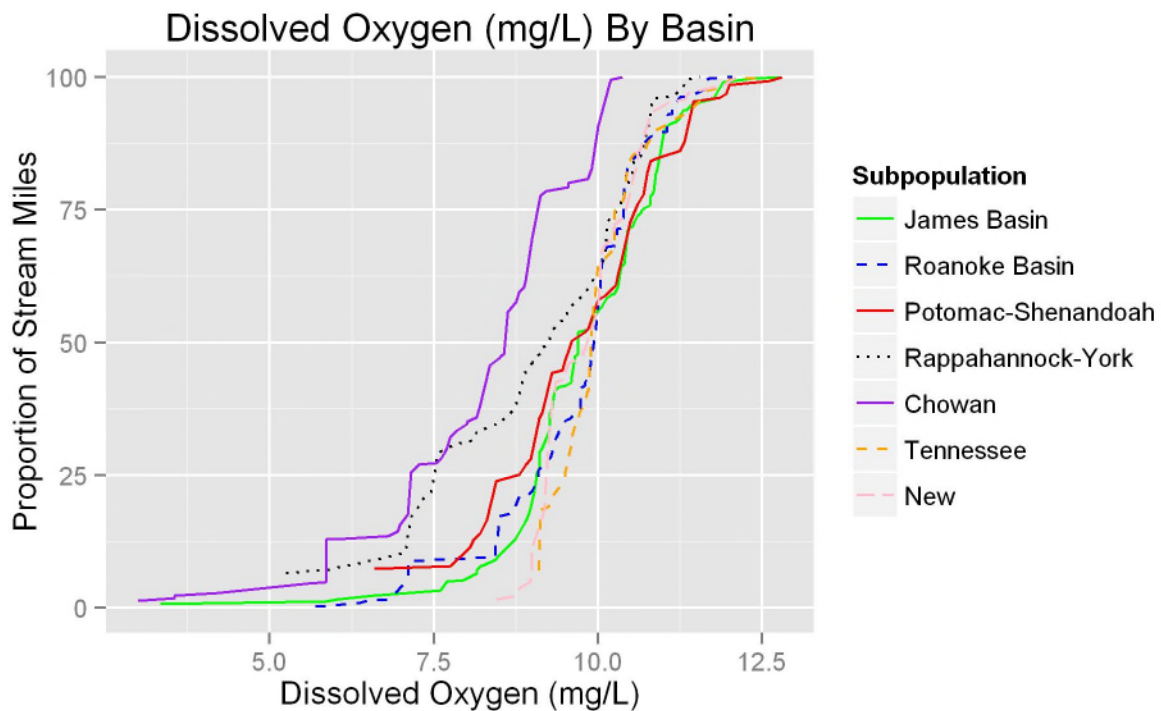


Figure 10. Dissolved Oxygen by Super Basin CDF graph.

The CDF curve in Figure 10 shows super basin CDF curves for DO. The Chowan is the CDF shown overall to have lower DO concentrations. Fifty percent of Chowan streams have a DO of 7.7 mg/L. In the James Basin, 52% of streams have DO concentrations less than 9.7 mg/L. Similarly, 52% of streams in the Roanoke Basin, New Basin, and Tennessee Basin have DO concentrations below 9.9 mg/L. Fifty-two percent of streams in the Rappahannock-Shenandoah Basins have DO concentrations below 9.3 mg/L.

Table 4. Dissolved Oxygen Estimates by Super Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	DO	3.34	1	0.73	0.00	1.98
James Basin	DO	5.86	2	1.27	0.00	2.83
James Basin	DO	6.02	3	1.57	0.00	3.22
James Basin	DO	6.58	4	2.31	0.19	4.42
James Basin	DO	7.60	6	3.34	0.84	5.84
James Basin	DO	7.65	7	4.08	1.44	6.72
James Basin	DO	7.70	9	4.91	2.06	7.77
James Basin	DO	7.95	10	5.22	2.29	8.15
James Basin	DO	8.10	12	6.13	2.90	9.36
James Basin	DO	8.15	13	6.43	3.21	9.66
James Basin	DO	8.16	14	7.17	3.63	10.70
James Basin	DO	8.21	15	7.90	4.41	11.39
James Basin	DO	8.24	16	7.99	4.49	11.49

James Basin	DO	8.34	17	8.52	4.82	12.23
James Basin	DO	8.44	18	9.06	5.19	12.92
James Basin	DO	8.47	19	9.59	5.60	13.58
James Basin	DO	8.50	21	9.95	5.91	13.99
James Basin	DO	8.74	22	13.05	6.91	19.20
James Basin	DO	8.90	24	16.34	8.38	24.30
James Basin	DO	8.95	26	17.81	9.81	25.80
James Basin	DO	8.97	27	18.54	10.56	26.53
James Basin	DO	9.03	28	21.65	12.70	30.60
James Basin	DO	9.06	29	24.75	15.75	33.76
James Basin	DO	9.07	30	25.29	16.26	34.31
James Basin	DO	9.10	32	26.33	17.21	35.44
James Basin	DO	9.11	33	29.43	20.09	38.77
James Basin	DO	9.14	34	29.96	20.54	39.39
James Basin	DO	9.25	35	33.07	23.18	42.96
James Basin	DO	9.26	36	33.60	23.79	43.41
James Basin	DO	9.27	37	36.71	26.40	47.01
James Basin	DO	9.30	39	37.62	27.32	47.93
James Basin	DO	9.34	40	40.73	30.38	51.08
James Basin	DO	9.40	42	41.57	31.16	51.97
James Basin	DO	9.45	43	41.75	31.33	52.16
James Basin	DO	9.50	44	41.92	31.49	52.35
James Basin	DO	9.59	45	42.46	32.06	52.85
James Basin	DO	9.60	47	43.73	33.33	54.12
James Basin	DO	9.65	49	47.37	37.05	57.68
James Basin	DO	9.70	50	47.90	37.65	58.15
James Basin	DO	9.70	53	52.04	41.51	62.57
James Basin	DO	9.83	54	52.34	41.79	62.90
James Basin	DO	9.90	58	53.86	43.41	64.32
James Basin	DO	9.95	59	54.60	44.12	65.08
James Basin	DO	10.00	61	56.07	45.66	66.48
James Basin	DO	10.05	62	56.60	46.17	67.03
James Basin	DO	10.10	64	57.67	47.27	68.07
James Basin	DO	10.14	65	58.40	47.83	68.98
James Basin	DO	10.20	66	58.94	48.36	69.52
James Basin	DO	10.25	67	59.24	48.65	69.83
James Basin	DO	10.30	69	60.51	49.94	71.07
James Basin	DO	10.35	71	64.35	53.88	74.82
James Basin	DO	10.40	73	64.83	54.36	75.31
James Basin	DO	10.45	75	71.04	61.59	80.49
James Basin	DO	10.48	76	71.58	62.05	81.10
James Basin	DO	10.53	77	71.88	62.37	81.38
James Basin	DO	10.55	78	72.61	63.17	82.06
James Basin	DO	10.60	80	73.88	64.41	83.36
James Basin	DO	10.65	81	74.42	64.93	83.90
James Basin	DO	10.67	82	74.95	65.49	84.40
James Basin	DO	10.69	83	75.13	65.68	84.58
James Basin	DO	10.70	84	75.31	65.87	84.75
James Basin	DO	10.79	85	75.84	66.41	85.27
James Basin	DO	10.80	88	77.61	68.27	86.96
James Basin	DO	10.83	89	77.92	68.56	87.27
James Basin	DO	10.85	91	78.63	69.32	87.94
James Basin	DO	10.88	92	81.73	73.23	90.24

James Basin	DO	10.90	93	82.47	74.05	90.88
James Basin	DO	10.95	94	85.57	78.07	93.08
James Basin	DO	11.00	98	89.82	83.90	95.74
James Basin	DO	11.05	99	90.55	84.81	96.30
James Basin	DO	11.06	100	90.86	85.14	96.57
James Basin	DO	11.10	101	91.16	85.50	96.82
James Basin	DO	11.20	102	91.69	86.03	97.36
James Basin	DO	11.25	103	92.43	86.87	97.98
James Basin	DO	11.26	104	92.96	87.50	98.43
James Basin	DO	11.30	105	93.70	88.39	99.00
James Basin	DO	11.35	106	93.88	88.58	99.17
James Basin	DO	11.40	108	94.59	89.36	99.82
James Basin	DO	11.55	109	95.32	90.23	100.00
James Basin	DO	11.76	110	95.86	90.83	100.00
James Basin	DO	11.90	111	98.96	97.66	100.00
James Basin	DO	12.35	112	99.70	99.16	100.00
James Basin	DO	12.80	113	100.00	100.00	100.00
Roanoke Basin	DO	5.70	1	0.31	0.00	0.88
Roanoke Basin	DO	6.35	2	0.87	0.00	1.98
Roanoke Basin	DO	6.52	3	1.42	0.00	2.85
Roanoke Basin	DO	6.81	4	1.61	0.15	3.06
Roanoke Basin	DO	6.89	5	2.37	0.49	4.24
Roanoke Basin	DO	7.10	6	5.59	0.08	11.10
Roanoke Basin	DO	7.12	7	8.81	1.50	16.11
Roanoke Basin	DO	8.43	8	9.57	2.14	16.99
Roanoke Basin	DO	8.45	9	12.79	4.08	21.49
Roanoke Basin	DO	8.47	10	13.55	4.81	22.29
Roanoke Basin	DO	8.50	12	17.32	8.09	26.55
Roanoke Basin	DO	8.70	13	17.87	8.66	27.08
Roanoke Basin	DO	8.80	14	21.09	10.89	31.30
Roanoke Basin	DO	8.95	15	21.41	11.21	31.60
Roanoke Basin	DO	9.00	17	22.27	12.05	32.49
Roanoke Basin	DO	9.05	19	23.59	13.34	33.83
Roanoke Basin	DO	9.08	20	24.35	13.98	34.71
Roanoke Basin	DO	9.10	22	25.87	15.45	36.29
Roanoke Basin	DO	9.10	23	26.06	15.62	36.49
Roanoke Basin	DO	9.15	24	26.82	16.30	37.34
Roanoke Basin	DO	9.20	25	27.58	17.08	38.08
Roanoke Basin	DO	9.28	26	28.34	17.79	38.90
Roanoke Basin	DO	9.35	27	31.56	20.42	42.71
Roanoke Basin	DO	9.37	28	32.11	20.94	43.29
Roanoke Basin	DO	9.40	30	33.19	21.93	44.45
Roanoke Basin	DO	9.50	33	35.27	24.24	46.29
Roanoke Basin	DO	9.53	34	35.45	24.42	46.48
Roanoke Basin	DO	9.56	35	35.64	24.60	46.68
Roanoke Basin	DO	9.64	36	36.40	25.31	47.49
Roanoke Basin	DO	9.65	37	37.16	26.11	48.21
Roanoke Basin	DO	9.74	38	37.71	26.61	48.81
Roanoke Basin	DO	9.75	40	41.49	30.02	52.96
Roanoke Basin	DO	9.79	41	41.80	30.36	53.24
Roanoke Basin	DO	9.80	42	41.99	30.55	53.42
Roanoke Basin	DO	9.81	43	42.54	31.09	53.99
Roanoke Basin	DO	9.85	45	43.64	32.17	55.12

Roanoke Basin	DO	9.87	46	44.20	32.72	55.68
Roanoke Basin	DO	9.90	48	47.73	36.21	59.26
Roanoke Basin	DO	9.91	49	48.49	36.88	60.10
Roanoke Basin	DO	9.92	50	48.81	37.19	60.42
Roanoke Basin	DO	9.97	51	52.03	40.42	63.63
Roanoke Basin	DO	10.00	56	56.85	45.49	68.21
Roanoke Basin	DO	10.03	57	60.07	48.89	71.25
Roanoke Basin	DO	10.05	58	63.29	52.44	74.14
Roanoke Basin	DO	10.07	59	66.51	56.17	76.85
Roanoke Basin	DO	10.09	60	67.27	56.92	77.61
Roanoke Basin	DO	10.15	61	68.03	57.69	78.37
Roanoke Basin	DO	10.26	62	68.22	57.90	78.54
Roanoke Basin	DO	10.29	63	71.44	61.53	81.34
Roanoke Basin	DO	10.38	64	71.62	61.74	81.51
Roanoke Basin	DO	10.39	65	72.38	62.43	82.34
Roanoke Basin	DO	10.39	66	75.60	66.42	84.78
Roanoke Basin	DO	10.40	68	79.13	70.69	87.58
Roanoke Basin	DO	10.45	71	83.22	76.04	90.40
Roanoke Basin	DO	10.50	72	83.77	76.67	90.88
Roanoke Basin	DO	10.51	73	83.96	76.87	91.05
Roanoke Basin	DO	10.55	74	84.72	77.71	91.73
Roanoke Basin	DO	10.60	75	85.48	78.58	92.39
Roanoke Basin	DO	10.62	77	86.22	79.41	93.04
Roanoke Basin	DO	10.65	78	86.98	80.23	93.74
Roanoke Basin	DO	10.80	81	88.82	82.27	95.37
Roanoke Basin	DO	10.85	82	89.13	82.61	95.66
Roanoke Basin	DO	10.90	83	89.45	82.95	95.95
Roanoke Basin	DO	11.05	84	89.76	83.30	96.22
Roanoke Basin	DO	11.06	85	92.98	89.09	96.87
Roanoke Basin	DO	11.13	86	93.17	89.30	97.04
Roanoke Basin	DO	11.14	87	93.93	90.39	97.47
Roanoke Basin	DO	11.14	88	94.69	91.46	97.92
Roanoke Basin	DO	11.20	89	95.45	92.59	98.32
Roanoke Basin	DO	11.25	90	96.21	93.68	98.75
Roanoke Basin	DO	11.41	91	96.53	94.06	98.99
Roanoke Basin	DO	11.53	92	97.08	94.82	99.34
Roanoke Basin	DO	11.62	93	97.63	95.60	99.67
Roanoke Basin	DO	11.64	94	98.19	96.42	99.95
Roanoke Basin	DO	11.65	95	98.95	97.79	100.00
Roanoke Basin	DO	11.66	96	99.50	98.87	100.00
Roanoke Basin	DO	11.70	97	99.69	99.15	100.00
Roanoke Basin	DO	12.05	98	100.00	100.00	100.00
Potomac-Shenandoah	DO	6.60	1	7.44	0.00	19.15
Potomac-Shenandoah	DO	7.75	2	7.87	0.00	19.60
Potomac-Shenandoah	DO	7.90	3	9.62	0.00	21.60
Potomac-Shenandoah	DO	8.05	4	11.38	0.00	23.58
Potomac-Shenandoah	DO	8.10	5	12.66	0.33	24.99
Potomac-Shenandoah	DO	8.20	6	13.94	1.91	25.97
Potomac-Shenandoah	DO	8.30	8	16.42	4.13	28.72
Potomac-Shenandoah	DO	8.45	9	23.86	8.94	38.78
Potomac-Shenandoah	DO	8.80	10	25.14	10.45	39.82
Potomac-Shenandoah	DO	8.90	11	26.89	11.97	41.82
Potomac-Shenandoah	DO	8.98	12	28.17	13.28	43.06

Potomac-Shenandoah	DO	9.10	13	35.61	19.42	51.79
Potomac-Shenandoah	DO	9.15	14	36.89	20.77	53.00
Potomac-Shenandoah	DO	9.30	15	44.32	27.25	61.39
Potomac-Shenandoah	DO	9.46	16	44.75	27.73	61.77
Potomac-Shenandoah	DO	9.50	18	46.75	30.11	63.40
Potomac-Shenandoah	DO	9.55	19	48.51	32.07	64.96
Potomac-Shenandoah	DO	9.60	20	50.27	33.85	66.69
Potomac-Shenandoah	DO	9.80	21	52.03	35.92	68.14
Potomac-Shenandoah	DO	9.85	22	52.75	36.74	68.77
Potomac-Shenandoah	DO	9.90	23	54.51	38.37	70.66
Potomac-Shenandoah	DO	10.00	25	58.03	42.00	74.06
Potomac-Shenandoah	DO	10.10	26	58.76	42.84	74.67
Potomac-Shenandoah	DO	10.25	27	60.52	45.15	75.88
Potomac-Shenandoah	DO	10.27	28	60.94	45.56	76.32
Potomac-Shenandoah	DO	10.30	29	62.70	47.57	77.83
Potomac-Shenandoah	DO	10.35	31	65.19	50.12	80.26
Potomac-Shenandoah	DO	10.49	32	72.62	59.12	86.13
Potomac-Shenandoah	DO	10.55	33	74.38	61.05	87.71
Potomac-Shenandoah	DO	10.60	34	76.14	63.20	89.08
Potomac-Shenandoah	DO	10.69	35	77.90	65.17	90.63
Potomac-Shenandoah	DO	10.75	38	82.14	70.34	93.95
Potomac-Shenandoah	DO	10.80	40	84.15	72.25	96.04
Potomac-Shenandoah	DO	10.95	41	84.87	72.91	96.83
Potomac-Shenandoah	DO	11.25	42	86.15	73.86	98.43
Potomac-Shenandoah	DO	11.32	43	87.91	75.94	99.87
Potomac-Shenandoah	DO	11.45	44	95.34	91.14	99.55
Potomac-Shenandoah	DO	11.85	45	96.07	92.18	99.96
Potomac-Shenandoah	DO	11.95	46	96.79	93.22	100.00
Potomac-Shenandoah	DO	12.00	47	98.55	96.68	100.00
Potomac-Shenandoah	DO	12.60	48	99.28	97.97	100.00
Potomac-Shenandoah	DO	12.80	49	100.00	100.00	100.00
Rappahannock-York	DO	5.25	1	6.55	0.00	15.16
Rappahannock-York	DO	5.85	2	7.19	0.00	15.85
Rappahannock-York	DO	6.33	3	8.32	0.00	17.17
Rappahannock-York	DO	6.75	4	9.44	0.39	18.49
Rappahannock-York	DO	7.07	5	10.57	1.32	19.82
Rappahannock-York	DO	7.15	6	17.12	3.06	31.18
Rappahannock-York	DO	7.25	7	18.67	4.53	32.81
Rappahannock-York	DO	7.30	8	20.22	5.92	34.52
Rappahannock-York	DO	7.45	9	21.77	7.39	36.15
Rappahannock-York	DO	7.55	10	28.33	13.57	43.08
Rappahannock-York	DO	7.60	11	29.45	14.72	44.18
Rappahannock-York	DO	7.65	12	29.83	15.08	44.58
Rappahannock-York	DO	7.85	13	30.96	16.05	45.86
Rappahannock-York	DO	8.05	14	31.34	16.42	46.25
Rappahannock-York	DO	8.14	15	31.97	17.05	46.90
Rappahannock-York	DO	8.15	16	33.10	18.28	47.92
Rappahannock-York	DO	8.45	17	34.65	19.69	49.60
Rappahannock-York	DO	8.54	18	35.03	20.06	49.99
Rappahannock-York	DO	8.55	19	35.41	20.45	50.36
Rappahannock-York	DO	8.60	20	36.05	21.06	51.03
Rappahannock-York	DO	8.67	21	36.68	21.51	51.86
Rappahannock-York	DO	8.75	22	38.23	22.95	53.52

Rappahannock-York	DO	8.90	23	44.79	28.82	60.75
Rappahannock-York	DO	9.00	24	46.34	30.49	62.18
Rappahannock-York	DO	9.02	25	46.98	31.10	62.85
Rappahannock-York	DO	9.09	26	47.62	31.73	63.50
Rappahannock-York	DO	9.13	27	47.99	32.13	63.86
Rappahannock-York	DO	9.15	28	49.12	33.37	64.87
Rappahannock-York	DO	9.23	29	49.50	33.74	65.26
Rappahannock-York	DO	9.30	31	52.17	36.85	67.50
Rappahannock-York	DO	9.40	33	53.94	38.73	69.15
Rappahannock-York	DO	9.50	34	54.32	39.04	69.60
Rappahannock-York	DO	9.54	35	55.87	40.13	71.61
Rappahannock-York	DO	9.55	36	56.51	40.77	72.25
Rappahannock-York	DO	9.70	37	58.06	42.31	73.80
Rappahannock-York	DO	9.80	38	59.18	43.37	74.99
Rappahannock-York	DO	10.10	39	65.74	50.74	80.73
Rappahannock-York	DO	10.11	40	66.11	51.15	81.08
Rappahannock-York	DO	10.15	41	72.67	59.24	86.09
Rappahannock-York	DO	10.20	42	74.22	60.58	87.86
Rappahannock-York	DO	10.30	43	74.86	61.21	88.50
Rappahannock-York	DO	10.50	44	81.41	69.03	93.79
Rappahannock-York	DO	10.52	45	81.79	69.43	94.14
Rappahannock-York	DO	10.55	47	84.46	72.45	96.48
Rappahannock-York	DO	10.65	48	85.10	73.16	97.04
Rappahannock-York	DO	10.67	49	86.23	74.57	97.89
Rappahannock-York	DO	10.80	50	92.78	87.04	98.53
Rappahannock-York	DO	10.81	51	94.33	89.58	99.08
Rappahannock-York	DO	10.83	52	95.88	92.03	99.74
Rappahannock-York	DO	11.15	53	96.52	92.88	100.00
Rappahannock-York	DO	11.30	54	98.07	95.47	100.00
Rappahannock-York	DO	11.35	55	99.62	98.95	100.00
Rappahannock-York	DO	11.55	56	100.00	100.00	100.00
Chowan	DO	3.00	1	1.38	0.00	3.57
Chowan	DO	3.55	2	1.84	0.00	4.15
Chowan	DO	3.56	3	2.30	0.00	4.63
Chowan	DO	4.20	4	2.76	0.58	4.95
Chowan	DO	5.59	5	4.66	0.83	8.49
Chowan	DO	5.85	6	4.88	1.01	8.74
Chowan	DO	5.86	7	12.88	0.00	26.60
Chowan	DO	6.16	8	13.11	0.00	26.84
Chowan	DO	6.80	9	13.57	0.00	27.34
Chowan	DO	6.95	10	14.35	0.47	28.23
Chowan	DO	6.99	11	15.72	1.55	29.90
Chowan	DO	7.10	12	17.62	3.00	32.24
Chowan	DO	7.15	13	25.62	8.03	43.22
Chowan	DO	7.28	14	27.00	9.51	44.48
Chowan	DO	7.53	15	27.22	9.73	44.71
Chowan	DO	7.60	16	28.00	10.49	45.51
Chowan	DO	7.67	17	29.38	11.64	47.11
Chowan	DO	7.70	18	30.16	12.34	47.97
Chowan	DO	7.75	19	32.05	14.11	49.99
Chowan	DO	7.85	20	33.42	15.43	51.42
Chowan	DO	8.00	22	34.67	16.54	52.80
Chowan	DO	8.01	23	35.13	16.95	53.31



Chowan	DO	8.10	24	35.59	17.29	53.89
Chowan	DO	8.15	25	35.81	17.50	54.13
Chowan	DO	8.20	26	37.71	19.50	55.92
Chowan	DO	8.35	27	45.71	26.84	64.58
Chowan	DO	8.50	28	47.09	28.24	65.94
Chowan	DO	8.53	29	47.55	28.61	66.49
Chowan	DO	8.57	30	47.77	28.83	66.71
Chowan	DO	8.63	31	55.78	36.74	74.81
Chowan	DO	8.75	32	57.67	38.40	76.94
Chowan	DO	8.80	33	59.57	40.41	78.72
Chowan	DO	8.87	34	60.35	41.12	79.57
Chowan	DO	8.90	35	61.72	42.17	81.27
Chowan	DO	8.99	36	69.73	51.68	87.77
Chowan	DO	9.13	37	77.73	61.02	94.44
Chowan	DO	9.21	38	78.51	61.93	95.09
Chowan	DO	9.55	39	79.29	62.78	95.81
Chowan	DO	9.56	40	80.07	63.63	96.52
Chowan	DO	9.84	41	80.85	64.32	97.39
Chowan	DO	9.90	42	82.75	66.41	99.08
Chowan	DO	10.00	43	90.75	78.12	100.00
Chowan	DO	10.17	44	98.76	97.07	100.00
Chowan	DO	10.20	45	99.54	98.71	100.00
Chowan	DO	10.37	46	100.00	100.00	100.00
Tennessee	DO	9.10	2	7.07	0.00	16.96
Tennessee	DO	9.11	3	12.79	0.69	24.89
Tennessee	DO	9.13	4	18.51	4.50	32.53
Tennessee	DO	9.25	5	19.07	5.06	33.08
Tennessee	DO	9.27	6	20.43	6.34	34.51
Tennessee	DO	9.35	7	21.78	7.61	35.94
Tennessee	DO	9.43	8	23.13	8.82	37.44
Tennessee	DO	9.44	9	23.69	9.38	38.00
Tennessee	DO	9.50	10	24.67	10.49	38.85
Tennessee	DO	9.50	11	25.66	11.48	39.83
Tennessee	DO	9.60	12	31.38	16.13	46.62
Tennessee	DO	9.60	13	32.36	17.10	47.62
Tennessee	DO	9.65	15	34.27	18.99	49.55
Tennessee	DO	9.68	16	34.60	19.34	49.86
Tennessee	DO	9.70	17	35.95	20.64	51.26
Tennessee	DO	9.72	18	36.28	20.99	51.58
Tennessee	DO	9.72	19	36.84	21.53	52.15
Tennessee	DO	9.78	20	38.19	22.90	53.49
Tennessee	DO	9.80	21	39.18	23.91	54.45
Tennessee	DO	9.84	22	40.53	25.33	55.73
Tennessee	DO	9.86	23	41.51	26.20	56.83
Tennessee	DO	9.89	24	47.23	31.43	63.04
Tennessee	DO	9.90	25	52.95	37.82	68.09
Tennessee	DO	9.95	26	58.68	44.19	73.16
Tennessee	DO	10.00	27	64.40	50.71	78.08
Tennessee	DO	10.20	29	67.10	54.13	80.08
Tennessee	DO	10.25	31	69.01	56.51	81.51
Tennessee	DO	10.26	32	74.73	64.82	84.65
Tennessee	DO	10.35	33	75.72	65.99	85.44
Tennessee	DO	10.40	35	77.68	68.42	86.94

Tennessee	DO	10.45	40	82.97	75.27	90.66
Tennessee	DO	10.50	43	84.64	77.33	91.95
Tennessee	DO	10.55	45	85.53	78.41	92.65
Tennessee	DO	10.72	46	86.51	79.79	93.23
Tennessee	DO	10.75	47	87.49	81.13	93.86
Tennessee	DO	10.90	51	90.15	84.55	95.74
Tennessee	DO	11.08	52	91.13	85.79	96.48
Tennessee	DO	11.13	53	91.69	86.55	96.83
Tennessee	DO	11.20	54	92.25	87.15	97.35
Tennessee	DO	11.40	55	93.60	89.10	98.10
Tennessee	DO	11.44	56	94.16	89.84	98.47
Tennessee	DO	11.55	57	95.51	91.92	99.10
Tennessee	DO	11.60	58	96.49	93.35	99.64
Tennessee	DO	11.67	59	97.48	94.93	100.00
Tennessee	DO	11.93	60	98.46	96.67	100.00
Tennessee	DO	12.00	61	99.44	98.45	100.00
Tennessee	DO	12.50	62	100.00	100.00	100.00
New	DO	8.45	1	1.59	0.00	4.42
New	DO	8.72	2	2.25	0.00	5.33
New	DO	8.82	3	3.84	0.00	7.68
New	DO	8.98	4	5.00	0.51	9.48
New	DO	9.00	5	11.72	0.46	22.99
New	DO	9.18	6	18.45	4.90	32.01
New	DO	9.25	8	31.91	15.90	47.92
New	DO	9.30	9	38.64	21.65	55.63
New	DO	9.33	10	39.79	22.86	56.73
New	DO	9.35	11	41.39	25.13	57.64
New	DO	9.36	12	42.54	26.36	58.72
New	DO	9.48	13	42.93	26.76	59.10
New	DO	9.50	14	44.52	28.61	60.43
New	DO	9.55	15	46.11	30.09	62.14
New	DO	9.68	16	46.77	30.74	62.80
New	DO	9.72	17	47.43	31.68	63.17
New	DO	9.77	18	47.81	31.99	63.64
New	DO	9.80	19	48.97	33.36	64.58
New	DO	9.82	20	49.36	33.74	64.98
New	DO	10.00	21	56.09	40.21	71.97
New	DO	10.05	25	66.72	50.94	82.50
New	DO	10.10	26	68.31	52.66	83.97
New	DO	10.20	27	69.47	53.92	85.02
New	DO	10.24	28	71.06	55.61	86.51
New	DO	10.25	29	72.22	56.70	87.73
New	DO	10.40	30	73.81	58.49	89.12
New	DO	10.55	32	81.69	69.55	93.83
New	DO	10.57	33	82.08	69.98	94.18
New	DO	10.60	34	83.67	71.87	95.48
New	DO	10.60	36	85.92	74.53	97.31
New	DO	10.64	37	86.31	74.94	97.68
New	DO	10.80	38	93.04	87.79	98.28
New	DO	10.87	39	93.69	88.69	98.70
New	DO	11.09	40	95.28	91.34	99.23
New	DO	11.33	41	95.94	92.20	99.68
New	DO	11.35	42	96.60	93.11	100.00

New	DO	11.40	43	97.25	93.85	100.00
New	DO	11.90	44	98.41	95.76	100.00
New	DO	12.10	45	100.00	100.00	100.00

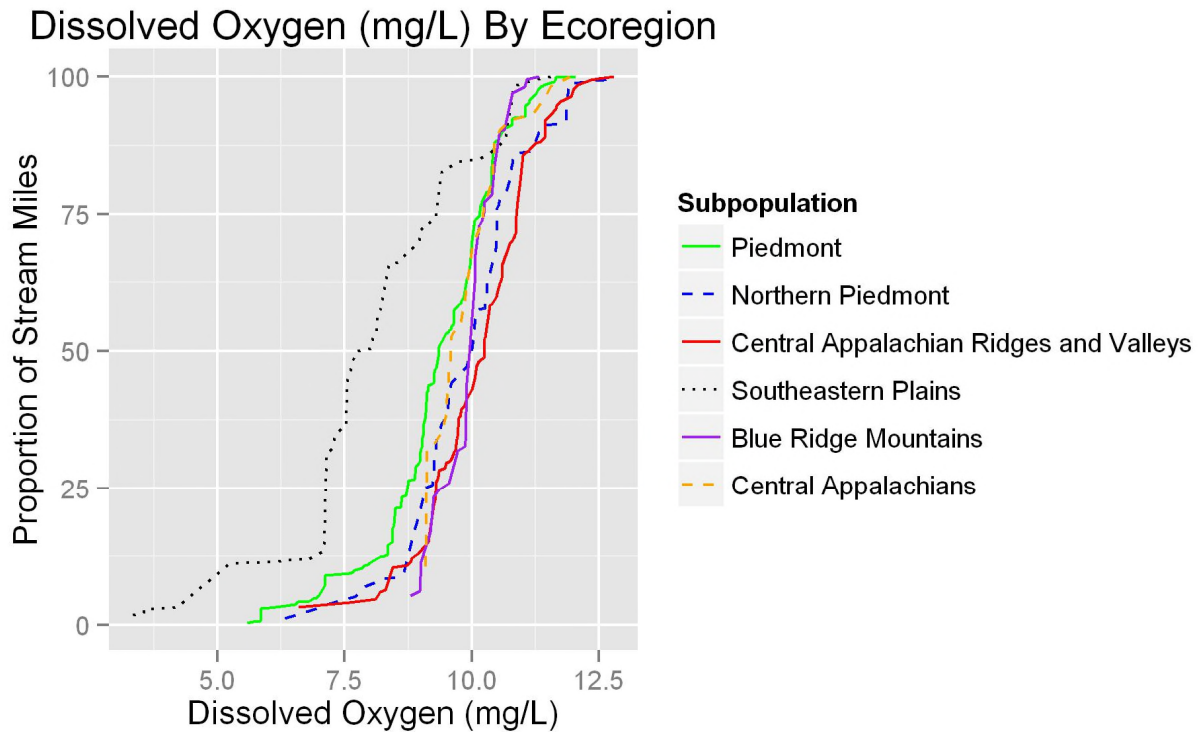


Figure 11. **Dissolved Oxygen by Major Ecoregion (Level III) CDF graph.**

Figure 11 depicts Level III ecoregion by DO concentration. The corresponding values and percentiles are presented in Table 5. The Southeastern Plains CDF shows the 50<sup>th</sup> percentile of streams with DO concentrations of 7.75 mg/L. By contrast, the Northern Piedmont, Central Appalachians Ridges and Valleys and Blue Ridge Mountains estimate 50% of streams have DO concentrations less than 10 mg/L.

Table 5. **Dissolved Oxygen Population Estimates by Major Ecoregion (Level III).**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	DO	5.59	1	0.44	0.00	1.15
Piedmont	DO	5.70	2	0.62	0.00	1.40
Piedmont	DO	5.85	3	0.81	0.00	1.65
Piedmont	DO	5.86	5	2.99	0.00	6.31
Piedmont	DO	6.02	6	3.17	0.00	6.51
Piedmont	DO	6.35	7	3.50	0.11	6.88
Piedmont	DO	6.52	8	3.82	0.39	7.24
Piedmont	DO	6.58	9	4.26	0.75	7.76

Piedmont	DO	6.81	10	4.37	0.85	7.88
Piedmont	DO	6.89	11	4.81	1.23	8.38
Piedmont	DO	6.95	12	4.99	1.40	8.58
Piedmont	DO	6.99	13	5.31	1.67	8.95
Piedmont	DO	7.10	14	7.18	2.50	11.85
Piedmont	DO	7.12	15	9.04	3.60	14.49
Piedmont	DO	7.60	17	9.41	3.96	14.86
Piedmont	DO	7.67	18	9.73	4.26	15.20
Piedmont	DO	7.70	20	10.09	4.61	15.57
Piedmont	DO	7.85	21	10.41	4.93	15.90
Piedmont	DO	7.90	22	10.85	5.32	16.38
Piedmont	DO	7.95	23	11.03	5.49	16.58
Piedmont	DO	8.00	25	11.32	5.78	16.87
Piedmont	DO	8.10	28	11.98	6.37	17.60
Piedmont	DO	8.20	29	12.42	6.84	18.00
Piedmont	DO	8.24	30	12.47	6.90	18.05
Piedmont	DO	8.34	31	12.80	7.17	18.42
Piedmont	DO	8.35	32	14.66	8.57	20.75
Piedmont	DO	8.43	33	15.10	8.95	21.25
Piedmont	DO	8.44	34	15.42	9.24	21.60
Piedmont	DO	8.45	36	17.73	11.01	24.45
Piedmont	DO	8.47	37	18.05	11.32	24.79
Piedmont	DO	8.47	38	18.49	11.72	25.26
Piedmont	DO	8.50	43	21.22	14.19	28.24
Piedmont	DO	8.53	44	21.33	14.30	28.35
Piedmont	DO	8.60	45	21.51	14.47	28.54
Piedmont	DO	8.63	46	23.37	16.32	30.43
Piedmont	DO	8.70	47	23.69	16.63	30.76
Piedmont	DO	8.74	48	25.56	18.20	32.92
Piedmont	DO	8.75	50	26.44	19.03	33.86
Piedmont	DO	8.87	51	26.63	19.21	34.04
Piedmont	DO	8.90	54	28.92	21.03	36.81
Piedmont	DO	8.95	56	29.54	21.66	37.42
Piedmont	DO	8.98	57	29.86	21.98	37.75
Piedmont	DO	8.99	58	31.73	23.64	39.83
Piedmont	DO	9.00	60	32.23	24.11	40.36
Piedmont	DO	9.02	61	32.42	24.29	40.54
Piedmont	DO	9.03	62	34.28	25.99	42.57
Piedmont	DO	9.05	64	35.04	26.72	43.37
Piedmont	DO	9.06	65	36.91	28.48	45.34
Piedmont	DO	9.07	66	37.23	28.81	45.65
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Piedmont	DO	9.28	81	46.58	37.98	55.18

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Piedmont	DO	10.55	144	89.10	84.78	93.42
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Piedmont	DO	10.62	148	90.41	86.25	94.58
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Piedmont	DO	11.30	166	97.58	96.06	99.09
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Piedmont	DO	11.40	169	98.23	96.94	99.52
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Piedmont	DO	11.62	172	99.06	98.07	100.00
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Northern Piedmont	DO	7.25	3	4.03	0.09	7.98
Northern Piedmont	DO	7.70	4	5.23	0.65	9.81
Northern Piedmont	DO	7.75	5	5.63	0.93	10.33
Northern Piedmont	DO	7.85	6	6.83	1.76	11.89
Northern Piedmont	DO	8.30	7	8.47	2.51	14.43
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Northern Piedmont	DO	9.10	12	25.10	10.91	39.30
Northern Piedmont	DO	9.23	13	25.50	11.33	39.67
Northern Piedmont	DO	9.30	15	33.65	17.48	49.83
Northern Piedmont	DO	9.40	18	36.72	20.98	52.46
Northern Piedmont	DO	9.45	19	37.12	21.36	52.88
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Northern Piedmont	DO	9.50	22	38.60	22.86	54.35
Northern Piedmont	DO	9.54	23	40.25	24.55	55.95
Northern Piedmont	DO	9.55	25	42.57	26.94	58.20
Northern Piedmont	DO	9.60	26	44.22	28.46	59.97
Northern Piedmont	DO	9.80	27	45.86	30.23	61.49
Northern Piedmont	DO	9.83	28	46.54	30.85	62.22
Northern Piedmont	DO	9.90	29	47.22	31.49	62.94
Northern Piedmont	DO	9.95	30	48.86	33.03	64.69
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Northern Piedmont	DO	10.27	33	57.86	42.13	73.59
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Northern Piedmont	DO	10.50	38	76.25	63.63	88.88
Northern Piedmont	DO	10.52	39	76.65	64.08	89.23
Northern Piedmont	DO	10.55	40	77.85	65.41	90.28
Northern Piedmont	DO	10.67	41	79.04	66.94	91.15
Northern Piedmont	DO	10.75	43	81.37	69.74	93.00
Northern Piedmont	DO	10.80	45	84.21	72.93	95.49
Northern Piedmont	DO	10.83	46	85.85	74.92	96.78
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Northern Piedmont	DO	11.25	48	88.17	77.73	98.62

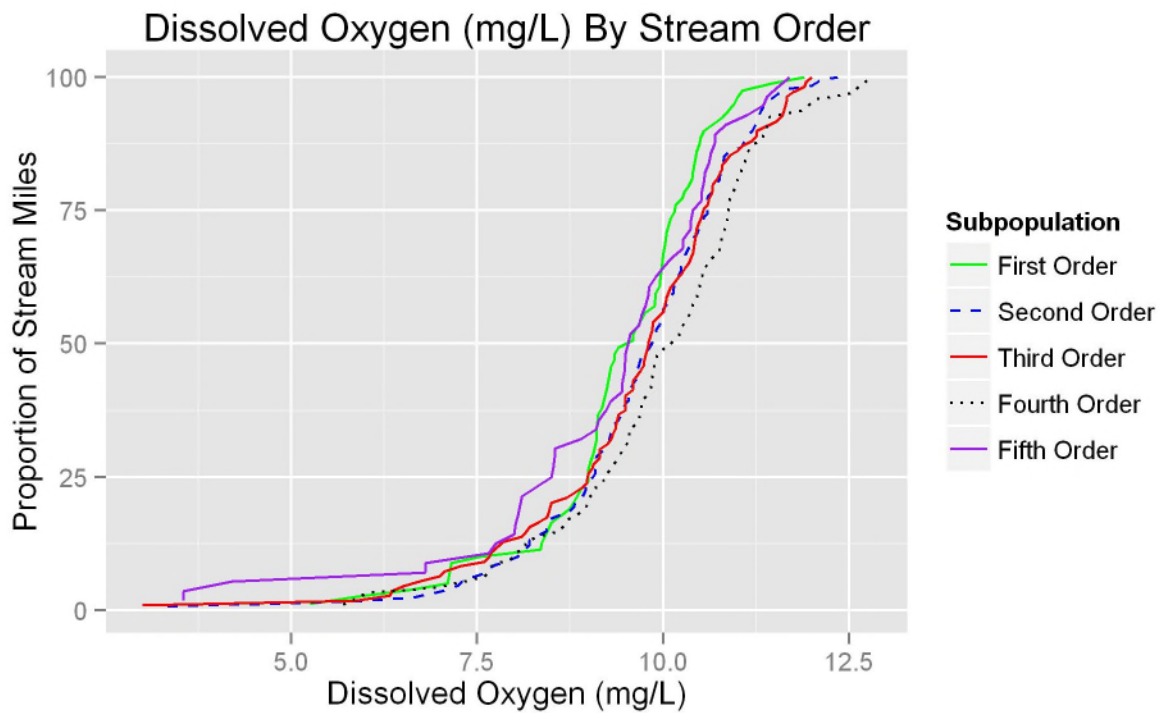
Northern Piedmont	DO	11.32	49	89.82	79.73	99.90
Northern Piedmont	DO	11.40	50	91.01	81.01	100.00
Northern Piedmont	DO	11.85	51	91.69	81.77	100.00
Northern Piedmont	DO	11.90	52	98.64	96.91	100.00
Northern Piedmont	DO	12.60	53	99.32	98.10	100.00
Northern Piedmont	DO	12.80	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	DO	6.60	1	3.35	0.00	8.43
Central Appalachian Ridges and Valleys	DO	7.60	2	4.14	0.00	9.37
Central Appalachian Ridges and Valleys	DO	8.10	3	4.71	0.00	10.02
Central Appalachian Ridges and Valleys	DO	8.16	4	5.51	0.05	10.96
Central Appalachian Ridges and Valleys	DO	8.20	5	6.08	0.83	11.33
Central Appalachian Ridges and Valleys	DO	8.30	6	6.41	1.15	11.67
Central Appalachian Ridges and Valleys	DO	8.45	8	10.55	3.49	17.60
Central Appalachian Ridges and Valleys	DO	8.72	9	10.87	3.80	17.94
Central Appalachian Ridges and Valleys	DO	8.80	10	11.45	4.55	18.35
Central Appalachian Ridges and Valleys	DO	8.82	11	12.24	5.27	19.21
Central Appalachian Ridges and Valleys	DO	8.95	12	13.03	6.04	20.02
Central Appalachian Ridges and Valleys	DO	9.10	14	14.61	7.41	21.82
Central Appalachian Ridges and Valleys	DO	9.15	15	15.19	7.98	22.40
Central Appalachian Ridges and Valleys	DO	9.25	17	21.88	12.91	30.86
Central Appalachian Ridges and Valleys	DO	9.27	18	22.68	13.65	31.70
Central Appalachian Ridges and Valleys	DO	9.30	20	26.22	16.41	36.02
Central Appalachian Ridges and Valleys	DO	9.33	21	26.79	17.01	36.57
Central Appalachian Ridges and Valleys	DO	9.35	22	27.58	17.77	37.40
Central Appalachian Ridges and Valleys	DO	9.36	23	28.16	18.37	37.94
Central Appalachian Ridges and Valleys	DO	9.40	24	28.48	18.68	38.29
Central Appalachian Ridges and Valleys	DO	9.48	25	28.68	18.88	38.48
Central Appalachian Ridges and Valleys	DO	9.50	27	29.66	19.90	39.43
Central Appalachian Ridges and Valleys	DO	9.56	28	29.86	20.09	39.62
Central Appalachian Ridges and Valleys	DO	9.60	29	30.43	20.66	40.20
Central Appalachian Ridges and Valleys	DO	9.65	31	31.55	21.77	41.33
Central Appalachian Ridges and Valleys	DO	9.68	33	32.07	22.28	41.85
Central Appalachian Ridges and Valleys	DO	9.70	36	33.98	24.11	43.85
Central Appalachian Ridges and Valleys	DO	9.72	37	34.17	24.30	44.05
Central Appalachian Ridges and Valleys	DO	9.72	38	34.50	24.65	44.35
Central Appalachian Ridges and Valleys	DO	9.75	39	37.84	27.57	48.12
Central Appalachian Ridges and Valleys	DO	9.77	40	38.04	27.79	48.29
Central Appalachian Ridges and Valleys	DO	9.80	43	39.38	29.22	49.54
Central Appalachian Ridges and Valleys	DO	9.82	44	39.58	29.42	49.73
Central Appalachian Ridges and Valleys	DO	9.85	45	39.90	29.76	50.04
Central Appalachian Ridges and Valleys	DO	9.90	48	41.35	31.16	51.53
Central Appalachian Ridges and Valleys	DO	10.00	51	43.04	32.82	53.26
Central Appalachian Ridges and Valleys	DO	10.05	54	44.98	34.73	55.23
Central Appalachian Ridges and Valleys	DO	10.10	58	47.25	37.07	57.43
Central Appalachian Ridges and Valleys	DO	10.14	59	48.04	37.68	58.40
Central Appalachian Ridges and Valleys	DO	10.20	60	48.62	38.27	58.96
Central Appalachian Ridges and Valleys	DO	10.25	61	48.94	38.58	59.31
Central Appalachian Ridges and Valleys	DO	10.26	62	52.29	42.04	62.53
Central Appalachian Ridges and Valleys	DO	10.26	63	52.48	42.24	62.72
Central Appalachian Ridges and Valleys	DO	10.35	68	58.31	48.19	68.43
Central Appalachian Ridges and Valleys	DO	10.40	69	58.51	48.37	68.64
Central Appalachian Ridges and Valleys	DO	10.45	70	59.30	49.16	69.44
Central Appalachian Ridges and Valleys	DO	10.48	71	59.87	49.66	70.08

Central Appalachian Ridges and Valleys	DO	10.50	73	60.53	50.33	70.72
Central Appalachian Ridges and Valleys	DO	10.55	76	62.30	52.17	72.44
Central Appalachian Ridges and Valleys	DO	10.57	77	62.50	52.37	72.62
Central Appalachian Ridges and Valleys	DO	10.60	78	63.29	53.22	73.36
Central Appalachian Ridges and Valleys	DO	10.60	82	65.77	55.85	75.70
Central Appalachian Ridges and Valleys	DO	10.65	84	67.14	57.24	77.04
Central Appalachian Ridges and Valleys	DO	10.69	86	68.13	58.26	77.99
Central Appalachian Ridges and Valleys	DO	10.75	88	69.49	59.72	79.26
Central Appalachian Ridges and Valleys	DO	10.80	90	70.15	60.32	79.97
Central Appalachian Ridges and Valleys	DO	10.83	91	70.47	60.63	80.31
Central Appalachian Ridges and Valleys	DO	10.85	92	71.05	61.23	80.86
Central Appalachian Ridges and Valleys	DO	10.87	93	71.37	61.57	81.17
Central Appalachian Ridges and Valleys	DO	10.88	94	74.72	65.62	83.82
Central Appalachian Ridges and Valleys	DO	10.90	100	77.39	68.43	86.35
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Central Appalachian Ridges and Valleys	DO	11.00	106	85.64	79.17	92.11
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Central Appalachian Ridges and Valleys	DO	11.13	108	86.54	80.08	93.00
Central Appalachian Ridges and Valleys	DO	11.13	109	86.73	80.28	93.19
Central Appalachian Ridges and Valleys	DO	11.20	110	87.31	80.86	93.75
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Central Appalachian Ridges and Valleys	DO	11.35	112	88.21	81.71	94.71
Central Appalachian Ridges and Valleys	DO	11.40	113	88.54	82.07	95.00
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Central Appalachian Ridges and Valleys	DO	11.45	115	92.21	88.33	96.09
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Central Appalachian Ridges and Valleys	DO	11.60	117	93.58	90.06	97.09
Central Appalachian Ridges and Valleys	DO	11.66	118	94.15	90.80	97.50
Central Appalachian Ridges and Valleys	DO	11.67	119	94.73	91.55	97.91
Central Appalachian Ridges and Valleys	DO	11.70	120	94.92	91.77	98.07
Central Appalachian Ridges and Valleys	DO	11.76	121	95.50	92.52	98.47
Central Appalachian Ridges and Valleys	DO	11.90	122	96.07	93.32	98.82
Central Appalachian Ridges and Valleys	DO	11.95	123	96.40	93.74	99.06
Central Appalachian Ridges and Valleys	DO	12.00	125	97.76	95.71	99.81
Central Appalachian Ridges and Valleys	DO	12.10	126	98.56	97.02	100.00
Central Appalachian Ridges and Valleys	DO	12.35	127	99.35	98.51	100.00
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Southeastern Plains	DO	3.56	3	2.79	0.00	6.15
Southeastern Plains	DO	4.20	4	3.25	0.00	6.64
Southeastern Plains	DO	5.25	5	11.18	0.00	24.07
Southeastern Plains	DO	5.85	6	11.40	0.00	24.31
Southeastern Plains	DO	6.16	7	11.62	0.00	24.55
Southeastern Plains	DO	6.80	8	12.08	0.00	25.03
Southeastern Plains	DO	7.07	9	13.44	0.20	26.68
Southeastern Plains	DO	7.10	10	15.32	1.77	28.86
Southeastern Plains	DO	7.15	12	31.17	11.16	51.19
Southeastern Plains	DO	7.28	13	32.54	12.76	52.32
Southeastern Plains	DO	7.30	14	34.41	14.61	54.22
Southeastern Plains	DO	7.45	15	36.29	16.27	56.31
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Southeastern Plains	DO	7.55	17	44.44	24.12	64.75
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Southeastern Plains	DO	7.65	20	48.13	27.87	68.40
Southeastern Plains	DO	7.75	21	50.01	29.82	70.20
Southeastern Plains	DO	8.01	22	50.47	30.31	70.63
Southeastern Plains	DO	8.05	24	52.80	32.53	73.08
Southeastern Plains	DO	8.14	25	53.57	33.34	73.81
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Southeastern Plains	DO	8.21	29	57.81	37.81	77.80
Southeastern Plains	DO	8.37	30	65.74	48.15	83.32
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Southeastern Plains	DO	8.57	32	66.41	48.77	84.05
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Southeastern Plains	DO	10.55	42	87.60	74.89	100.00
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Blue Ridge Mountains	DO	8.80	1	5.31	0.00	12.81
Blue Ridge Mountains	DO	8.98	2	6.23	0.00	13.85
Blue Ridge Mountains	DO	9.00	3	11.54	0.58	22.50
Blue Ridge Mountains	DO	9.18	4	16.85	4.55	29.16
Blue Ridge Mountains	DO	9.20	5	18.11	6.12	30.09
Blue Ridge Mountains	DO	9.25	6	23.42	9.97	36.87
Blue Ridge Mountains	DO	9.35	7	24.68	11.54	37.81
Blue Ridge Mountains	DO	9.55	8	25.94	12.63	39.25
Blue Ridge Mountains	DO	9.70	9	31.25	16.19	46.31
Blue Ridge Mountains	DO	9.72	10	31.77	16.90	46.64
Blue Ridge Mountains	DO	9.86	11	32.68	17.53	47.83
Blue Ridge Mountains	DO	9.87	12	33.59	18.73	48.46
Blue Ridge Mountains	DO	9.89	13	38.91	23.18	54.63
Blue Ridge Mountains	DO	9.90	14	44.22	28.27	60.17
Blue Ridge Mountains	DO	9.95	15	49.53	35.16	63.90
Blue Ridge Mountains	DO	10.00	17	56.10	40.93	71.28
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Blue Ridge Mountains	DO	10.07	20	67.64	52.73	82.56
Blue Ridge Mountains	DO	10.15	21	72.96	58.65	87.26
Blue Ridge Mountains	DO	10.20	22	73.87	59.56	88.18
Blue Ridge Mountains	DO	10.24	23	75.13	60.93	89.32
Blue Ridge Mountains	DO	10.25	25	77.30	63.19	91.40
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Blue Ridge Mountains	DO	10.45	27	83.87	71.47	96.26
Blue Ridge Mountains	DO	10.55	29	90.09	80.91	99.27
Blue Ridge Mountains	DO	10.64	30	90.40	81.24	99.56

Blue Ridge Mountains	DO	10.80	32	96.97	93.62	100.00
Blue Ridge Mountains	DO	11.05	33	98.23	95.87	100.00
Blue Ridge Mountains	DO	11.09	34	99.48	98.59	100.00
Blue Ridge Mountains	DO	11.33	35	100.00	100.00	100.00
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Central Appalachians	DO	9.13	3	32.03	9.54	54.51
Central Appalachians	DO	9.25	4	33.07	10.66	55.48
Central Appalachians	DO	9.43	5	35.59	13.30	57.88
Central Appalachians	DO	9.44	6	36.63	14.48	58.79
Central Appalachians	DO	9.50	7	38.47	16.60	60.33
Central Appalachians	DO	9.50	8	40.30	18.61	61.99
Central Appalachians	DO	9.60	9	50.98	29.48	72.48
Central Appalachians	DO	9.60	10	52.81	31.46	74.16
Central Appalachians	DO	9.78	11	55.34	34.37	76.30
Central Appalachians	DO	9.84	12	57.86	37.83	77.89
Central Appalachians	DO	10.00	13	68.54	51.44	85.63
Central Appalachians	DO	10.20	15	73.59	59.02	88.16
Central Appalachians	DO	10.25	17	77.15	64.09	90.22
Central Appalachians	DO	10.40	19	80.82	68.95	92.70
Central Appalachians	DO	10.45	23	88.16	79.42	96.90
Central Appalachians	DO	10.50	24	89.20	80.91	97.49
Central Appalachians	DO	10.55	25	90.24	82.23	98.25
Central Appalachians	DO	10.72	26	92.07	85.07	99.08
Central Appalachians	DO	11.20	27	93.12	86.19	100.00
Central Appalachians	DO	11.40	28	95.64	90.21	100.00
Central Appalachians	DO	11.55	29	98.17	94.95	100.00
Central Appalachians	DO	11.93	30	100.00	100.00	100.00



**Figure 12.** Dissolved Oxygen by Stream Order CDF graph.

Figure 12 depicts DO concentrations by stream order. Table 6 shows the corresponding percentiles and values. All stream orders except fourth order estimate the 50<sup>th</sup> percentile less than 10.0 mg/L. Fifty percent of fourth order streams are less than 10.1 mg/L.

**Table 6. Dissolved Oxygen Population Estimates by Stream Order.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	DO	5.25	1	1.27	0.00	3.43
First Order	DO	5.86	2	2.53	0.00	5.56
First Order	DO	6.60	3	3.80	0.07	7.52
First Order	DO	7.10	4	5.06	0.72	9.40
First Order	DO	7.12	5	6.33	1.53	11.13
First Order	DO	7.15	7	8.86	3.25	14.47
First Order	DO	7.55	8	10.13	4.39	15.86
First Order	DO	8.35	9	11.39	5.49	17.29
First Order	DO	8.37	10	12.66	6.60	18.71
First Order	DO	8.45	12	15.19	8.52	21.86
First Order	DO	8.50	13	16.46	9.64	23.27
First Order	DO	8.63	14	17.72	10.84	24.60
First Order	DO	8.74	15	18.99	11.77	26.21
First Order	DO	8.80	16	20.25	12.86	27.65
First Order	DO	8.90	18	22.78	14.91	30.66
First Order	DO	8.99	19	24.05	16.26	31.84
First Order	DO	9.00	21	26.58	18.47	34.69

First Order	DO	9.03	22	27.85	19.68	36.02
First Order	DO	9.06	23	29.11	20.97	37.26
First Order	DO	9.10	25	31.65	23.14	40.15
First Order	DO	9.11	27	34.18	25.53	42.83
First Order	DO	9.13	29	36.71	28.00	45.42
First Order	DO	9.18	30	37.97	29.17	46.78
First Order	DO	9.25	33	41.77	32.61	50.94
First Order	DO	9.27	34	43.04	33.68	52.40
First Order	DO	9.30	36	45.57	36.28	54.86
First Order	DO	9.34	37	46.84	37.64	56.03
First Order	DO	9.35	38	48.10	38.71	57.49
First Order	DO	9.40	39	49.37	40.16	58.57
First Order	DO	9.60	40	50.63	41.40	59.86
First Order	DO	9.60	41	51.90	42.89	60.91
First Order	DO	9.65	42	53.16	44.23	62.09
First Order	DO	9.70	43	54.43	45.58	63.28
First Order	DO	9.75	44	55.70	46.66	64.73
First Order	DO	9.89	45	56.96	47.96	65.96
First Order	DO	9.90	47	59.49	50.40	68.59
First Order	DO	9.95	48	60.76	51.89	69.63
First Order	DO	9.97	49	62.03	53.26	70.79
First Order	DO	10.00	53	67.09	58.75	75.43
First Order	DO	10.03	54	68.35	59.94	76.76
First Order	DO	10.05	56	70.89	62.64	79.13
First Order	DO	10.07	57	72.15	63.92	80.38
First Order	DO	10.10	58	73.42	65.20	81.63
First Order	DO	10.15	59	74.68	66.61	82.76
First Order	DO	10.17	60	75.95	68.17	83.73
First Order	DO	10.26	61	77.22	69.70	84.73
First Order	DO	10.29	62	78.48	71.06	85.90
First Order	DO	10.35	63	79.75	72.07	87.42
First Order	DO	10.39	64	81.01	73.58	88.45
First Order	DO	10.40	65	82.28	75.09	89.46
First Order	DO	10.45	68	86.08	79.84	92.31
First Order	DO	10.49	69	87.34	81.31	93.38
First Order	DO	10.50	70	88.61	82.87	94.34
First Order	DO	10.55	71	89.87	84.53	95.22
First Order	DO	10.80	73	92.41	87.94	96.87
First Order	DO	10.88	74	93.67	89.13	98.21
First Order	DO	10.95	75	94.94	90.69	99.19
First Order	DO	11.00	76	96.20	92.61	99.79
First Order	DO	11.06	77	97.47	94.50	100.00
First Order	DO	11.45	78	98.73	96.62	100.00
First Order	DO	11.90	79	100.00	100.00	100.00
Second Order	DO	3.34	1	0.78	0.00	2.14
Second Order	DO	5.59	2	1.55	0.00	3.35
Second Order	DO	6.58	3	2.33	0.20	4.45
Second Order	DO	6.89	4	3.10	0.56	5.64
Second Order	DO	7.10	5	3.88	1.14	6.61
Second Order	DO	7.25	6	4.65	1.62	7.68
Second Order	DO	7.30	7	5.43	2.10	8.75
Second Order	DO	7.45	8	6.20	2.68	9.72
Second Order	DO	7.60	9	6.98	3.21	10.74

Second Order	DO	7.65	10	7.75	3.90	11.60
Second Order	DO	7.75	11	8.53	4.67	12.39
Second Order	DO	7.90	12	9.30	5.25	13.36
Second Order	DO	8.05	13	10.08	6.00	14.15
Second Order	DO	8.10	14	10.85	6.59	15.12
Second Order	DO	8.16	15	11.63	7.16	16.10
Second Order	DO	8.20	16	12.40	7.78	17.03
Second Order	DO	8.21	17	13.18	8.61	17.75
Second Order	DO	8.30	18	13.95	9.29	18.61
Second Order	DO	8.43	19	14.73	9.89	19.57
Second Order	DO	8.45	21	16.28	11.17	21.39
Second Order	DO	8.47	22	17.05	11.79	22.32
Second Order	DO	8.75	24	18.60	13.13	24.07
Second Order	DO	8.80	25	19.38	14.05	24.71
Second Order	DO	8.82	26	20.16	14.78	25.53
Second Order	DO	8.90	27	20.93	15.43	26.43
Second Order	DO	8.95	29	22.48	16.91	28.05
Second Order	DO	8.97	30	23.26	17.72	28.79
Second Order	DO	9.00	31	24.03	18.57	29.49
Second Order	DO	9.05	32	24.81	19.25	30.36
Second Order	DO	9.08	33	25.58	19.90	31.27
Second Order	DO	9.10	35	27.13	21.24	33.03
Second Order	DO	9.10	37	28.68	22.54	34.83
Second Order	DO	9.15	38	29.46	23.31	35.60
Second Order	DO	9.20	39	30.23	23.96	36.51
Second Order	DO	9.27	40	31.01	24.67	37.34
Second Order	DO	9.28	41	31.78	25.35	38.22
Second Order	DO	9.30	43	33.33	27.14	39.52
Second Order	DO	9.35	45	34.88	28.47	41.30
Second Order	DO	9.40	46	35.66	29.21	42.10
Second Order	DO	9.43	47	36.43	29.90	42.96
Second Order	DO	9.50	50	38.76	32.27	45.25
Second Order	DO	9.54	51	39.53	32.96	46.11
Second Order	DO	9.55	53	41.09	34.57	47.60
Second Order	DO	9.60	55	42.64	36.03	49.24
Second Order	DO	9.64	56	43.41	36.83	49.99
Second Order	DO	9.65	58	44.96	38.37	51.55
Second Order	DO	9.70	61	47.29	40.82	53.75
Second Order	DO	9.78	62	48.06	41.48	54.65
Second Order	DO	9.80	63	48.84	42.25	55.42
Second Order	DO	9.84	64	49.61	42.96	56.27
Second Order	DO	9.90	67	51.94	45.35	58.53
Second Order	DO	9.91	68	52.71	46.17	59.26
Second Order	DO	9.95	69	53.49	46.83	60.15
Second Order	DO	10.00	73	56.59	49.84	63.34
Second Order	DO	10.05	74	57.36	50.57	64.16
Second Order	DO	10.09	75	58.14	51.32	64.96
Second Order	DO	10.10	76	58.91	52.10	65.73
Second Order	DO	10.14	77	59.69	52.77	66.61
Second Order	DO	10.15	78	60.47	53.66	67.27
Second Order	DO	10.20	81	62.79	56.00	69.59
Second Order	DO	10.24	82	63.57	56.73	70.40
Second Order	DO	10.25	84	65.12	58.39	71.84

Second Order	DO	10.30	86	66.67	59.97	73.36
Second Order	DO	10.35	88	68.22	61.47	74.96
Second Order	DO	10.39	89	68.99	62.30	75.68
Second Order	DO	10.40	90	69.77	63.14	76.39
Second Order	DO	10.45	91	70.54	64.04	77.05
Second Order	DO	10.55	95	73.64	67.21	80.08
Second Order	DO	10.60	96	74.42	68.09	80.75
Second Order	DO	10.60	100	77.52	71.43	83.61
Second Order	DO	10.65	101	78.29	72.28	84.31
Second Order	DO	10.69	102	79.07	73.13	85.01
Second Order	DO	10.75	104	80.62	74.88	86.36
Second Order	DO	10.80	108	83.72	78.32	89.12
Second Order	DO	10.81	109	84.50	79.22	89.78
Second Order	DO	10.83	110	85.27	80.12	90.42
Second Order	DO	10.90	111	86.05	80.96	91.14
Second Order	DO	11.05	112	86.82	81.83	91.81
Second Order	DO	11.09	113	87.60	82.67	92.52
Second Order	DO	11.14	114	88.37	83.52	93.22
Second Order	DO	11.14	115	89.15	84.46	93.83
Second Order	DO	11.20	116	89.92	85.29	94.55
Second Order	DO	11.25	118	91.47	87.22	95.73
Second Order	DO	11.30	120	93.02	89.18	96.86
Second Order	DO	11.32	121	93.80	90.22	97.37
Second Order	DO	11.35	122	94.57	91.23	97.92
Second Order	DO	11.40	123	95.35	92.21	98.49
Second Order	DO	11.55	125	96.90	94.31	99.49
Second Order	DO	11.65	126	97.67	95.45	99.89
Second Order	DO	12.00	127	98.45	96.69	100.00
Second Order	DO	12.10	128	99.22	97.99	100.00
Second Order	DO	12.35	129	100.00	100.00	100.00
Third Order	DO	3.00	1	0.92	0.00	2.39
Third Order	DO	5.86	2	1.83	0.00	3.99
Third Order	DO	6.33	3	2.75	0.12	5.38
Third Order	DO	6.35	4	3.67	0.64	6.70
Third Order	DO	6.52	5	4.59	1.24	7.93
Third Order	DO	6.75	6	5.50	1.87	9.14
Third Order	DO	6.99	7	6.42	2.57	10.28
Third Order	DO	7.07	8	7.34	3.25	11.43
Third Order	DO	7.28	9	8.26	4.26	12.25
Third Order	DO	7.60	10	9.17	5.06	13.29
Third Order	DO	7.67	11	10.09	5.91	14.28
Third Order	DO	7.70	12	11.01	6.74	15.27
Third Order	DO	7.85	14	12.84	8.44	17.25
Third Order	DO	8.10	15	13.76	9.12	18.41
Third Order	DO	8.15	16	14.68	10.14	19.21
Third Order	DO	8.20	17	15.60	10.84	20.36
Third Order	DO	8.34	18	16.51	11.54	21.49
Third Order	DO	8.44	19	17.43	12.22	22.64
Third Order	DO	8.47	20	18.35	13.05	23.65
Third Order	DO	8.50	22	20.18	14.93	25.43
Third Order	DO	8.70	23	21.10	15.97	26.24
Third Order	DO	8.80	24	22.02	16.84	27.19
Third Order	DO	8.90	25	22.94	17.95	27.92

Third Order	DO	8.98	26	23.85	18.67	29.04
Third Order	DO	8.98	27	24.77	19.35	30.19
Third Order	DO	9.00	28	25.69	20.06	31.31
Third Order	DO	9.05	29	26.61	21.00	32.21
Third Order	DO	9.07	30	27.52	21.79	33.26
Third Order	DO	9.14	31	28.44	22.64	34.24
Third Order	DO	9.15	33	30.28	24.63	35.92
Third Order	DO	9.26	34	31.19	25.56	36.82
Third Order	DO	9.30	35	32.11	26.45	37.77
Third Order	DO	9.33	36	33.03	27.17	38.89
Third Order	DO	9.36	37	33.94	28.03	39.86
Third Order	DO	9.37	38	34.86	28.79	40.94
Third Order	DO	9.40	40	36.70	30.57	42.82
Third Order	DO	9.50	41	37.61	31.28	43.95
Third Order	DO	9.50	44	40.37	33.87	46.87
Third Order	DO	9.59	45	41.28	34.76	47.81
Third Order	DO	9.60	47	43.12	36.26	49.98
Third Order	DO	9.65	48	44.04	37.25	50.82
Third Order	DO	9.70	49	44.95	38.29	51.62
Third Order	DO	9.74	50	45.87	39.12	52.63
Third Order	DO	9.75	51	46.79	39.91	53.67
Third Order	DO	9.80	54	49.54	42.67	56.42
Third Order	DO	9.81	55	50.46	43.53	57.39
Third Order	DO	9.85	57	52.29	45.37	59.21
Third Order	DO	9.86	58	53.21	46.15	60.27
Third Order	DO	9.87	59	54.13	47.11	61.15
Third Order	DO	10.00	61	55.96	48.80	63.12
Third Order	DO	10.05	64	58.72	51.32	66.11
Third Order	DO	10.10	66	60.55	53.04	68.06
Third Order	DO	10.20	68	62.39	55.00	69.78
Third Order	DO	10.25	69	63.30	56.01	70.60
Third Order	DO	10.30	70	64.22	56.97	71.47
Third Order	DO	10.35	71	65.14	57.88	72.40
Third Order	DO	10.40	73	66.97	59.58	74.36
Third Order	DO	10.45	78	71.56	64.33	78.79
Third Order	DO	10.48	79	72.48	65.15	79.80
Third Order	DO	10.50	80	73.39	66.16	80.63
Third Order	DO	10.55	82	75.23	68.30	82.16
Third Order	DO	10.60	83	76.15	69.33	82.96
Third Order	DO	10.62	84	77.06	70.29	83.84
Third Order	DO	10.65	85	77.98	71.24	84.72
Third Order	DO	10.67	86	78.90	72.30	85.50
Third Order	DO	10.67	87	79.82	73.31	86.32
Third Order	DO	10.72	88	80.73	74.40	87.07
Third Order	DO	10.75	89	81.65	75.37	87.93
Third Order	DO	10.79	90	82.57	76.50	88.63
Third Order	DO	10.80	91	83.49	77.59	89.38
Third Order	DO	10.85	92	84.40	78.55	90.26
Third Order	DO	10.90	93	85.32	79.65	90.99
Third Order	DO	11.00	94	86.24	80.74	91.73
Third Order	DO	11.08	95	87.16	81.72	92.59
Third Order	DO	11.20	96	88.07	82.88	93.27
Third Order	DO	11.25	97	88.99	84.02	93.96

Third Order	DO	11.26	98	89.91	85.20	94.62
Third Order	DO	11.40	99	90.83	86.36	95.29
Third Order	DO	11.53	100	91.74	87.55	95.94
Third Order	DO	11.60	101	92.66	88.59	96.73
Third Order	DO	11.62	102	93.58	89.79	97.37
Third Order	DO	11.64	103	94.50	91.03	97.96
Third Order	DO	11.66	104	95.41	92.29	98.54
Third Order	DO	11.67	105	96.33	93.41	99.25
Third Order	DO	11.76	106	97.25	94.74	99.75
Third Order	DO	11.90	107	98.17	96.15	100.00
Third Order	DO	11.93	108	99.08	97.60	100.00
Third Order	DO	12.00	109	100.00	100.00	100.00
Fourth Order	DO	5.70	1	1.06	0.00	2.80
Fourth Order	DO	5.85	2	2.13	0.00	4.65
Fourth Order	DO	6.02	3	3.19	0.11	6.27
Fourth Order	DO	6.95	4	4.26	0.79	7.73
Fourth Order	DO	7.60	6	6.38	2.24	10.53
Fourth Order	DO	7.70	8	8.51	3.89	13.13
Fourth Order	DO	7.95	9	9.57	5.12	14.03
Fourth Order	DO	8.00	10	10.64	5.98	15.29
Fourth Order	DO	8.14	11	11.70	6.82	16.58
Fourth Order	DO	8.15	12	12.77	7.85	17.68
Fourth Order	DO	8.30	13	13.83	8.58	19.08
Fourth Order	DO	8.60	14	14.89	9.65	20.14
Fourth Order	DO	8.67	15	15.96	10.39	21.52
Fourth Order	DO	8.72	16	17.02	11.15	22.90
Fourth Order	DO	8.87	17	18.09	12.18	23.99
Fourth Order	DO	8.95	18	19.15	12.97	25.33
Fourth Order	DO	9.00	19	20.21	13.86	26.57
Fourth Order	DO	9.02	20	21.28	15.07	27.48
Fourth Order	DO	9.09	21	22.34	16.21	28.47
Fourth Order	DO	9.10	22	23.40	17.29	29.52
Fourth Order	DO	9.21	23	24.47	18.47	30.46
Fourth Order	DO	9.25	24	25.53	19.27	31.79
Fourth Order	DO	9.40	27	28.72	21.84	35.60
Fourth Order	DO	9.44	28	29.79	22.74	36.83
Fourth Order	DO	9.50	29	30.85	23.64	38.06
Fourth Order	DO	9.55	30	31.91	24.82	39.01
Fourth Order	DO	9.55	31	32.98	25.86	40.10
Fourth Order	DO	9.56	32	34.04	27.11	40.98
Fourth Order	DO	9.65	33	35.11	27.94	42.28
Fourth Order	DO	9.68	34	36.17	28.88	43.46
Fourth Order	DO	9.70	35	37.23	29.72	44.75
Fourth Order	DO	9.72	37	39.36	31.61	47.12
Fourth Order	DO	9.79	38	40.43	32.63	48.22
Fourth Order	DO	9.83	39	41.49	33.66	49.32
Fourth Order	DO	9.84	40	42.55	34.87	50.23
Fourth Order	DO	9.85	41	43.62	35.87	51.37
Fourth Order	DO	9.90	44	46.81	38.76	54.86
Fourth Order	DO	9.92	45	47.87	39.85	55.90
Fourth Order	DO	10.00	46	48.94	40.94	56.93
Fourth Order	DO	10.10	47	50.00	41.92	58.08
Fourth Order	DO	10.20	48	51.06	43.17	58.95



Fourth Order	DO	10.25	50	53.19	45.25	61.13
Fourth Order	DO	10.30	51	54.26	46.40	62.11
Fourth Order	DO	10.35	52	55.32	47.34	63.30
Fourth Order	DO	10.40	54	57.45	49.46	65.43
Fourth Order	DO	10.45	55	58.51	50.65	66.37
Fourth Order	DO	10.50	58	61.70	53.54	69.86
Fourth Order	DO	10.53	59	62.77	54.68	70.85
Fourth Order	DO	10.55	60	63.83	55.89	71.77
Fourth Order	DO	10.60	61	64.89	57.00	72.79
Fourth Order	DO	10.65	62	65.96	58.25	73.66
Fourth Order	DO	10.75	63	67.02	59.36	74.68
Fourth Order	DO	10.80	66	70.21	62.81	77.61
Fourth Order	DO	10.83	67	71.28	63.82	78.73
Fourth Order	DO	10.85	68	72.34	65.04	79.64
Fourth Order	DO	10.87	69	73.40	66.29	80.52
Fourth Order	DO	10.90	73	77.66	70.70	84.62
Fourth Order	DO	10.95	74	78.72	71.79	85.65
Fourth Order	DO	11.00	76	80.85	74.16	87.54
Fourth Order	DO	11.05	77	81.91	75.45	88.38
Fourth Order	DO	11.06	78	82.98	76.53	89.42
Fourth Order	DO	11.10	79	84.04	77.74	90.34
Fourth Order	DO	11.13	80	85.11	78.97	91.24
Fourth Order	DO	11.15	81	86.17	80.28	92.06
Fourth Order	DO	11.20	82	87.23	81.52	92.95
Fourth Order	DO	11.33	83	88.30	82.65	93.95
Fourth Order	DO	11.35	84	89.36	83.99	94.73
Fourth Order	DO	11.40	85	90.43	85.34	95.51
Fourth Order	DO	11.41	86	91.49	86.52	96.46
Fourth Order	DO	11.44	87	92.55	87.98	97.13
Fourth Order	DO	11.85	88	93.62	89.23	98.01
Fourth Order	DO	11.95	89	94.68	90.67	98.70
Fourth Order	DO	12.05	90	95.74	92.11	99.38
Fourth Order	DO	12.50	91	96.81	93.60	100.00
Fourth Order	DO	12.60	92	97.87	95.28	100.00
Fourth Order	DO	12.80	94	100.00	100.00	100.00
Fifth Order	DO	3.55	1	1.79	0.00	4.89
Fifth Order	DO	3.56	2	3.57	0.00	7.28
Fifth Order	DO	4.20	3	5.36	2.08	8.64
Fifth Order	DO	6.80	4	7.14	4.28	10.00
Fifth Order	DO	6.81	5	8.93	4.85	13.01
Fifth Order	DO	7.65	6	10.71	5.69	15.74
Fifth Order	DO	7.75	7	12.50	6.62	18.38
Fifth Order	DO	8.00	8	14.29	7.73	20.84
Fifth Order	DO	8.01	9	16.07	10.17	21.97
Fifth Order	DO	8.05	10	17.86	11.55	24.16
Fifth Order	DO	8.10	12	21.43	14.27	28.58
Fifth Order	DO	8.50	14	25.00	17.08	32.92
Fifth Order	DO	8.53	15	26.79	19.06	34.51
Fifth Order	DO	8.54	16	28.57	20.35	36.79
Fifth Order	DO	8.55	17	30.36	21.89	38.82
Fifth Order	DO	8.90	18	32.14	23.84	40.44
Fifth Order	DO	9.10	19	33.93	25.49	42.36
Fifth Order	DO	9.13	20	35.71	27.54	43.89

## Appendix B. pH Statistical Analyses

### *Stressor Linkage to Aquatic Health*

VSCI scores are not likely to be depressed from average pH concentrations that are within Virginia water quality standards (Table 7). If pH levels are above 9 or below 6, it is important to make sure the pH levels are not altered due to natural conditions (i.e. low pH values are natural in many swamps in eastern Virginia). In small headwater streams with low pH, it is critical to establish perennial flows. Streams that dry up in the autumn months maybe contributing to aquatic life stress then low pH values. The pH dataset did not lend itself to the full suite of statistical analysis techniques; thus, relative extent and risk, conditional probability, and quantile regression are not discussed in this appendix. Figure 13 shows pH data plotted against VSCI scores and Table 7 shows the pH stressor thresholds. pH stressor thresholds are based on Virginia's Water Quality Standards.

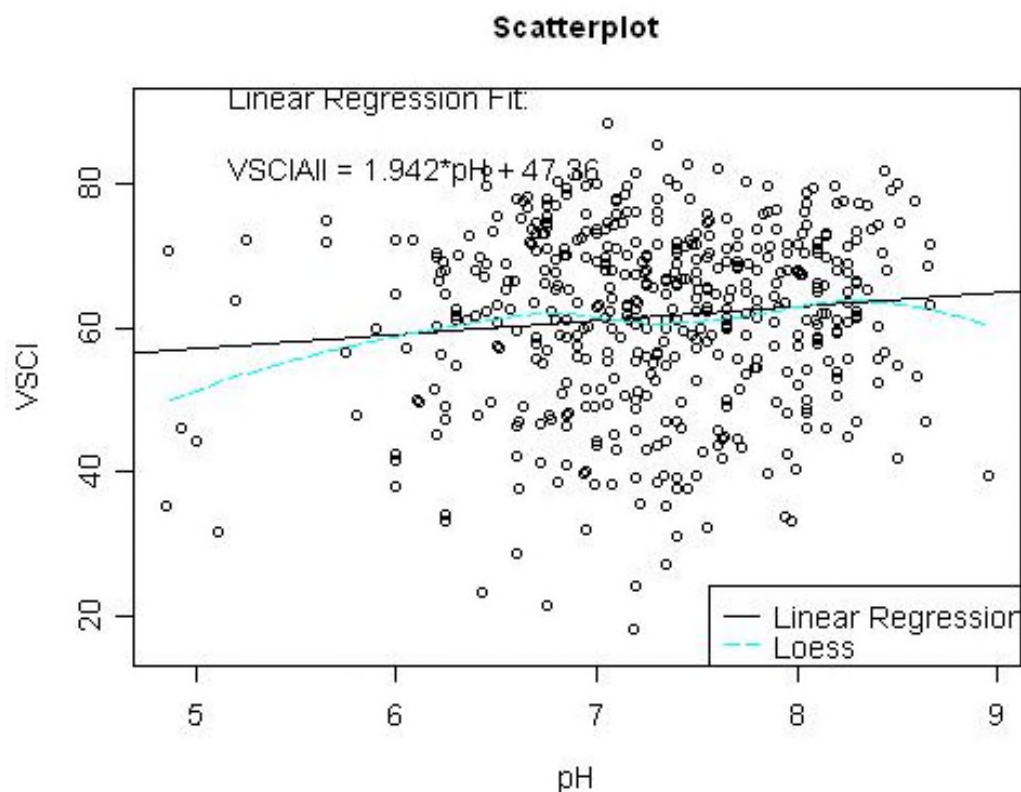


Figure 13. pH Stressor Gradient Scatterplot.

Table 7. pH concentration ranges and associated probability of stress to aquatic life (based on Virginia's Water Quality Standards).

pH	
Probability of Stress to Aquatic Life	Concentration (unitless)
Medium	< 6
Low	6 to 9
Medium	> 9

### *pH Cumulative Distribution Function curves*

pH CDF curves in Figures 14, 15, 16 and 17 show pH statewide, by major basin, ecoregion (level III), and stream order, respectively. Tables 8, 9, 10, and 11 are associated with the aforementioned figures. Knowing the prevalence of pH through the CDFs provides pH context in Virginia and allows VDEQ to identify whether it is a potential stressor.

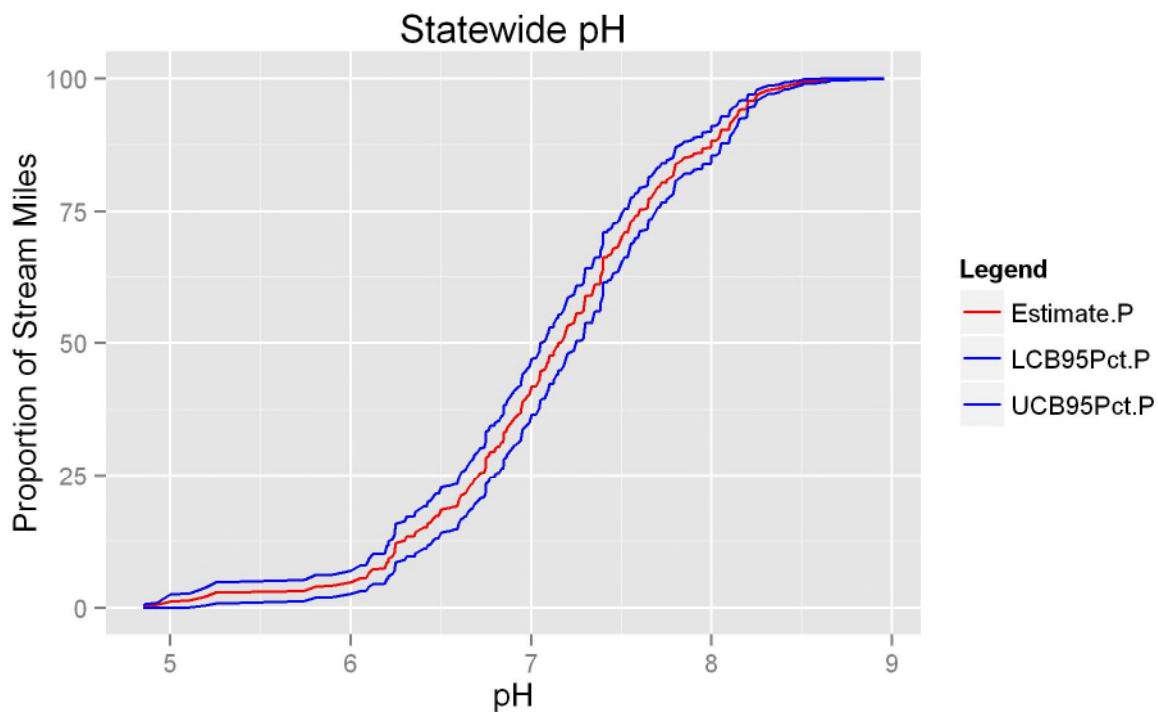


Figure 14. pH Statewide CDF graph.

Figure 14 shows that 50% of stream miles in Virginia have pH concentrations less than 7.2. The 95<sup>th</sup> percentile of streams have pH concentrations under 8.2. Table 8 provides each percentile and pH value corresponding to Figure 14.

Table 8. **Statewide pH Estimates.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	pH	4.9	1	0.17	0.00	0.45
Virginia	pH	4.9	2	0.34	0.00	0.73
Virginia	pH	4.9	3	0.50	0.03	0.98
Virginia	pH	5.0	4	1.21	0.00	2.54
Virginia	pH	5.1	5	1.38	0.02	2.74
Virginia	pH	5.2	6	2.09	0.38	3.80
Virginia	pH	5.3	7	2.80	0.80	4.81
Virginia	pH	5.7	9	3.14	1.10	5.17
Virginia	pH	5.7	10	3.26	1.23	5.29
Virginia	pH	5.8	11	3.97	1.85	6.09
Virginia	pH	5.9	12	4.14	2.02	6.26
Virginia	pH	6.0	17	4.78	2.61	6.95
Virginia	pH	6.1	18	5.49	3.06	7.93
Virginia	pH	6.1	19	5.66	3.21	8.11
Virginia	pH	6.1	21	6.54	3.91	9.16
Virginia	pH	6.1	22	7.25	4.39	10.10
Virginia	pH	6.2	23	7.42	4.55	10.29
Virginia	pH	6.2	27	8.54	5.45	11.63
Virginia	pH	6.2	28	8.58	5.49	11.66
Virginia	pH	6.2	29	9.29	6.02	12.56
Virginia	pH	6.2	30	9.46	6.18	12.73
Virginia	pH	6.2	31	9.53	6.25	12.80
Virginia	pH	6.2	32	9.65	6.37	12.93
Virginia	pH	6.2	33	10.36	6.92	13.80
Virginia	pH	6.3	38	12.14	8.52	15.76
Virginia	pH	6.3	42	12.68	9.05	16.31
Virginia	pH	6.3	43	13.39	9.62	17.17
Virginia	pH	6.4	44	13.46	9.68	17.24
Virginia	pH	6.4	45	14.17	10.29	18.06
Virginia	pH	6.4	47	15.05	11.06	19.04
Virginia	pH	6.4	48	15.09	11.10	19.08
Virginia	pH	6.4	49	15.13	11.15	19.12
Virginia	pH	6.4	50	15.84	11.74	19.94
Virginia	pH	6.4	51	16.01	11.90	20.12
Virginia	pH	6.5	55	16.54	12.41	20.67
Virginia	pH	6.5	56	17.25	13.03	21.47
Virginia	pH	6.5	57	17.32	13.10	21.54
Virginia	pH	6.5	61	18.44	14.14	22.74
Virginia	pH	6.5	62	18.56	14.28	22.85
Virginia	pH	6.6	64	18.81	14.52	23.10
Virginia	pH	6.6	65	18.93	14.64	23.22
Virginia	pH	6.6	66	19.00	14.71	23.28
Virginia	pH	6.6	67	19.17	14.87	23.46
Virginia	pH	6.6	72	20.37	16.02	24.73

Virginia	pH	6.6	73	21.08	16.64	25.53
Virginia	pH	6.6	74	21.25	16.80	25.70
Virginia	pH	6.6	75	21.37	16.92	25.83
Virginia	pH	6.6	76	21.54	17.08	26.00
Virginia	pH	6.6	77	21.58	17.12	26.04
Virginia	pH	6.7	79	22.46	17.92	27.01
Virginia	pH	6.7	80	23.17	18.53	27.82
Virginia	pH	6.7	82	23.41	18.76	28.06
Virginia	pH	6.7	83	24.12	19.39	28.85
Virginia	pH	6.7	89	24.62	19.90	29.33
Virginia	pH	6.7	90	25.33	20.55	30.10
Virginia	pH	6.7	91	25.45	20.69	30.20
Virginia	pH	6.7	93	25.56	20.81	30.31
Virginia	pH	6.7	95	25.62	20.87	30.37
Virginia	pH	6.7	96	26.33	21.53	31.13
Virginia	pH	6.8	103	28.35	23.42	33.29
Virginia	pH	6.8	104	28.52	23.59	33.45
Virginia	pH	6.8	105	28.69	23.75	33.63
Virginia	pH	6.8	106	29.40	24.49	34.31
Virginia	pH	6.8	107	29.52	24.61	34.43
Virginia	pH	6.8	108	29.59	24.68	34.50
Virginia	pH	6.8	112	30.12	25.21	35.02
Virginia	pH	6.8	113	30.16	25.26	35.06
Virginia	pH	6.8	115	30.40	25.49	35.31
Virginia	pH	6.8	116	30.42	25.51	35.33
Virginia	pH	6.8	117	30.59	25.67	35.51
Virginia	pH	6.8	118	31.30	26.34	36.26
Virginia	pH	6.8	119	31.34	26.38	36.30
Virginia	pH	6.8	121	31.63	26.67	36.60
Virginia	pH	6.9	128	33.20	28.15	38.25
Virginia	pH	6.9	129	33.37	28.34	38.40
Virginia	pH	6.9	130	34.08	28.98	39.18
Virginia	pH	6.9	134	35.69	30.52	40.86
Virginia	pH	6.9	136	35.85	30.68	41.03
Virginia	pH	6.9	137	36.56	31.34	41.79
Virginia	pH	6.9	139	36.85	31.63	42.08
Virginia	pH	6.9	141	37.63	32.42	42.85
Virginia	pH	7.0	148	38.88	33.66	44.10
Virginia	pH	7.0	149	39.00	33.78	44.23
Virginia	pH	7.0	151	40.43	35.13	45.72
Virginia	pH	7.0	158	41.76	36.48	47.05
Virginia	pH	7.0	159	41.80	36.52	47.09
Virginia	pH	7.0	160	41.93	36.64	47.21
Virginia	pH	7.0	163	42.75	37.45	48.04
Virginia	pH	7.0	165	42.98	37.68	48.29
Virginia	pH	7.1	171	44.65	39.30	50.00
Virginia	pH	7.1	172	44.82	39.47	50.17
Virginia	pH	7.1	174	44.91	39.56	50.26
Virginia	pH	7.1	176	45.02	39.67	50.37
Virginia	pH	7.1	178	45.31	39.97	50.65
Virginia	pH	7.1	179	46.02	40.65	51.39
Virginia	pH	7.1	181	46.36	40.99	51.72
Virginia	pH	7.1	182	46.42	41.06	51.79

Virginia	pH	7.1	187	47.57	42.24	52.90
Virginia	pH	7.1	188	47.69	42.37	53.02
Virginia	pH	7.1	189	48.40	43.08	53.73
Virginia	pH	7.1	191	49.28	43.96	54.60
Virginia	pH	7.1	192	49.40	44.09	54.72
Virginia	pH	7.2	198	50.07	44.78	55.36
Virginia	pH	7.2	199	50.19	44.90	55.48
Virginia	pH	7.2	200	50.90	45.63	56.17
Virginia	pH	7.2	213	53.16	47.91	58.40
Virginia	pH	7.2	214	53.28	48.02	58.54
Virginia	pH	7.2	216	53.44	48.20	58.69
Virginia	pH	7.2	217	53.56	48.32	58.81
Virginia	pH	7.2	218	53.69	48.45	58.93
Virginia	pH	7.2	220	53.83	48.59	59.06
Virginia	pH	7.3	229	55.59	50.40	60.79
Virginia	pH	7.3	230	55.71	50.52	60.91
Virginia	pH	7.3	231	55.76	50.56	60.95
Virginia	pH	7.3	232	55.92	50.74	61.10
Virginia	pH	7.3	233	56.09	50.92	61.27
Virginia	pH	7.3	242	58.89	53.73	64.04
Virginia	pH	7.3	243	58.93	53.77	64.09
Virginia	pH	7.3	244	58.97	53.82	64.13
Virginia	pH	7.4	254	60.85	55.76	65.93
Virginia	pH	7.4	255	61.01	55.94	66.09
Virginia	pH	7.4	256	61.14	56.06	66.21
Virginia	pH	7.4	258	62.56	57.65	67.47
Virginia	pH	7.4	261	63.56	58.69	68.42
Virginia	pH	7.4	272	66.12	61.36	70.88
Virginia	pH	7.4	273	66.24	61.48	71.00
Virginia	pH	7.4	275	66.53	61.79	71.28
Virginia	pH	7.4	276	66.65	61.92	71.39
Virginia	pH	7.4	277	66.78	62.04	71.51
Virginia	pH	7.4	278	66.94	62.20	71.68
Virginia	pH	7.5	279	67.65	62.94	72.36
Virginia	pH	7.5	280	67.82	63.11	72.53
Virginia	pH	7.5	281	67.86	63.15	72.57
Virginia	pH	7.5	282	67.93	63.22	72.64
Virginia	pH	7.5	283	68.10	63.40	72.80
Virginia	pH	7.5	284	68.14	63.44	72.84
Virginia	pH	7.5	295	69.95	65.27	74.64
Virginia	pH	7.5	296	70.07	65.39	74.76
Virginia	pH	7.5	297	70.78	66.15	75.42
Virginia	pH	7.5	298	70.85	66.23	75.48
Virginia	pH	7.6	307	73.06	68.63	77.48
Virginia	pH	7.6	310	73.34	68.91	77.76
Virginia	pH	7.6	311	74.05	69.72	78.37
Virginia	pH	7.6	312	74.21	69.90	78.53
Virginia	pH	7.6	317	75.27	71.06	79.48
Virginia	pH	7.6	319	75.48	71.28	79.69
Virginia	pH	7.6	320	75.52	71.32	79.73
Virginia	pH	7.6	322	75.71	71.51	79.91
Virginia	pH	7.7	330	77.40	73.37	81.43
Virginia	pH	7.7	331	77.52	73.50	81.55

Virginia	pH	7.7	332	77.56	73.54	81.59
Virginia	pH	7.7	339	79.50	75.70	83.30
Virginia	pH	7.7	340	79.62	75.82	83.42
Virginia	pH	7.7	341	80.33	76.67	84.00
Virginia	pH	7.7	343	80.44	76.77	84.11
Virginia	pH	7.8	347	80.83	77.19	84.46
Virginia	pH	7.8	348	80.95	77.32	84.57
Virginia	pH	7.8	349	81.66	78.17	85.14
Virginia	pH	7.8	357	83.90	80.70	87.09
Virginia	pH	7.8	358	84.61	81.55	87.66
Virginia	pH	7.9	362	85.09	82.06	88.12
Virginia	pH	7.9	363	85.16	82.13	88.18
Virginia	pH	7.9	365	85.29	82.26	88.33
Virginia	pH	7.9	366	85.46	82.44	88.49
Virginia	pH	7.9	367	85.50	82.48	88.53
Virginia	pH	7.9	370	85.83	82.81	88.86
Virginia	pH	7.9	371	85.88	82.85	88.90
Virginia	pH	7.9	372	85.92	82.89	88.94
Virginia	pH	7.9	373	85.96	82.94	88.98
Virginia	pH	7.9	374	86.13	83.11	89.15
Virginia	pH	8.0	379	86.79	83.80	89.79
Virginia	pH	8.0	380	86.83	83.84	89.83
Virginia	pH	8.0	381	86.90	83.91	89.90
Virginia	pH	8.0	382	87.03	84.03	90.02
Virginia	pH	8.0	388	88.23	85.41	91.05
Virginia	pH	8.0	389	88.27	85.45	91.09
Virginia	pH	8.0	391	88.51	85.70	91.32
Virginia	pH	8.0	393	88.80	85.98	91.61
Virginia	pH	8.1	402	90.28	87.75	92.82
Virginia	pH	8.1	403	90.32	87.79	92.86
Virginia	pH	8.1	404	90.39	87.86	92.93
Virginia	pH	8.1	414	91.52	89.04	94.00
Virginia	pH	8.1	415	92.23	89.95	94.51
Virginia	pH	8.1	416	92.94	90.97	94.91
Virginia	pH	8.1	417	93.01	91.04	94.98
Virginia	pH	8.2	421	94.03	92.36	95.71
Virginia	pH	8.2	422	94.15	92.48	95.83
Virginia	pH	8.2	423	94.22	92.55	95.90
Virginia	pH	8.2	424	94.35	92.68	96.01
Virginia	pH	8.2	432	95.75	94.55	96.96
Virginia	pH	8.2	433	95.92	94.76	97.08
Virginia	pH	8.3	441	96.90	95.91	97.89
Virginia	pH	8.3	449	97.73	96.88	98.58
Virginia	pH	8.3	450	97.85	97.03	98.67
Virginia	pH	8.4	452	97.99	97.19	98.79
Virginia	pH	8.4	453	98.16	97.42	98.90
Virginia	pH	8.4	457	98.53	97.87	99.20
Virginia	pH	8.4	458	98.60	97.95	99.25
Virginia	pH	8.4	460	98.79	98.19	99.40
Virginia	pH	8.5	461	98.86	98.27	99.46
Virginia	pH	8.5	462	99.03	98.51	99.56
Virginia	pH	8.5	464	99.22	98.75	99.70
Virginia	pH	8.5	465	99.34	98.92	99.77

Virginia	pH	8.5	466	99.39	98.96	99.81
Virginia	pH	8.6	467	99.51	99.14	99.88
Virginia	pH	8.6	468	99.58	99.23	99.92
Virginia	pH	8.6	469	99.70	99.42	99.98
Virginia	pH	8.7	470	99.77	99.52	100.00
Virginia	pH	8.7	471	99.84	99.62	100.00
Virginia	pH	8.7	472	99.88	99.67	100.00
Virginia	pH	9.0	473	100.00	100.00	100.00

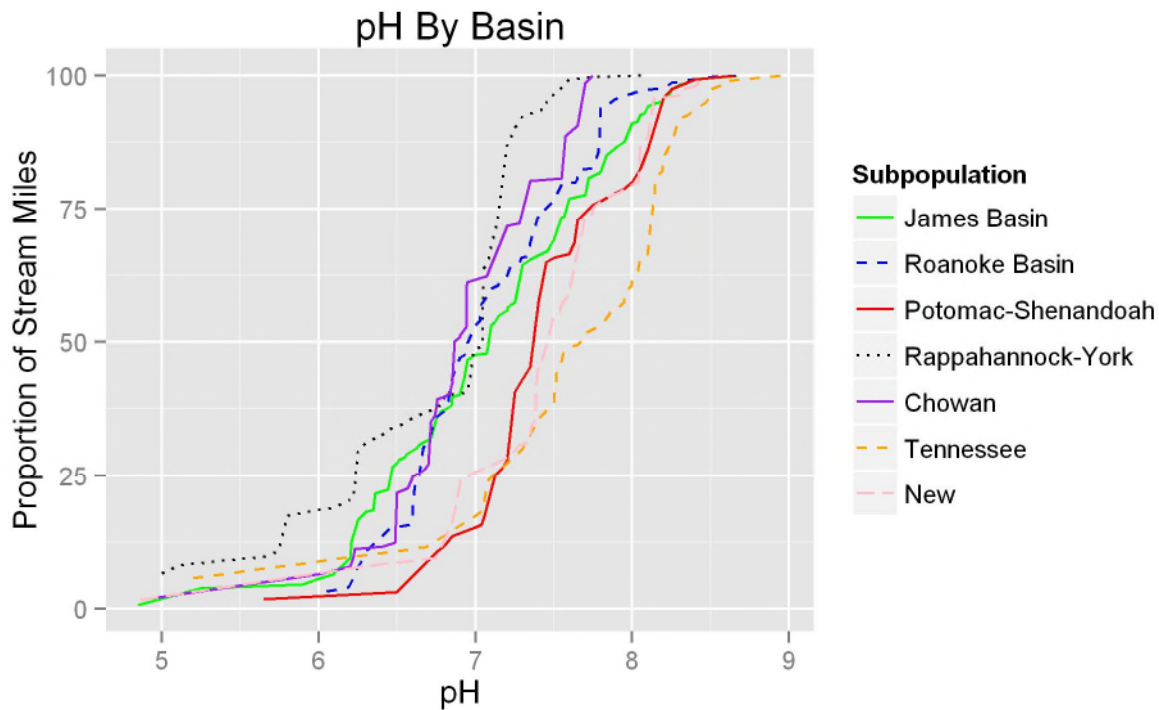


Figure 15. pH by Major Basin CDF graph.

Figure 15 depicts the variability of pH across Virginia's super basins. The 50<sup>th</sup> percentiles in the Potomac-Shenandoah, New, and Tennessee are higher relative to the other basins. The CDFs are more spread out among the basins at the 75<sup>th</sup> percentile of stream miles.

Table 9. pH Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	pH	4.9	1	0.73	0.00	1.98
James Basin	pH	5.3	2	3.84	0.00	8.47
James Basin	pH	5.9	3	4.57	0.00	9.25
James Basin	pH	6.0	5	5.61	0.77	10.45
James Basin	pH	6.1	6	6.35	1.37	11.32
James Basin	pH	6.2	7	9.45	2.71	16.20
James Basin	pH	6.2	8	12.56	4.38	20.74
James Basin	pH	6.2	9	15.66	6.43	24.89



James Basin	pH	6.3	11	16.50	7.31	25.69
James Basin	pH	6.3	14	18.15	8.99	27.31
James Basin	pH	6.4	15	18.45	9.28	27.62
James Basin	pH	6.4	16	21.56	11.71	31.40
James Basin	pH	6.4	17	22.29	12.38	32.21
James Basin	pH	6.5	19	23.56	13.56	33.56
James Basin	pH	6.5	20	26.67	16.37	36.96
James Basin	pH	6.5	21	27.40	17.00	37.80
James Basin	pH	6.5	22	27.93	17.65	38.21
James Basin	pH	6.6	23	28.47	18.18	38.76
James Basin	pH	6.6	24	29.00	18.75	39.26
James Basin	pH	6.6	25	29.74	19.53	39.94
James Basin	pH	6.6	26	30.27	20.02	40.52
James Basin	pH	6.7	27	31.00	20.69	41.32
James Basin	pH	6.7	29	31.72	21.48	41.95
James Basin	pH	6.7	30	32.25	22.20	42.30
James Basin	pH	6.8	32	35.66	25.09	46.23
James Basin	pH	6.8	33	36.39	25.73	47.05
James Basin	pH	6.8	34	36.93	26.25	47.60
James Basin	pH	6.8	35	37.46	26.76	48.17
James Basin	pH	6.8	36	38.20	27.48	48.91
James Basin	pH	6.9	38	39.67	28.90	50.43
James Basin	pH	6.9	39	40.20	29.43	50.96
James Basin	pH	6.9	40	43.30	32.15	54.46
James Basin	pH	7.0	42	46.71	35.59	57.83
James Basin	pH	7.0	44	47.63	36.52	58.74
James Basin	pH	7.1	45	47.93	36.83	59.03
James Basin	pH	7.1	47	49.20	38.19	60.20
James Basin	pH	7.1	50	53.14	42.47	63.81
James Basin	pH	7.1	51	53.67	43.03	64.32
James Basin	pH	7.2	54	55.01	44.46	65.57
James Basin	pH	7.2	56	55.93	45.40	66.46
James Basin	pH	7.2	57	56.46	45.84	67.08
James Basin	pH	7.2	59	57.08	46.49	67.68
James Basin	pH	7.3	60	57.38	46.84	67.93
James Basin	pH	7.3	64	64.43	53.92	74.94
James Basin	pH	7.4	66	65.35	54.94	75.75
James Basin	pH	7.4	68	66.26	55.89	76.63
James Basin	pH	7.5	69	66.99	56.58	77.40
James Basin	pH	7.5	70	67.30	56.90	77.70
James Basin	pH	7.5	71	68.03	57.69	78.37
James Basin	pH	7.5	73	69.07	58.78	79.35
James Basin	pH	7.5	74	69.60	59.35	79.85
James Basin	pH	7.6	77	73.42	64.06	82.79
James Basin	pH	7.6	78	73.60	64.25	82.95
James Basin	pH	7.6	80	76.89	68.29	85.48
James Basin	pH	7.7	81	77.62	69.12	86.12
James Basin	pH	7.7	82	80.73	73.41	88.04
James Basin	pH	7.8	83	81.26	74.06	88.46
James Basin	pH	7.8	84	81.99	74.95	89.04
James Basin	pH	7.8	85	85.10	79.36	90.84
James Basin	pH	7.9	86	85.40	79.64	91.16
James Basin	pH	7.9	88	86.67	80.93	92.41

James Basin	pH	8.0	90	87.58	81.91	93.26
James Basin	pH	8.0	93	91.05	87.39	94.71
James Basin	pH	8.0	94	91.35	87.72	94.99
James Basin	pH	8.1	97	92.69	89.34	96.04
James Basin	pH	8.1	98	92.87	89.54	96.21
James Basin	pH	8.1	101	94.24	91.19	97.30
James Basin	pH	8.2	102	94.78	91.89	97.66
James Basin	pH	8.2	103	95.08	92.23	97.93
James Basin	pH	8.2	104	95.61	92.93	98.29
James Basin	pH	8.2	105	96.35	94.05	98.64
James Basin	pH	8.3	107	97.41	95.39	99.44
James Basin	pH	8.3	109	98.25	96.57	99.93
James Basin	pH	8.4	110	98.55	96.96	100.00
James Basin	pH	8.4	111	99.29	98.36	100.00
James Basin	pH	8.6	112	99.82	99.52	100.00
James Basin	pH	8.7	113	100.00	100.00	100.00
Roanoke Basin	pH	6.1	1	3.22	0.00	8.30
Roanoke Basin	pH	6.2	2	3.98	0.00	9.22
Roanoke Basin	pH	6.2	3	4.53	0.00	9.87
Roanoke Basin	pH	6.3	4	7.75	0.42	15.08
Roanoke Basin	pH	6.3	5	10.97	2.18	19.76
Roanoke Basin	pH	6.4	6	14.19	4.41	23.98
Roanoke Basin	pH	6.5	7	14.95	5.11	24.80
Roanoke Basin	pH	6.6	8	15.71	5.80	25.63
Roanoke Basin	pH	6.6	9	18.93	8.51	29.36
Roanoke Basin	pH	6.6	10	22.15	10.99	33.31
Roanoke Basin	pH	6.6	11	22.91	11.73	34.10
Roanoke Basin	pH	6.6	12	23.67	12.48	34.87
Roanoke Basin	pH	6.7	13	26.89	15.24	38.55
Roanoke Basin	pH	6.7	14	30.11	18.13	42.09
Roanoke Basin	pH	6.7	15	30.87	18.91	42.84
Roanoke Basin	pH	6.7	16	31.43	19.44	43.41
Roanoke Basin	pH	6.8	19	35.96	23.83	48.09
Roanoke Basin	pH	6.8	21	37.04	24.91	49.17
Roanoke Basin	pH	6.8	22	37.59	25.52	49.66
Roanoke Basin	pH	6.8	23	38.35	26.23	50.48
Roanoke Basin	pH	6.8	24	41.57	29.31	53.83
Roanoke Basin	pH	6.9	26	43.09	30.82	55.37
Roanoke Basin	pH	6.9	27	43.85	31.78	55.93
Roanoke Basin	pH	6.9	28	47.07	35.22	58.92
Roanoke Basin	pH	6.9	29	47.84	36.00	59.67
Roanoke Basin	pH	6.9	30	48.15	36.34	59.96
Roanoke Basin	pH	7.0	33	49.78	38.04	61.52
Roanoke Basin	pH	7.0	35	53.18	41.63	64.74
Roanoke Basin	pH	7.0	36	53.37	41.83	64.91
Roanoke Basin	pH	7.0	37	53.92	42.39	65.45
Roanoke Basin	pH	7.0	38	57.14	45.85	68.43
Roanoke Basin	pH	7.1	40	57.64	46.42	68.86
Roanoke Basin	pH	7.1	42	59.16	48.00	70.33
Roanoke Basin	pH	7.1	43	59.48	48.35	70.61
Roanoke Basin	pH	7.1	44	60.03	48.93	71.13
Roanoke Basin	pH	7.1	45	60.58	49.58	71.58
Roanoke Basin	pH	7.2	46	61.34	50.40	72.29

Roanoke Basin	pH	7.2	48	62.42	51.50	73.34
Roanoke Basin	pH	7.2	50	63.16	52.30	74.02
Roanoke Basin	pH	7.2	51	63.71	52.90	74.52
Roanoke Basin	pH	7.2	52	64.27	53.49	75.04
Roanoke Basin	pH	7.3	53	65.03	54.38	75.68
Roanoke Basin	pH	7.3	54	65.79	55.19	76.39
Roanoke Basin	pH	7.3	55	65.97	55.37	76.58
Roanoke Basin	pH	7.4	59	68.60	58.18	79.02
Roanoke Basin	pH	7.4	62	73.14	63.35	82.93
Roanoke Basin	pH	7.4	64	73.76	64.01	83.52
Roanoke Basin	pH	7.4	65	74.32	64.61	84.02
Roanoke Basin	pH	7.4	66	74.87	65.23	84.52
Roanoke Basin	pH	7.5	70	76.60	67.02	86.19
Roanoke Basin	pH	7.6	71	79.82	71.14	88.51
Roanoke Basin	pH	7.6	72	80.01	71.34	88.68
Roanoke Basin	pH	7.6	73	80.56	71.96	89.16
Roanoke Basin	pH	7.7	75	81.64	73.21	90.07
Roanoke Basin	pH	7.7	76	82.19	73.81	90.58
Roanoke Basin	pH	7.7	77	82.38	74.00	90.75
Roanoke Basin	pH	7.7	78	82.69	74.34	91.04
Roanoke Basin	pH	7.8	79	85.91	79.12	92.70
Roanoke Basin	pH	7.8	84	93.98	91.22	96.74
Roanoke Basin	pH	7.9	85	94.74	92.38	97.10
Roanoke Basin	pH	7.9	86	95.50	93.56	97.44
Roanoke Basin	pH	7.9	87	95.69	93.73	97.64
Roanoke Basin	pH	7.9	88	95.87	93.93	97.81
Roanoke Basin	pH	8.0	89	96.63	94.72	98.55
Roanoke Basin	pH	8.0	90	96.82	94.89	98.75
Roanoke Basin	pH	8.1	91	97.37	95.56	99.18
Roanoke Basin	pH	8.2	92	97.69	95.90	99.47
Roanoke Basin	pH	8.3	94	98.63	97.44	99.83
Roanoke Basin	pH	8.3	95	98.95	97.89	100.00
Roanoke Basin	pH	8.4	96	99.50	98.89	100.00
Roanoke Basin	pH	8.5	97	99.69	99.12	100.00
Roanoke Basin	pH	8.7	98	100.00	100.00	100.00
Potomac-Shenandoah	pH	5.7	1	1.76	0.00	4.56
Potomac-Shenandoah	pH	6.5	2	3.04	0.02	6.06
Potomac-Shenandoah	pH	6.7	3	10.47	0.00	21.09
Potomac-Shenandoah	pH	6.8	4	11.75	0.86	22.64
Potomac-Shenandoah	pH	6.9	5	13.51	2.21	24.80
Potomac-Shenandoah	pH	7.0	6	15.27	3.59	26.94
Potomac-Shenandoah	pH	7.0	7	15.70	3.95	27.45
Potomac-Shenandoah	pH	7.1	8	17.46	5.52	29.40
Potomac-Shenandoah	pH	7.1	9	24.89	10.54	39.24
Potomac-Shenandoah	pH	7.2	10	26.17	11.95	40.39
Potomac-Shenandoah	pH	7.2	11	27.93	13.38	42.48
Potomac-Shenandoah	pH	7.3	15	40.64	23.64	57.64
Potomac-Shenandoah	pH	7.3	17	43.12	25.99	60.26
Potomac-Shenandoah	pH	7.4	19	45.31	28.21	62.42
Potomac-Shenandoah	pH	7.4	23	57.54	41.97	73.12
Potomac-Shenandoah	pH	7.5	24	64.98	50.84	79.12
Potomac-Shenandoah	pH	7.5	25	65.70	51.62	79.79
Potomac-Shenandoah	pH	7.6	26	66.43	52.49	80.37

Potomac-Shenandoah	pH	7.6	28	68.62	54.86	82.38
Potomac-Shenandoah	pH	7.7	31	72.86	59.71	86.01
Potomac-Shenandoah	pH	7.7	33	74.31	61.24	87.39
Potomac-Shenandoah	pH	7.8	35	75.76	63.05	88.47
Potomac-Shenandoah	pH	8.0	37	78.80	66.53	91.06
Potomac-Shenandoah	pH	8.0	38	80.07	68.08	92.07
Potomac-Shenandoah	pH	8.1	40	82.56	71.05	94.07
Potomac-Shenandoah	pH	8.1	43	86.32	74.96	97.68
Potomac-Shenandoah	pH	8.2	46	95.76	91.49	100.00
Potomac-Shenandoah	pH	8.3	47	97.52	94.67	100.00
Potomac-Shenandoah	pH	8.4	48	99.28	97.95	100.00
Potomac-Shenandoah	pH	8.7	49	100.00	100.00	100.00
Rappahannock-York	pH	5.0	1	6.55	0.00	17.79
Rappahannock-York	pH	5.1	2	8.10	0.00	19.59
Rappahannock-York	pH	5.7	3	9.65	0.00	21.37
Rappahannock-York	pH	5.7	4	10.78	0.00	22.45
Rappahannock-York	pH	5.8	5	17.33	4.75	29.91
Rappahannock-York	pH	6.1	6	18.88	6.10	31.66
Rappahannock-York	pH	6.2	7	20.43	7.47	33.40
Rappahannock-York	pH	6.2	8	20.81	7.85	33.77
Rappahannock-York	pH	6.2	9	21.45	8.48	34.42
Rappahannock-York	pH	6.3	11	29.55	16.74	42.37
Rappahannock-York	pH	6.3	12	31.10	18.15	44.06
Rappahannock-York	pH	6.4	13	32.65	19.78	45.52
Rappahannock-York	pH	6.4	14	33.03	20.18	45.88
Rappahannock-York	pH	6.5	15	33.67	20.87	46.48
Rappahannock-York	pH	6.6	16	34.80	21.87	47.73
Rappahannock-York	pH	6.6	17	35.92	23.00	48.85
Rappahannock-York	pH	6.7	18	37.05	23.97	50.13
Rappahannock-York	pH	6.7	19	37.43	24.36	50.50
Rappahannock-York	pH	6.7	20	37.81	24.78	50.83
Rappahannock-York	pH	6.8	21	38.44	25.41	51.47
Rappahannock-York	pH	6.8	22	39.99	27.02	52.97
Rappahannock-York	pH	7.0	23	40.63	27.71	53.56
Rappahannock-York	pH	7.0	24	41.76	28.61	54.91
Rappahannock-York	pH	7.0	25	48.31	34.36	62.27
Rappahannock-York	pH	7.0	26	48.69	34.77	62.61
Rappahannock-York	pH	7.0	27	49.33	35.15	63.51
Rappahannock-York	pH	7.1	31	63.71	50.04	77.39
Rappahannock-York	pH	7.1	33	64.73	51.16	78.31
Rappahannock-York	pH	7.1	35	72.83	61.07	84.59
Rappahannock-York	pH	7.2	37	74.60	63.12	86.08
Rappahannock-York	pH	7.2	42	86.93	79.21	94.64
Rappahannock-York	pH	7.3	45	90.24	83.96	96.52
Rappahannock-York	pH	7.3	47	92.43	87.23	97.63
Rappahannock-York	pH	7.4	48	93.56	88.59	98.52
Rappahannock-York	pH	7.4	49	94.68	90.33	99.04
Rappahannock-York	pH	7.5	50	95.06	90.80	99.33
Rappahannock-York	pH	7.5	51	95.44	91.24	99.64
Rappahannock-York	pH	7.5	52	96.57	92.92	100.00
Rappahannock-York	pH	7.6	53	97.69	94.66	100.00
Rappahannock-York	pH	7.6	54	99.24	98.32	100.00
Rappahannock-York	pH	7.7	55	99.62	98.98	100.00

Rappahannock-York	pH	8.1	56	100.00	100.00	100.00
Chowan	pH	4.9	1	1.89	0.00	5.04
Chowan	pH	6.0	4	6.46	1.08	11.85
Chowan	pH	6.2	5	7.84	1.72	13.95
Chowan	pH	6.2	6	9.73	2.92	16.54
Chowan	pH	6.2	7	11.11	3.80	18.41
Chowan	pH	6.4	8	11.57	4.14	18.99
Chowan	pH	6.5	9	12.35	4.82	19.88
Chowan	pH	6.5	11	21.73	9.20	34.26
Chowan	pH	6.6	12	22.51	9.90	35.12
Chowan	pH	6.6	14	24.87	11.93	37.80
Chowan	pH	6.6	15	25.33	12.35	38.30
Chowan	pH	6.7	16	26.11	13.00	39.22
Chowan	pH	6.7	18	27.11	14.17	40.05
Chowan	pH	6.7	19	35.12	19.93	50.30
Chowan	pH	6.7	20	35.90	20.74	51.05
Chowan	pH	6.7	21	36.12	20.96	51.28
Chowan	pH	6.8	22	37.49	22.06	52.93
Chowan	pH	6.8	23	39.39	23.91	54.86
Chowan	pH	6.8	24	39.85	24.38	55.32
Chowan	pH	6.8	25	40.07	24.54	55.60
Chowan	pH	6.8	26	40.53	24.95	56.12
Chowan	pH	6.8	27	41.91	26.16	57.66
Chowan	pH	6.9	28	42.13	26.39	57.87
Chowan	pH	6.9	29	50.14	31.88	68.40
Chowan	pH	6.9	30	50.92	32.69	69.14
Chowan	pH	6.9	31	51.38	33.08	69.68
Chowan	pH	6.9	32	52.75	34.38	71.13
Chowan	pH	6.9	33	60.76	40.94	80.58
Chowan	pH	7.0	34	61.22	41.42	81.03
Chowan	pH	7.0	35	62.00	41.99	82.02
Chowan	pH	7.1	36	62.22	42.21	82.23
Chowan	pH	7.2	37	70.23	50.80	89.66
Chowan	pH	7.2	39	71.79	52.37	91.21
Chowan	pH	7.3	40	72.25	52.87	91.64
Chowan	pH	7.4	41	80.26	63.25	97.27
Chowan	pH	7.6	42	80.72	63.70	97.74
Chowan	pH	7.6	43	88.73	76.99	100.00
Chowan	pH	7.7	44	90.62	79.22	100.00
Chowan	pH	7.7	45	98.62	96.22	100.00
Chowan	pH	7.8	46	100.00	100.00	100.00
Tennessee	pH	5.2	1	5.72	0.00	13.88
Tennessee	pH	6.7	2	11.44	0.00	23.17
Tennessee	pH	7.0	3	17.16	3.42	30.90
Tennessee	pH	7.0	4	18.51	4.65	32.38
Tennessee	pH	7.1	5	24.24	8.89	39.58
Tennessee	pH	7.3	6	29.96	13.79	46.12
Tennessee	pH	7.4	7	35.68	18.82	52.54
Tennessee	pH	7.4	8	37.03	20.26	53.80
Tennessee	pH	7.5	9	38.38	21.70	55.06
Tennessee	pH	7.5	10	44.10	27.61	60.60
Tennessee	pH	7.6	12	46.44	30.39	62.49
Tennessee	pH	7.6	14	48.35	32.56	64.14

Tennessee	pH	7.6	15	48.91	33.25	64.56
Tennessee	pH	7.6	16	49.47	33.84	65.10
Tennessee	pH	7.7	17	50.82	35.23	66.40
Tennessee	pH	7.7	18	51.80	36.42	67.19
Tennessee	pH	7.8	19	53.15	37.80	68.51
Tennessee	pH	7.9	21	55.12	40.24	70.01
Tennessee	pH	7.9	22	55.68	40.93	70.43
Tennessee	pH	7.9	23	56.01	41.28	70.74
Tennessee	pH	7.9	24	57.36	42.81	71.91
Tennessee	pH	8.0	25	58.71	44.29	73.14
Tennessee	pH	8.0	26	59.05	44.65	73.44
Tennessee	pH	8.0	27	59.60	45.21	73.99
Tennessee	pH	8.0	28	60.59	46.28	74.89
Tennessee	pH	8.0	29	61.57	47.41	75.73
Tennessee	pH	8.0	30	62.92	48.96	76.89
Tennessee	pH	8.0	31	63.90	50.00	77.81
Tennessee	pH	8.1	34	65.78	52.13	79.42
Tennessee	pH	8.1	35	66.33	52.78	79.89
Tennessee	pH	8.1	36	67.32	53.83	80.80
Tennessee	pH	8.1	37	73.04	61.26	84.81
Tennessee	pH	8.2	40	80.30	71.40	89.20
Tennessee	pH	8.2	41	81.28	72.57	90.00
Tennessee	pH	8.2	42	82.26	73.81	90.72
Tennessee	pH	8.2	45	84.79	77.17	92.40
Tennessee	pH	8.3	48	87.68	81.09	94.27
Tennessee	pH	8.3	52	91.93	86.80	97.05
Tennessee	pH	8.4	53	92.48	87.54	97.43
Tennessee	pH	8.4	55	93.60	88.97	98.23
Tennessee	pH	8.5	56	94.95	91.02	98.88
Tennessee	pH	8.5	58	96.49	93.18	99.81
Tennessee	pH	8.5	59	97.48	94.77	100.00
Tennessee	pH	8.6	60	98.46	96.45	100.00
Tennessee	pH	8.6	61	99.02	97.31	100.00
Tennessee	pH	9.0	62	100.00	100.00	100.00
New	pH	4.9	1	1.59	0.00	4.16
New	pH	6.4	2	8.32	0.00	19.08
New	pH	6.8	3	9.48	0.00	20.36
New	pH	6.9	4	16.20	1.79	30.62
New	pH	6.9	5	22.93	6.15	39.72
New	pH	6.9	6	24.09	7.24	40.94
New	pH	7.0	7	25.68	9.19	42.18
New	pH	7.1	8	26.84	10.29	43.39
New	pH	7.2	9	28.43	11.89	44.97
New	pH	7.3	10	29.58	12.99	46.18
New	pH	7.3	11	30.74	13.90	47.59
New	pH	7.3	12	31.13	14.32	47.94
New	pH	7.4	13	32.72	15.76	49.68
New	pH	7.4	14	34.31	17.55	51.08
New	pH	7.4	15	35.47	18.66	52.27
New	pH	7.4	16	42.20	25.26	59.14
New	pH	7.4	18	45.38	28.17	62.60
New	pH	7.4	19	46.97	30.11	63.84
New	pH	7.5	21	54.86	37.31	72.40

New	pH	7.5	22	55.51	38.16	72.87
New	pH	7.6	23	57.10	39.83	74.38
New	pH	7.6	24	58.70	41.47	75.92
New	pH	7.7	26	67.02	50.66	83.38
New	pH	7.7	27	73.75	58.79	88.70
New	pH	7.7	28	74.13	59.12	89.15
New	pH	7.8	29	75.29	60.53	90.05
New	pH	7.8	30	76.45	61.75	91.14
New	pH	7.9	32	77.76	62.85	92.67
New	pH	7.9	33	78.15	63.23	93.06
New	pH	7.9	34	78.54	63.62	93.45
New	pH	8.0	35	80.13	65.01	95.24
New	pH	8.1	36	86.86	75.01	98.70
New	pH	8.1	37	88.45	76.77	100.00
New	pH	8.1	38	95.18	91.60	98.76
New	pH	8.1	39	95.83	92.52	99.15
New	pH	8.3	40	96.22	93.03	99.42
New	pH	8.3	41	97.38	95.06	99.69
New	pH	8.4	42	98.03	95.94	100.00
New	pH	8.4	43	98.69	97.04	100.00
New	pH	8.4	44	99.34	98.18	100.00
New	pH	8.5	45	100.00	100.00	100.00

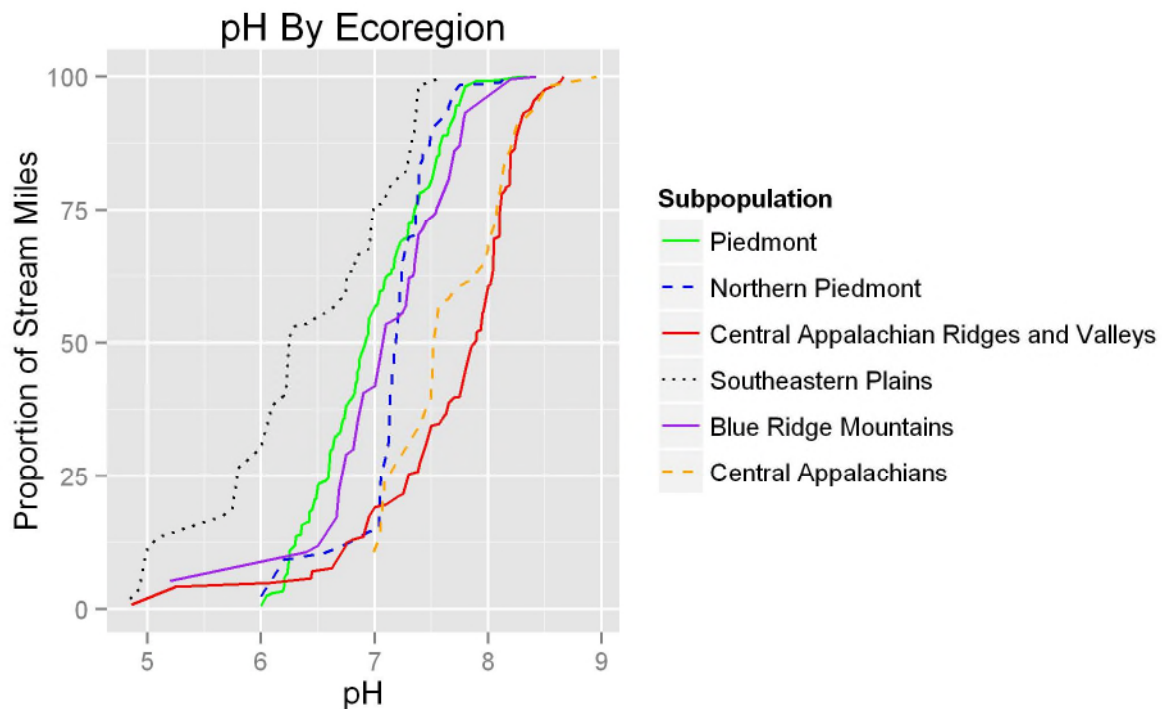


Figure16. pH by Major Ecoregion (Level III) CDF graph.

The CDF curves shown in Figure 16 vary by ecoregion. Fifty percent of streams have pH concentrations less than 6.3 in the Southeastern Plains. Piedmont streams have pH concentrations less than 6.9. The Blue Ridge Mountains and Northern Piedmont streams show the 50<sup>th</sup> percentile of pH values at 7.5 and 7.2, respectively. The 50<sup>th</sup> percentiles in the Central Appalachians and Central Appalachian Ridges and Valleys are 7.5 and 7.9, respectively. Table 10 details the ecoregion estimates.

Table10. **pH Population Estimates by Major Ecoregion (Level III).**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	pH	6.0	2	0.62	0.00	1.44
Piedmont	pH	6.1	3	2.49	0.00	5.55
Piedmont	pH	6.1	4	2.93	0.00	6.07
Piedmont	pH	6.2	5	3.37	0.14	6.60
Piedmont	pH	6.2	7	4.01	0.68	7.35
Piedmont	pH	6.2	8	5.88	1.47	10.29
Piedmont	pH	6.2	9	6.32	1.88	10.76
Piedmont	pH	6.2	10	6.64	2.18	11.11
Piedmont	pH	6.2	11	8.51	3.23	13.79
Piedmont	pH	6.3	14	10.88	4.93	16.83
Piedmont	pH	6.3	17	11.87	5.89	17.85
Piedmont	pH	6.3	18	13.74	7.16	20.31
Piedmont	pH	6.4	19	13.92	7.33	20.50
Piedmont	pH	6.4	20	15.78	8.79	22.78
Piedmont	pH	6.4	21	16.23	9.25	23.20
Piedmont	pH	6.4	22	16.33	9.37	23.30
Piedmont	pH	6.4	23	18.20	10.83	25.57
Piedmont	pH	6.5	24	18.64	11.23	26.05
Piedmont	pH	6.5	25	20.51	12.73	28.29
Piedmont	pH	6.5	26	20.69	12.91	28.47
Piedmont	pH	6.5	29	23.20	15.24	31.15
Piedmont	pH	6.5	30	23.52	15.62	31.41
Piedmont	pH	6.6	31	23.84	15.94	31.74
Piedmont	pH	6.6	32	24.02	16.12	31.92
Piedmont	pH	6.6	33	24.46	16.52	32.40
Piedmont	pH	6.6	37	27.53	19.49	35.57
Piedmont	pH	6.6	38	29.40	21.10	37.70
Piedmont	pH	6.6	39	29.84	21.53	38.15
Piedmont	pH	6.6	40	30.28	21.96	38.61
Piedmont	pH	6.7	41	32.15	23.66	40.64
Piedmont	pH	6.7	43	32.77	24.26	41.28
Piedmont	pH	6.7	46	33.38	24.87	41.89
Piedmont	pH	6.7	47	35.25	26.67	43.83
Piedmont	pH	6.7	48	35.57	27.04	44.10
Piedmont	pH	6.7	49	35.75	27.23	44.27
Piedmont	pH	6.8	52	38.26	29.65	46.87
Piedmont	pH	6.8	53	38.70	30.06	47.34
Piedmont	pH	6.8	54	39.02	30.38	47.66
Piedmont	pH	6.8	56	39.64	30.99	48.29
Piedmont	pH	6.8	57	39.75	31.11	48.40



Piedmont	pH	6.8	58	40.07	31.42	48.72
Piedmont	pH	6.8	59	40.51	31.84	49.19
Piedmont	pH	6.8	60	42.38	33.63	51.13
Piedmont	pH	6.8	61	42.49	33.74	51.24
Piedmont	pH	6.8	62	42.93	34.19	51.67
Piedmont	pH	6.9	66	44.70	35.87	53.53
Piedmont	pH	6.9	67	45.14	36.39	53.89
Piedmont	pH	6.9	68	47.00	38.04	55.97
Piedmont	pH	6.9	70	49.05	40.17	57.94
Piedmont	pH	6.9	71	49.16	40.28	58.04
Piedmont	pH	6.9	72	51.03	42.06	59.99
Piedmont	pH	6.9	73	51.47	42.50	60.43
Piedmont	pH	6.9	75	53.52	44.71	62.33
Piedmont	pH	7.0	79	54.64	45.86	63.42
Piedmont	pH	7.0	82	56.72	48.04	65.41
Piedmont	pH	7.0	83	56.83	48.15	65.52
Piedmont	pH	7.0	84	57.15	48.47	65.83
Piedmont	pH	7.0	86	59.20	50.64	67.76
Piedmont	pH	7.1	89	59.67	51.11	68.23
Piedmont	pH	7.1	90	59.86	51.30	68.41
Piedmont	pH	7.1	91	60.04	51.49	68.59
Piedmont	pH	7.1	93	60.80	52.28	69.32
Piedmont	pH	7.1	95	61.68	53.21	70.16
Piedmont	pH	7.1	96	61.86	53.40	70.33
Piedmont	pH	7.1	98	62.37	53.90	70.83
Piedmont	pH	7.1	99	62.69	54.24	71.14
Piedmont	pH	7.1	100	63.01	54.58	71.44
Piedmont	pH	7.2	102	63.63	55.24	72.03
Piedmont	pH	7.2	103	63.95	55.56	72.35
Piedmont	pH	7.2	104	65.82	57.60	74.04
Piedmont	pH	7.2	110	67.36	59.21	75.50
Piedmont	pH	7.2	111	67.68	59.48	75.87
Piedmont	pH	7.2	113	68.10	59.94	76.27
Piedmont	pH	7.2	114	68.43	60.28	76.57
Piedmont	pH	7.2	115	68.75	60.61	76.89
Piedmont	pH	7.2	117	69.12	61.00	77.24
Piedmont	pH	7.3	118	69.30	61.20	77.40
Piedmont	pH	7.3	119	69.74	61.69	77.79
Piedmont	pH	7.3	120	70.18	62.14	78.22
Piedmont	pH	7.3	122	72.49	64.54	80.44
Piedmont	pH	7.3	123	72.60	64.65	80.55
Piedmont	pH	7.4	130	75.11	67.29	82.94
Piedmont	pH	7.4	133	77.74	70.22	85.26
Piedmont	pH	7.4	136	78.21	70.72	85.71
Piedmont	pH	7.4	137	78.54	71.05	86.02
Piedmont	pH	7.4	138	78.86	71.40	86.32
Piedmont	pH	7.5	139	79.30	71.85	86.75
Piedmont	pH	7.5	144	80.48	73.05	87.92
Piedmont	pH	7.5	145	80.81	73.38	88.23
Piedmont	pH	7.6	150	85.07	78.57	91.58
Piedmont	pH	7.6	151	85.18	78.68	91.68
Piedmont	pH	7.6	152	87.05	81.11	92.99
Piedmont	pH	7.6	153	88.92	83.53	94.30

Piedmont	pH	7.6	154	89.02	83.64	94.40
Piedmont	pH	7.6	155	89.34	83.99	94.70
Piedmont	pH	7.7	158	90.41	85.17	95.65
Piedmont	pH	7.7	159	90.73	85.51	95.95
Piedmont	pH	7.7	160	90.84	85.62	96.05
Piedmont	pH	7.7	161	92.70	88.15	97.26
Piedmont	pH	7.7	162	94.57	90.95	98.19
Piedmont	pH	7.7	163	94.75	91.15	98.35
Piedmont	pH	7.8	164	95.07	91.53	98.62
Piedmont	pH	7.8	165	95.39	91.90	98.89
Piedmont	pH	7.8	169	98.20	96.84	99.57
Piedmont	pH	7.9	170	98.65	97.51	99.79
Piedmont	pH	7.9	171	99.09	98.20	99.97
Piedmont	pH	8.0	172	99.19	98.33	100.00
Piedmont	pH	8.1	173	99.38	98.57	100.00
Piedmont	pH	8.3	174	99.82	99.51	100.00
Piedmont	pH	8.4	175	100.00	100.00	100.00
Northern Piedmont	pH	6.0	2	2.32	0.00	5.20
Northern Piedmont	pH	6.2	3	9.28	0.00	19.37
Northern Piedmont	pH	6.6	4	10.47	0.19	20.75
Northern Piedmont	pH	6.7	5	11.67	2.02	21.31
Northern Piedmont	pH	6.9	6	13.31	3.22	23.41
Northern Piedmont	pH	7.0	7	14.51	4.16	24.85
Northern Piedmont	pH	7.0	8	14.91	4.49	25.32
Northern Piedmont	pH	7.0	9	15.58	5.00	26.17
Northern Piedmont	pH	7.1	11	23.22	10.03	36.40
Northern Piedmont	pH	7.1	12	24.86	11.43	38.29
Northern Piedmont	pH	7.1	13	31.81	16.97	46.66
Northern Piedmont	pH	7.1	15	40.41	24.47	56.36
Northern Piedmont	pH	7.2	20	53.50	37.67	69.32
Northern Piedmont	pH	7.3	25	65.61	51.31	79.91
Northern Piedmont	pH	7.3	29	69.81	55.82	83.80
Northern Piedmont	pH	7.4	30	70.21	56.15	84.26
Northern Piedmont	pH	7.4	35	83.29	74.91	91.68
Northern Piedmont	pH	7.4	36	84.49	76.34	92.64
Northern Piedmont	pH	7.4	37	85.68	78.09	93.27
Northern Piedmont	pH	7.5	38	86.08	78.63	93.54
Northern Piedmont	pH	7.5	39	86.76	79.39	94.13
Northern Piedmont	pH	7.5	40	87.16	79.89	94.43
Northern Piedmont	pH	7.5	42	90.00	83.92	96.08
Northern Piedmont	pH	7.6	43	91.20	85.58	96.82
Northern Piedmont	pH	7.6	45	92.28	86.92	97.63
Northern Piedmont	pH	7.6	46	92.68	87.42	97.94
Northern Piedmont	pH	7.7	47	94.32	90.00	98.65
Northern Piedmont	pH	7.7	50	97.05	94.36	99.74
Northern Piedmont	pH	7.8	52	98.40	96.36	100.00
Northern Piedmont	pH	8.1	53	98.81	96.90	100.00
Northern Piedmont	pH	8.2	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	pH	4.9	1	0.79	0.00	2.06
Central Appalachian Ridges and Valleys	pH	5.3	2	4.14	0.00	9.17
Central Appalachian Ridges and Valleys	pH	6.1	3	4.93	0.00	10.10
Central Appalachian Ridges and Valleys	pH	6.4	4	5.72	0.39	11.05
Central Appalachian Ridges and Valleys	pH	6.5	6	7.09	1.54	12.64

Central Appalachian Ridges and Valleys	pH	6.6	7	7.66	2.04	13.29
Central Appalachian Ridges and Valleys	pH	6.7	8	8.46	2.69	14.22
Central Appalachian Ridges and Valleys	pH	6.7	9	11.80	4.49	19.12
Central Appalachian Ridges and Valleys	pH	6.8	10	12.38	5.02	19.74
Central Appalachian Ridges and Valleys	pH	6.8	11	12.95	5.51	20.39
Central Appalachian Ridges and Valleys	pH	6.9	12	13.53	6.07	20.98
Central Appalachian Ridges and Valleys	pH	6.9	13	14.10	6.58	21.63
Central Appalachian Ridges and Valleys	pH	7.0	14	17.45	9.03	25.87
Central Appalachian Ridges and Valleys	pH	7.0	16	19.03	10.54	27.53
Central Appalachian Ridges and Valleys	pH	7.1	17	19.61	11.09	28.13
Central Appalachian Ridges and Valleys	pH	7.2	19	20.26	11.79	28.73
Central Appalachian Ridges and Valleys	pH	7.2	20	21.05	12.57	29.54
Central Appalachian Ridges and Valleys	pH	7.3	21	21.63	13.12	30.14
Central Appalachian Ridges and Valleys	pH	7.3	23	25.30	15.92	34.68
Central Appalachian Ridges and Valleys	pH	7.4	24	25.88	16.49	35.27
Central Appalachian Ridges and Valleys	pH	7.4	26	27.46	17.98	36.94
Central Appalachian Ridges and Valleys	pH	7.5	27	30.81	20.71	40.90
Central Appalachian Ridges and Valleys	pH	7.5	29	34.48	24.02	44.95
Central Appalachian Ridges and Valleys	pH	7.6	30	34.81	24.33	45.28
Central Appalachian Ridges and Valleys	pH	7.6	31	35.60	25.20	45.99
Central Appalachian Ridges and Valleys	pH	7.6	32	35.92	25.53	46.32
Central Appalachian Ridges and Valleys	pH	7.6	33	36.72	26.31	47.12
Central Appalachian Ridges and Valleys	pH	7.7	36	38.63	28.38	48.87
Central Appalachian Ridges and Valleys	pH	7.7	38	39.74	29.46	50.03
Central Appalachian Ridges and Valleys	pH	7.7	39	39.94	29.63	50.25
Central Appalachian Ridges and Valleys	pH	7.8	42	44.87	34.27	55.46
Central Appalachian Ridges and Valleys	pH	7.8	43	48.22	37.74	58.70
Central Appalachian Ridges and Valleys	pH	7.9	45	49.12	38.64	59.60
Central Appalachian Ridges and Valleys	pH	7.9	46	49.44	38.97	59.91
Central Appalachian Ridges and Valleys	pH	7.9	48	50.10	39.65	60.54
Central Appalachian Ridges and Valleys	pH	7.9	49	50.29	39.84	60.74
Central Appalachian Ridges and Valleys	pH	7.9	52	51.85	41.41	62.29
Central Appalachian Ridges and Valleys	pH	7.9	53	52.04	41.61	62.48
Central Appalachian Ridges and Valleys	pH	7.9	54	52.24	41.82	62.65
Central Appalachian Ridges and Valleys	pH	7.9	55	52.43	42.02	62.83
Central Appalachian Ridges and Valleys	pH	8.0	60	55.57	45.41	65.74
Central Appalachian Ridges and Valleys	pH	8.0	61	55.77	45.60	65.93
Central Appalachian Ridges and Valleys	pH	8.0	65	60.67	50.94	70.41
Central Appalachian Ridges and Valleys	pH	8.0	66	60.87	51.14	70.60
Central Appalachian Ridges and Valleys	pH	8.0	68	61.99	52.33	71.64
Central Appalachian Ridges and Valleys	pH	8.0	70	63.35	53.82	72.89
Central Appalachian Ridges and Valleys	pH	8.1	77	69.45	60.97	77.94
Central Appalachian Ridges and Valleys	pH	8.1	78	69.65	61.20	78.10
Central Appalachian Ridges and Valleys	pH	8.1	79	69.97	61.54	78.41
Central Appalachian Ridges and Valleys	pH	8.1	87	74.76	66.76	82.76
Central Appalachian Ridges and Valleys	pH	8.1	88	78.11	70.71	85.50
Central Appalachian Ridges and Valleys	pH	8.1	89	78.43	71.08	85.79
Central Appalachian Ridges and Valleys	pH	8.2	90	78.76	71.44	86.08
Central Appalachian Ridges and Valleys	pH	8.2	91	79.33	72.00	86.67
Central Appalachian Ridges and Valleys	pH	8.2	92	79.66	72.36	86.96
Central Appalachian Ridges and Valleys	pH	8.2	99	85.71	80.44	90.98
Central Appalachian Ridges and Valleys	pH	8.2	100	86.50	81.54	91.47
Central Appalachian Ridges and Valleys	pH	8.3	105	88.96	84.51	93.41

Central Appalachian Ridges and Valleys	pH	8.3	112	92.54	88.95	96.14
Central Appalachian Ridges and Valleys	pH	8.3	113	93.12	89.73	96.51
Central Appalachian Ridges and Valleys	pH	8.4	114	93.91	90.89	96.93
Central Appalachian Ridges and Valleys	pH	8.4	117	95.36	92.83	97.88
Central Appalachian Ridges and Valleys	pH	8.4	119	96.26	94.01	98.50
Central Appalachian Ridges and Valleys	pH	8.5	120	96.58	94.44	98.73
Central Appalachian Ridges and Valleys	pH	8.5	122	97.48	95.70	99.27
Central Appalachian Ridges and Valleys	pH	8.5	123	97.68	95.91	99.45
Central Appalachian Ridges and Valleys	pH	8.6	124	98.25	96.78	99.72
Central Appalachian Ridges and Valleys	pH	8.6	125	98.58	97.25	99.91
Central Appalachian Ridges and Valleys	pH	8.6	126	99.15	98.26	100.00
Central Appalachian Ridges and Valleys	pH	8.7	127	99.48	98.82	100.00
Central Appalachian Ridges and Valleys	pH	8.7	128	99.81	99.48	100.00
Central Appalachian Ridges and Valleys	pH	8.7	129	100.00	100.00	100.00
Southeastern Plains	pH	4.9	1	1.88	0.00	5.12
Southeastern Plains	pH	4.9	2	3.75	0.00	8.20
Southeastern Plains	pH	5.0	3	11.68	0.00	25.69
Southeastern Plains	pH	5.1	4	13.56	0.00	27.98
Southeastern Plains	pH	5.7	6	17.31	2.43	32.18
Southeastern Plains	pH	5.7	7	18.67	3.80	33.54
Southeastern Plains	pH	5.8	8	26.60	10.05	43.15
Southeastern Plains	pH	5.9	9	28.48	11.75	45.20
Southeastern Plains	pH	6.0	10	30.35	13.53	47.18
Southeastern Plains	pH	6.1	11	38.28	20.99	55.57
Southeastern Plains	pH	6.2	12	40.16	22.82	57.50
Southeastern Plains	pH	6.2	13	40.62	23.33	57.90
Southeastern Plains	pH	6.2	14	41.39	24.17	58.61
Southeastern Plains	pH	6.3	16	51.19	36.63	65.76
Southeastern Plains	pH	6.3	17	53.07	38.49	67.65
Southeastern Plains	pH	6.4	18	53.53	38.91	68.15
Southeastern Plains	pH	6.5	19	54.30	39.76	68.85
Southeastern Plains	pH	6.6	20	55.66	41.27	70.06
Southeastern Plains	pH	6.6	21	56.12	41.72	70.53
Southeastern Plains	pH	6.6	22	56.58	42.14	71.01
Southeastern Plains	pH	6.7	24	58.16	43.75	72.57
Southeastern Plains	pH	6.7	25	58.62	44.25	72.99
Southeastern Plains	pH	6.7	27	59.30	44.95	73.65
Southeastern Plains	pH	6.8	28	60.07	45.75	74.39
Southeastern Plains	pH	6.8	29	61.95	47.74	76.15
Southeastern Plains	pH	6.8	30	62.72	48.68	76.76
Southeastern Plains	pH	6.8	31	64.59	50.98	78.21
Southeastern Plains	pH	6.8	32	64.81	51.11	78.52
Southeastern Plains	pH	6.8	33	66.18	52.27	80.09
Southeastern Plains	pH	6.9	34	66.40	52.48	80.31
Southeastern Plains	pH	7.0	36	67.63	53.74	81.52
Southeastern Plains	pH	7.0	37	75.56	59.28	91.84
Southeastern Plains	pH	7.0	38	76.02	59.75	92.28
Southeastern Plains	pH	7.1	39	76.23	59.97	92.50
Southeastern Plains	pH	7.1	40	76.69	60.45	92.93
Southeastern Plains	pH	7.2	42	79.93	63.82	96.04
Southeastern Plains	pH	7.3	43	81.81	65.17	98.44
Southeastern Plains	pH	7.3	44	82.27	65.63	98.91
Southeastern Plains	pH	7.4	45	90.19	77.69	100.00

Southeastern Plains	pH	7.4	46	98.12	94.68	100.00
Southeastern Plains	pH	7.6	47	100.00	100.00	100.00
Blue Ridge Mountains	pH	5.2	1	5.31	0.00	14.02
Blue Ridge Mountains	pH	6.4	2	10.63	0.00	22.58
Blue Ridge Mountains	pH	6.5	3	11.88	0.00	24.09
Blue Ridge Mountains	pH	6.7	4	17.20	2.68	31.71
Blue Ridge Mountains	pH	6.7	5	22.51	7.14	37.88
Blue Ridge Mountains	pH	6.8	7	29.08	12.05	46.11
Blue Ridge Mountains	pH	6.8	8	29.99	12.91	47.08
Blue Ridge Mountains	pH	6.9	9	35.31	17.46	53.15
Blue Ridge Mountains	pH	6.9	10	40.62	21.81	59.43
Blue Ridge Mountains	pH	7.0	11	41.88	23.36	60.39
Blue Ridge Mountains	pH	7.1	12	47.19	28.53	65.84
Blue Ridge Mountains	pH	7.1	14	53.42	35.33	71.51
Blue Ridge Mountains	pH	7.2	15	54.67	36.84	72.50
Blue Ridge Mountains	pH	7.3	16	55.93	38.45	73.41
Blue Ridge Mountains	pH	7.3	17	56.84	39.33	74.35
Blue Ridge Mountains	pH	7.3	18	62.16	46.01	78.30
Blue Ridge Mountains	pH	7.3	19	62.46	46.30	78.62
Blue Ridge Mountains	pH	7.4	20	63.72	47.42	80.02
Blue Ridge Mountains	pH	7.4	21	64.98	48.66	81.29
Blue Ridge Mountains	pH	7.4	22	70.29	54.67	85.91
Blue Ridge Mountains	pH	7.4	23	71.55	56.07	87.02
Blue Ridge Mountains	pH	7.5	24	72.80	57.60	88.01
Blue Ridge Mountains	pH	7.5	25	73.72	58.36	89.07
Blue Ridge Mountains	pH	7.5	26	74.23	58.95	89.52
Blue Ridge Mountains	pH	7.6	27	75.49	60.27	90.71
Blue Ridge Mountains	pH	7.7	28	80.80	67.19	94.41
Blue Ridge Mountains	pH	7.7	29	86.12	74.46	97.77
Blue Ridge Mountains	pH	7.8	30	87.03	75.57	98.49
Blue Ridge Mountains	pH	7.8	31	92.34	83.39	100.00
Blue Ridge Mountains	pH	7.8	32	93.26	84.15	100.00
Blue Ridge Mountains	pH	8.1	33	98.57	96.66	100.00
Blue Ridge Mountains	pH	8.2	34	99.48	98.59	100.00
Blue Ridge Mountains	pH	8.4	35	100.00	100.00	100.00
Central Appalachians	pH	7.0	1	10.68	0.00	26.23
Central Appalachians	pH	7.0	2	13.20	0.00	29.03
Central Appalachians	pH	7.1	3	23.88	3.18	44.58
Central Appalachians	pH	7.4	4	34.55	12.25	56.86
Central Appalachians	pH	7.4	5	37.08	14.96	59.19
Central Appalachians	pH	7.5	6	39.60	17.79	61.41
Central Appalachians	pH	7.5	7	50.28	27.93	72.63
Central Appalachians	pH	7.6	9	54.64	33.25	76.03
Central Appalachians	pH	7.6	10	57.16	36.13	78.20
Central Appalachians	pH	7.6	11	58.20	37.36	79.05
Central Appalachians	pH	7.7	12	60.04	39.65	80.42
Central Appalachians	pH	7.9	13	61.87	42.19	81.56
Central Appalachians	pH	7.9	14	64.40	45.65	83.15
Central Appalachians	pH	8.0	15	65.44	46.68	84.19
Central Appalachians	pH	8.0	16	67.27	48.69	85.86
Central Appalachians	pH	8.0	17	69.11	50.86	87.35
Central Appalachians	pH	8.1	19	71.98	54.24	89.72
Central Appalachians	pH	8.2	21	84.49	73.58	95.40

Central Appalachians	pH	8.2	22	86.32	76.12	96.53
Central Appalachians	pH	8.3	24	90.68	82.94	98.43
Central Appalachians	pH	8.3	25	91.73	84.18	99.27
Central Appalachians	pH	8.4	26	92.77	85.69	99.84
Central Appalachians	pH	8.4	27	93.81	87.17	100.00
Central Appalachians	pH	8.5	28	96.33	91.52	100.00
Central Appalachians	pH	8.5	29	98.17	94.91	100.00
Central Appalachians	pH	9.0	30	100.00	100.00	100.00

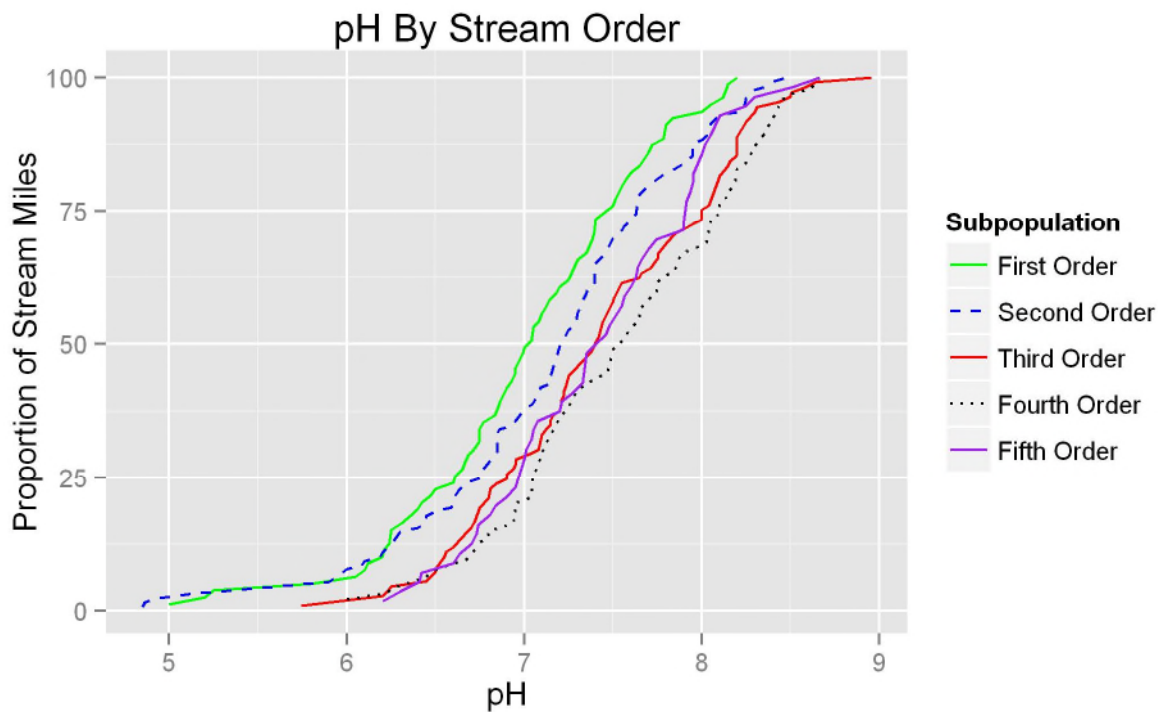


Figure17. pH by Stream Order CDF graph.

First order streams have lower pH concentrations overall as shown in Figure 17. First order streams show that 50% of stream miles have pH concentrations below 7.0 and 75% of streams are less than 7.5. Second order streams show 50% of streams with pHs less than 7.2. Fourth order stream CDF shows that 50% of streams have pH values less than 7.5. Half of both third and fifth order stream miles have pH values less than 7.4. See Table 11 for specific percentiles and pH concentrations.

Table 11. pH Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	pH	5.0	1	1.27	0.00	3.35
First Order	pH	5.2	2	2.53	0.00	5.48
First Order	pH	5.3	3	3.80	0.22	7.38
First Order	pH	5.8	4	5.06	1.26	8.87

First Order	pH	6.1	5	6.33	2.01	10.65
First Order	pH	6.1	6	7.59	2.95	12.24
First Order	pH	6.1	7	8.86	3.86	13.87
First Order	pH	6.2	8	10.13	4.69	15.56
First Order	pH	6.2	9	11.39	5.69	17.10
First Order	pH	6.2	10	12.66	6.91	18.41
First Order	pH	6.3	12	15.19	9.17	21.21
First Order	pH	6.3	13	16.46	10.17	22.75
First Order	pH	6.4	14	17.72	11.18	24.26
First Order	pH	6.4	15	18.99	12.10	25.87
First Order	pH	6.4	16	20.25	13.07	27.43
First Order	pH	6.5	17	21.52	14.46	28.58
First Order	pH	6.5	18	22.78	15.40	30.17
First Order	pH	6.6	19	24.05	16.59	31.51
First Order	pH	6.6	20	25.32	17.69	32.95
First Order	pH	6.7	21	26.58	18.86	34.30
First Order	pH	6.7	22	27.85	19.87	35.83
First Order	pH	6.7	23	29.11	20.95	37.27
First Order	pH	6.7	24	30.38	22.11	38.65
First Order	pH	6.7	25	31.65	23.12	40.17
First Order	pH	6.8	27	34.18	25.37	42.98
First Order	pH	6.8	28	35.44	26.66	44.23
First Order	pH	6.8	29	36.71	28.03	45.39
First Order	pH	6.9	30	37.97	29.23	46.72
First Order	pH	6.9	31	39.24	30.26	48.22
First Order	pH	6.9	33	41.77	32.76	50.78
First Order	pH	6.9	34	43.04	33.92	52.16
First Order	pH	6.9	35	44.30	35.14	53.47
First Order	pH	7.0	36	45.57	36.20	54.94
First Order	pH	7.0	38	48.10	38.59	57.62
First Order	pH	7.0	39	49.37	39.93	58.80
First Order	pH	7.0	40	50.63	41.33	59.93
First Order	pH	7.1	42	53.16	43.51	62.82
First Order	pH	7.1	43	54.43	44.66	64.20
First Order	pH	7.1	44	55.70	45.96	65.44
First Order	pH	7.1	45	56.96	47.20	66.72
First Order	pH	7.1	46	58.23	48.63	67.82
First Order	pH	7.2	47	59.49	50.02	68.97
First Order	pH	7.2	48	60.76	51.29	70.23
First Order	pH	7.3	49	62.03	52.73	71.32
First Order	pH	7.3	52	65.82	56.69	74.95
First Order	pH	7.4	53	67.09	58.05	76.13
First Order	pH	7.4	55	69.62	60.90	78.34
First Order	pH	7.4	56	70.89	62.32	79.45
First Order	pH	7.4	58	73.42	65.04	81.79
First Order	pH	7.5	59	74.68	66.45	82.92
First Order	pH	7.5	60	75.95	67.64	84.25
First Order	pH	7.5	61	77.22	69.07	85.36
First Order	pH	7.6	63	79.75	72.09	87.41
First Order	pH	7.6	64	81.01	73.62	88.40
First Order	pH	7.6	65	82.28	75.21	89.34
First Order	pH	7.7	66	83.54	76.49	90.60
First Order	pH	7.7	68	86.08	79.61	92.54

First Order	pH	7.7	69	87.34	81.16	93.53
First Order	pH	7.8	70	88.61	82.72	94.49
First Order	pH	7.8	72	91.14	85.86	96.42
First Order	pH	7.8	73	92.41	87.38	97.43
First Order	pH	8.0	74	93.67	89.19	98.16
First Order	pH	8.1	75	94.94	90.96	98.92
First Order	pH	8.1	76	96.20	92.47	99.93
First Order	pH	8.1	77	97.47	94.44	100.00
First Order	pH	8.2	78	98.73	96.65	100.00
First Order	pH	8.2	79	100.00	100.00	100.00
Second Order	pH	4.9	1	0.78	0.00	2.14
Second Order	pH	4.9	2	1.55	0.00	3.46
Second Order	pH	4.9	3	2.33	0.04	4.61
Second Order	pH	5.1	4	3.10	0.49	5.71
Second Order	pH	5.7	6	4.65	1.67	7.64
Second Order	pH	5.9	7	5.43	2.28	8.57
Second Order	pH	6.0	10	7.75	4.06	11.45
Second Order	pH	6.1	11	8.53	4.63	12.42
Second Order	pH	6.1	12	9.30	5.30	13.31
Second Order	pH	6.2	13	10.08	5.84	14.31
Second Order	pH	6.2	14	10.85	6.52	15.19
Second Order	pH	6.2	15	11.63	7.27	15.99
Second Order	pH	6.3	16	12.40	8.06	16.75
Second Order	pH	6.3	19	14.73	10.36	19.09
Second Order	pH	6.4	20	15.50	11.28	19.73
Second Order	pH	6.4	21	16.28	11.85	20.71
Second Order	pH	6.5	23	17.83	13.16	22.50
Second Order	pH	6.5	24	18.60	13.78	23.43
Second Order	pH	6.6	25	19.38	14.39	24.37
Second Order	pH	6.6	27	20.93	16.08	25.78
Second Order	pH	6.6	28	21.71	16.69	26.72
Second Order	pH	6.6	29	22.48	17.44	27.52
Second Order	pH	6.7	30	23.26	18.13	28.38
Second Order	pH	6.7	31	24.03	18.92	29.15
Second Order	pH	6.8	32	24.81	19.54	30.08
Second Order	pH	6.8	33	25.58	20.43	30.73
Second Order	pH	6.8	34	26.36	21.06	31.66
Second Order	pH	6.8	36	27.91	22.66	33.16
Second Order	pH	6.8	37	28.68	23.49	33.87
Second Order	pH	6.8	38	29.46	24.25	34.67
Second Order	pH	6.9	43	33.33	27.64	39.03
Second Order	pH	6.9	44	34.11	28.50	39.72
Second Order	pH	6.9	45	34.88	29.14	40.63
Second Order	pH	7.0	46	35.66	29.88	41.44
Second Order	pH	7.0	49	37.98	31.87	44.10
Second Order	pH	7.0	50	38.76	32.50	45.02
Second Order	pH	7.1	51	39.53	33.22	45.85
Second Order	pH	7.1	52	40.31	34.01	46.61
Second Order	pH	7.1	54	41.86	35.49	48.23
Second Order	pH	7.1	55	42.64	36.16	49.11
Second Order	pH	7.2	57	44.19	37.74	50.63
Second Order	pH	7.2	64	49.61	42.98	56.24
Second Order	pH	7.3	68	52.71	46.09	59.34



Second Order	pH	7.3	69	53.49	46.94	60.03
Second Order	pH	7.3	70	54.26	47.77	60.76
Second Order	pH	7.3	72	55.81	49.31	62.31
Second Order	pH	7.4	77	59.69	53.46	65.92
Second Order	pH	7.4	78	60.47	54.32	66.61
Second Order	pH	7.4	79	61.24	55.14	67.34
Second Order	pH	7.4	84	65.12	59.17	71.06
Second Order	pH	7.4	85	65.89	60.09	71.70
Second Order	pH	7.4	86	66.67	60.71	72.62
Second Order	pH	7.5	87	67.44	61.49	73.39
Second Order	pH	7.5	88	68.22	62.34	74.10
Second Order	pH	7.5	90	69.77	63.89	75.64
Second Order	pH	7.6	92	71.32	65.45	77.18
Second Order	pH	7.6	93	72.09	66.26	77.92
Second Order	pH	7.6	94	72.87	67.17	78.57
Second Order	pH	7.6	95	73.64	68.09	79.19
Second Order	pH	7.6	96	74.42	68.92	79.92
Second Order	pH	7.7	101	78.29	73.27	83.32
Second Order	pH	7.7	103	79.84	74.91	84.78
Second Order	pH	7.8	106	82.17	77.31	87.03
Second Order	pH	7.9	107	82.95	78.29	87.60
Second Order	pH	7.9	108	83.72	79.20	88.24
Second Order	pH	7.9	109	84.50	80.13	88.86
Second Order	pH	7.9	110	85.27	80.98	89.57
Second Order	pH	8.0	113	87.60	83.37	91.82
Second Order	pH	8.0	114	88.37	84.16	92.58
Second Order	pH	8.0	115	89.15	85.00	93.29
Second Order	pH	8.0	116	89.92	85.83	94.01
Second Order	pH	8.1	118	91.47	87.40	95.55
Second Order	pH	8.1	120	93.02	89.28	96.77
Second Order	pH	8.2	121	93.80	90.20	97.40
Second Order	pH	8.3	124	96.12	93.33	98.92
Second Order	pH	8.3	126	97.67	95.43	99.91
Second Order	pH	8.4	127	98.45	96.67	100.00
Second Order	pH	8.4	128	99.22	97.98	100.00
Second Order	pH	8.5	129	100.00	100.00	100.00
Third Order	pH	5.7	1	0.92	0.00	2.41
Third Order	pH	6.2	3	2.75	0.16	5.35
Third Order	pH	6.2	4	3.67	0.83	6.51
Third Order	pH	6.3	5	4.59	1.36	7.81
Third Order	pH	6.5	6	5.50	1.91	9.10
Third Order	pH	6.5	8	7.34	3.35	11.33
Third Order	pH	6.5	9	8.26	4.19	12.33
Third Order	pH	6.6	11	10.09	5.52	14.67
Third Order	pH	6.6	12	11.01	6.37	15.65
Third Order	pH	6.6	13	11.93	7.22	16.63
Third Order	pH	6.6	14	12.84	7.91	17.78
Third Order	pH	6.7	17	15.60	10.39	20.80
Third Order	pH	6.7	18	16.51	11.38	21.64
Third Order	pH	6.8	21	19.27	13.84	24.69
Third Order	pH	6.8	22	20.18	14.63	25.73
Third Order	pH	6.8	23	21.10	15.35	26.85
Third Order	pH	6.8	25	22.94	16.84	29.03

Third Order	pH	6.8	26	23.85	17.77	29.94
Third Order	pH	6.9	27	24.77	18.58	30.97
Third Order	pH	6.9	28	25.69	19.31	32.07
Third Order	pH	6.9	29	26.61	20.36	32.85
Third Order	pH	7.0	30	27.52	21.11	33.94
Third Order	pH	7.0	31	28.44	21.94	34.94
Third Order	pH	7.0	32	29.36	22.72	36.00
Third Order	pH	7.1	33	30.28	23.81	36.74
Third Order	pH	7.1	36	33.03	26.27	39.79
Third Order	pH	7.1	37	33.94	27.10	40.79
Third Order	pH	7.1	38	34.86	27.93	41.79
Third Order	pH	7.2	39	35.78	29.03	42.53
Third Order	pH	7.2	40	36.70	29.91	43.48
Third Order	pH	7.2	41	37.61	30.78	44.45
Third Order	pH	7.2	42	38.53	31.60	45.46
Third Order	pH	7.2	43	39.45	32.60	46.30
Third Order	pH	7.2	44	40.37	33.39	47.34
Third Order	pH	7.2	45	41.28	34.23	48.34
Third Order	pH	7.2	46	42.20	35.17	49.23
Third Order	pH	7.3	48	44.04	37.01	51.07
Third Order	pH	7.3	49	44.95	37.95	51.96
Third Order	pH	7.3	50	45.87	38.85	52.89
Third Order	pH	7.4	52	47.71	40.68	54.73
Third Order	pH	7.4	53	48.62	41.66	55.59
Third Order	pH	7.4	54	49.54	42.61	56.47
Third Order	pH	7.4	55	50.46	43.60	57.32
Third Order	pH	7.4	56	51.38	44.61	58.14
Third Order	pH	7.4	57	52.29	45.63	58.96
Third Order	pH	7.4	58	53.21	46.57	59.86
Third Order	pH	7.4	59	54.13	47.62	60.64
Third Order	pH	7.5	63	57.80	51.70	63.90
Third Order	pH	7.5	64	58.72	52.61	64.82
Third Order	pH	7.6	67	61.47	55.54	67.40
Third Order	pH	7.6	68	62.39	56.57	68.20
Third Order	pH	7.7	69	63.30	57.65	68.96
Third Order	pH	7.7	70	64.22	58.37	70.07
Third Order	pH	7.8	72	66.06	60.54	71.57
Third Order	pH	7.8	73	66.97	61.66	72.28
Third Order	pH	7.8	75	68.81	63.96	73.65
Third Order	pH	7.9	77	70.64	65.44	75.84
Third Order	pH	7.9	78	71.56	66.29	76.83
Third Order	pH	8.0	79	72.48	67.23	77.73
Third Order	pH	8.0	80	73.39	67.97	78.82
Third Order	pH	8.0	82	75.23	69.93	80.53
Third Order	pH	8.0	83	76.15	70.69	81.60
Third Order	pH	8.1	84	77.06	71.61	82.52
Third Order	pH	8.1	89	81.65	76.27	87.03
Third Order	pH	8.2	91	83.49	78.40	88.57
Third Order	pH	8.2	92	84.40	79.14	89.66
Third Order	pH	8.2	93	85.32	80.20	90.44
Third Order	pH	8.2	97	88.99	84.46	93.52
Third Order	pH	8.3	100	91.74	87.48	96.00
Third Order	pH	8.3	102	93.58	89.72	97.44

Third Order	pH	8.3	103	94.50	90.94	98.05
Third Order	pH	8.4	104	95.41	92.18	98.64
Third Order	pH	8.5	105	96.33	93.34	99.32
Third Order	pH	8.5	106	97.25	94.52	99.98
Third Order	pH	8.6	107	98.17	95.97	100.00
Third Order	pH	8.6	108	99.08	97.48	100.00
Third Order	pH	9.0	109	100.00	100.00	100.00
Fourth Order	pH	6.0	2	2.13	0.00	4.69
Fourth Order	pH	6.2	3	3.19	0.00	6.40
Fourth Order	pH	6.3	4	4.26	0.73	7.78
Fourth Order	pH	6.4	5	5.32	1.39	9.25
Fourth Order	pH	6.5	6	6.38	2.25	10.52
Fourth Order	pH	6.5	7	7.45	2.99	11.91
Fourth Order	pH	6.6	8	8.51	4.01	13.01
Fourth Order	pH	6.7	9	9.57	5.09	14.06
Fourth Order	pH	6.7	10	10.64	6.30	14.97
Fourth Order	pH	6.7	11	11.70	7.40	16.01
Fourth Order	pH	6.8	12	12.77	8.59	16.94
Fourth Order	pH	6.8	13	13.83	9.51	18.15
Fourth Order	pH	6.8	14	14.89	10.19	19.60
Fourth Order	pH	6.9	15	15.96	11.37	20.55
Fourth Order	pH	6.9	16	17.02	12.20	21.84
Fourth Order	pH	7.0	19	20.21	14.99	25.43
Fourth Order	pH	7.0	20	21.28	15.87	26.69
Fourth Order	pH	7.0	21	22.34	16.62	28.06
Fourth Order	pH	7.1	24	25.53	19.57	31.49
Fourth Order	pH	7.1	25	26.60	20.57	32.62
Fourth Order	pH	7.1	26	27.66	21.77	33.55
Fourth Order	pH	7.1	27	28.72	22.77	34.67
Fourth Order	pH	7.1	28	29.79	23.87	35.71
Fourth Order	pH	7.2	31	32.98	26.81	39.15
Fourth Order	pH	7.2	34	36.17	30.33	42.01
Fourth Order	pH	7.3	36	38.30	32.72	43.88
Fourth Order	pH	7.3	39	41.49	35.84	47.14
Fourth Order	pH	7.4	41	43.62	38.14	49.10
Fourth Order	pH	7.5	42	44.68	39.15	50.21
Fourth Order	pH	7.5	46	48.94	43.36	54.52
Fourth Order	pH	7.5	47	50.00	44.16	55.84
Fourth Order	pH	7.6	48	51.06	44.93	57.20
Fourth Order	pH	7.6	50	53.19	46.85	59.54
Fourth Order	pH	7.6	51	54.26	47.63	60.88
Fourth Order	pH	7.7	53	56.38	50.11	62.66
Fourth Order	pH	7.7	55	58.51	52.04	64.98
Fourth Order	pH	7.7	56	59.57	53.34	65.81
Fourth Order	pH	7.8	58	61.70	55.64	67.76
Fourth Order	pH	7.8	59	62.77	56.83	68.70
Fourth Order	pH	7.9	60	63.83	57.90	69.76
Fourth Order	pH	7.9	61	64.89	59.05	70.74
Fourth Order	pH	7.9	63	67.02	60.85	73.20
Fourth Order	pH	8.0	64	68.09	61.75	74.42
Fourth Order	pH	8.0	65	69.15	62.67	75.63
Fourth Order	pH	8.1	69	73.40	66.96	79.84
Fourth Order	pH	8.1	70	74.47	67.93	81.01

Fourth Order	pH	8.1	72	76.60	70.51	82.68
Fourth Order	pH	8.1	73	77.66	71.60	83.72
Fourth Order	pH	8.2	74	78.72	72.75	84.70
Fourth Order	pH	8.2	75	79.79	73.96	85.61
Fourth Order	pH	8.2	78	82.98	77.25	88.71
Fourth Order	pH	8.3	79	84.04	78.18	89.91
Fourth Order	pH	8.3	82	87.23	82.04	92.43
Fourth Order	pH	8.4	84	89.36	84.38	94.34
Fourth Order	pH	8.4	87	92.55	88.15	96.96
Fourth Order	pH	8.4	88	93.62	89.55	97.68
Fourth Order	pH	8.4	89	94.68	90.69	98.67
Fourth Order	pH	8.5	90	95.74	92.17	99.32
Fourth Order	pH	8.5	91	96.81	93.80	99.81
Fourth Order	pH	8.6	92	97.87	95.40	100.00
Fourth Order	pH	8.7	93	98.94	97.24	100.00
Fourth Order	pH	8.7	94	100.00	100.00	100.00
Fifth Order	pH	6.2	1	1.79	0.00	4.66
Fifth Order	pH	6.3	2	3.57	0.00	7.77
Fifth Order	pH	6.4	3	5.36	0.13	10.58
Fifth Order	pH	6.4	4	7.14	1.29	12.99
Fifth Order	pH	6.6	5	8.93	2.67	15.18
Fifth Order	pH	6.6	6	10.71	4.46	16.97
Fifth Order	pH	6.7	7	12.50	5.64	19.36
Fifth Order	pH	6.7	8	14.29	7.36	21.21
Fifth Order	pH	6.7	9	16.07	9.17	22.97
Fifth Order	pH	6.8	10	17.86	10.35	25.37
Fifth Order	pH	6.8	11	19.64	11.99	27.29
Fifth Order	pH	6.9	12	21.43	13.81	29.05
Fifth Order	pH	7.0	13	23.21	16.02	30.40
Fifth Order	pH	7.0	16	28.57	20.75	36.39
Fifth Order	pH	7.0	17	30.36	22.07	38.65
Fifth Order	pH	7.0	18	32.14	23.36	40.92
Fifth Order	pH	7.1	19	33.93	25.12	42.74
Fifth Order	pH	7.1	20	35.71	27.48	43.94
Fifth Order	pH	7.2	21	37.50	29.02	45.98
Fifth Order	pH	7.2	22	39.29	31.23	47.35
Fifth Order	pH	7.3	23	41.07	33.54	48.61
Fifth Order	pH	7.3	24	42.86	35.19	50.53
Fifth Order	pH	7.3	25	44.64	36.55	52.74
Fifth Order	pH	7.4	27	48.21	39.72	56.71
Fifth Order	pH	7.4	28	50.00	41.62	58.38
Fifth Order	pH	7.5	29	51.79	43.12	60.45
Fifth Order	pH	7.5	30	53.57	44.73	62.42
Fifth Order	pH	7.6	32	57.14	48.98	65.31
Fifth Order	pH	7.6	33	58.93	51.33	66.53
Fifth Order	pH	7.6	34	60.71	53.26	68.17
Fifth Order	pH	7.6	35	62.50	55.48	69.52
Fifth Order	pH	7.6	36	64.29	57.02	71.55
Fifth Order	pH	7.7	37	66.07	59.43	72.71
Fifth Order	pH	7.7	38	67.86	61.62	74.09
Fifth Order	pH	7.7	39	69.64	63.12	76.17
Fifth Order	pH	7.9	40	71.43	64.31	78.54
Fifth Order	pH	7.9	41	73.21	65.55	80.87

Fifth Order	pH	7.9	42	75.00	67.25	82.75
Fifth Order	pH	7.9	43	76.79	68.74	84.84
Fifth Order	pH	7.9	44	78.57	70.54	86.60
Fifth Order	pH	8.0	45	80.36	71.97	88.75
Fifth Order	pH	8.0	46	82.14	73.92	90.36
Fifth Order	pH	8.0	48	85.71	78.39	93.04
Fifth Order	pH	8.0	49	87.50	80.17	94.83
Fifth Order	pH	8.1	50	89.29	82.47	96.10
Fifth Order	pH	8.1	51	91.07	84.59	97.56
Fifth Order	pH	8.1	52	92.86	87.07	98.64
Fifth Order	pH	8.3	53	94.64	89.26	100.00
Fifth Order	pH	8.3	54	96.43	92.01	100.00
Fifth Order	pH	8.5	55	98.21	95.01	100.00
Fifth Order	pH	8.7	56	100.00	100.00	100.00

## Appendix C. Total Phosphorus Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Increases in Total Phosphorus concentrations have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Total Phosphorus (TP) levels over 0.1 mg/L increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). The case for this increased risk to the aquatic community is presented in this appendix. Figure 18 presents a scatterplot of TP data by VSCI score. Increasing TP concentrations correspond to decreasing VSCI scores. This relationship is further explored throughout Appendix C.

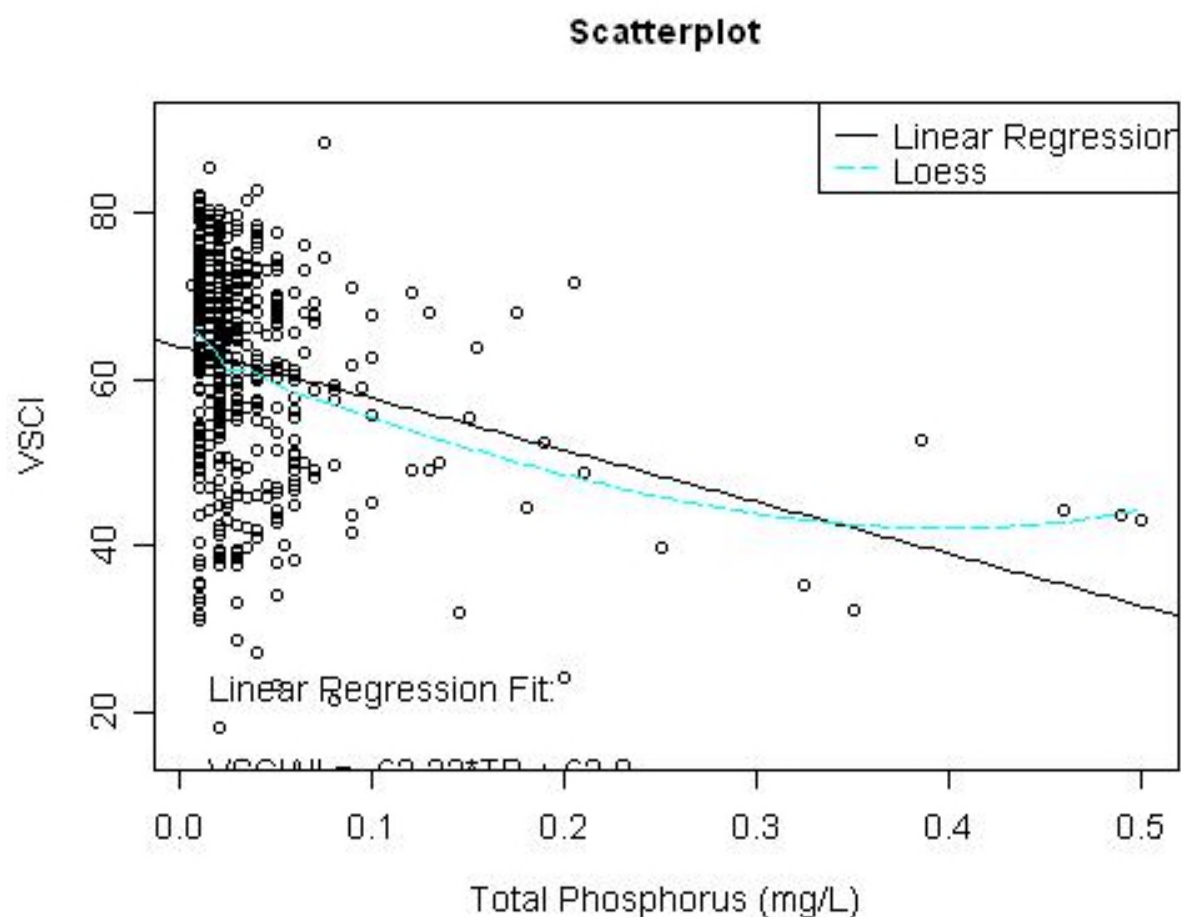


Figure 18. **Stressor Gradient Scatterplot Comparing Increasing Total Phosphorus (mg/L) values to Declining VSCI Scores.**

### *Total Phosphorus Relative Risk Results*

A TP concentration of 0.02 mg/L was selected based on least disturbed conditions in Virginia watersheds and is used as a reference filter to select biotic reference sites (VDEQ, 2006). VDEQ

estimates 50% of Virginia streams have a Total Phosphorus level below 0.02 mg/L (Figure 23). A Total Phosphorus concentration over 0.05 mg/L was considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 19) and scatter plot graphs. An estimated 23% of Virginia streams have a Total Phosphorus above 0.05 mg/L (Figure 20). VDEQ relative risk calculations found that a VSCI score is 3.9 times more likely to be below 50 when the TP is above 0.05 mg/L than when the TP concentration is below 0.02 mg/L (Figure 20).

Table12. Total Phosphorus **Relative Risk Categories**.

Stressor Parameters	Optimal	Suboptimal
Total Phosphorus (mg/L)	<0.02	>0.05

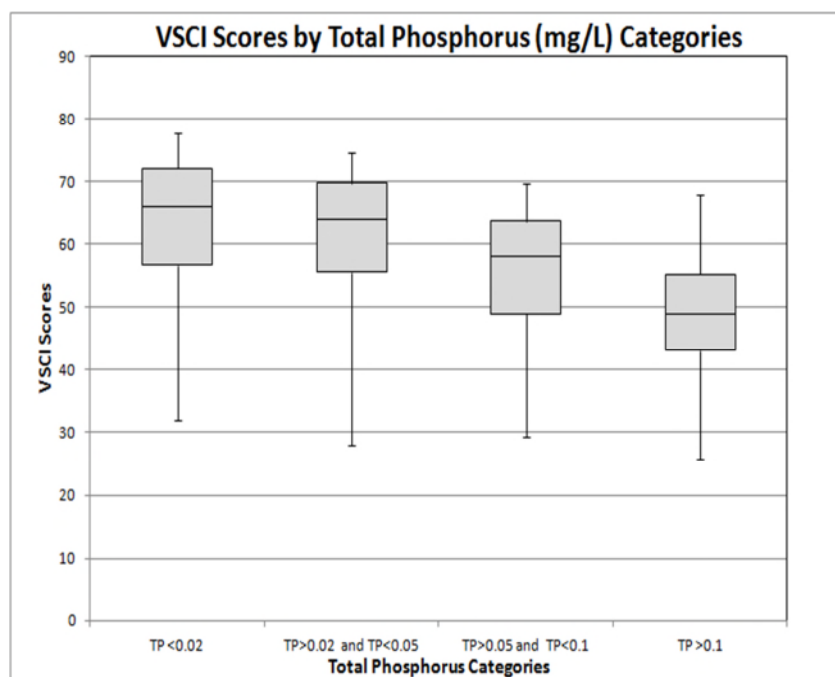
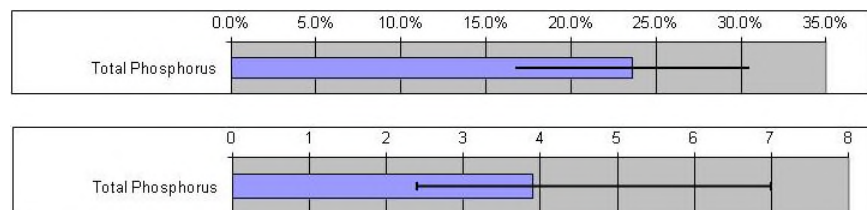


Figure 19. VSCI Scores by Total Phosphorus Categories.

Figure 20. Total Phosphorus Relative Extent and Risk Results.



### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 69 sites with a TP over 0.05 mg/L. Forty-six of 69 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the Total Phosphorus is over 0.05 mg/L is 67% (Figure 21). However, the riparian and instream habitat of a stream can ameliorate nutrient stress. Twenty-three sites have a VSCI above 60 and TP concentration over 0.05 mg/L, but 18 of these sites have Total Habitat scores greater than 130. VDEQ considers a total habitat score of 130 to be in fair condition (VDEQ, 2012). Total Habitat scores below 120 are considered suboptimal while scores above 140 are considered “best available” (VDEQ, 2006). Only 5 sites out of 51 have a passing VSCI score when the Total Phosphorus is over 0.05 mg/L and Total Habitat is greater than 130 (e.g. a 10% pass rate).

The probability of the VSCI score being less than 60 when the TP is over 0.1 mg/L is 76%. Again ‘fair’ stream habitat helps protect aquatic life, only one site out 17 had a VSCI score over 60 when TP is over 0.1 mg/L and Total Habitat is greater than 130 (6% pass rate). One hundred percent of VSCI scores are below the impairment threshold when the TP levels are over 0.21 mg/L, even considering protective riparian and instream habitat scores.

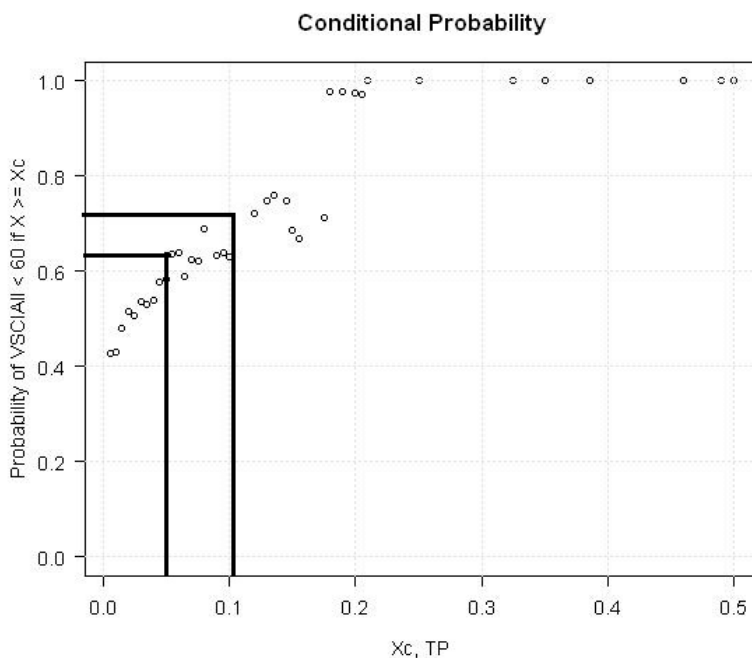


Figure 21. Probability of VSCI less than 60 if Total Phosphorus > 0.05 mg/L and 0.1 mg/L.



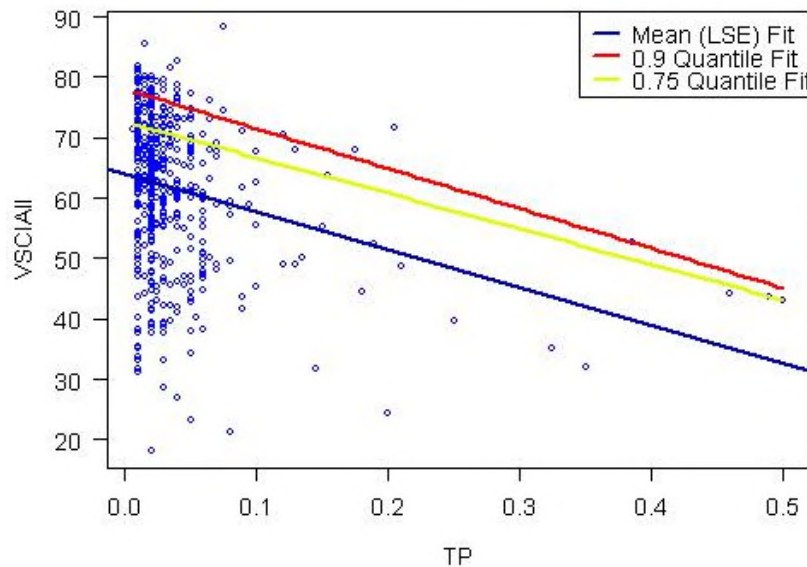


Figure 22. **Quantile Regression VSCI versus Total Phosphorus (mg/L).**

As described in the Appendices Introduction section, quantile regression techniques are used to fit a regression to the 90<sup>th</sup> quantile in order to remove the effects of other stressor variables to biological metrics. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared TP (mg/L) values in Figure 22. The 50<sup>th</sup> percentile of reference crosses at 0.9 mg/L, 25th percentile intersects at 0.18 mg/L, and the 10<sup>th</sup> percentile is equal to 0.27 mg/L. The 50<sup>th</sup> percentile of reference is associated with more protective water chemistry values, while values at the 10<sup>th</sup> percentile tend represent number where the aquatic community is already stressed.

### *Total Phosphorus (mg/L) and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from average Total Phosphorus concentrations less than 0.05 mg/L. Average TP levels above 0.05 mg/L are probable stressors especially in combination with degraded Total Habitat Scores (Total Habitat less than 130). When average TP concentrations exceed 0.1 mg/L there is a high probability that the VSCI will not pass the minimum impairment threshold of 60.

Table12. **Total Phosphorus (mg/L) concentration ranges and associated probability of stress to aquatic life (based on VSCI Scores).**

Total Phosphorus	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 0.1
Medium	> 0.05, < 0.1
Low	> 0.02, < 0.05
None	< 0.02

### *Total Phosphorus Cumulative Distribution Function curves*

Total Phosphorus cumulative distribution function (CDF) curves depict how TP concentrations are distributed. The following figures (23-26) show CDF curves statewide, by super basin, major ecoregion (level III), and stream order. Tables 13-16 correspond to the aforementioned CDF curves.

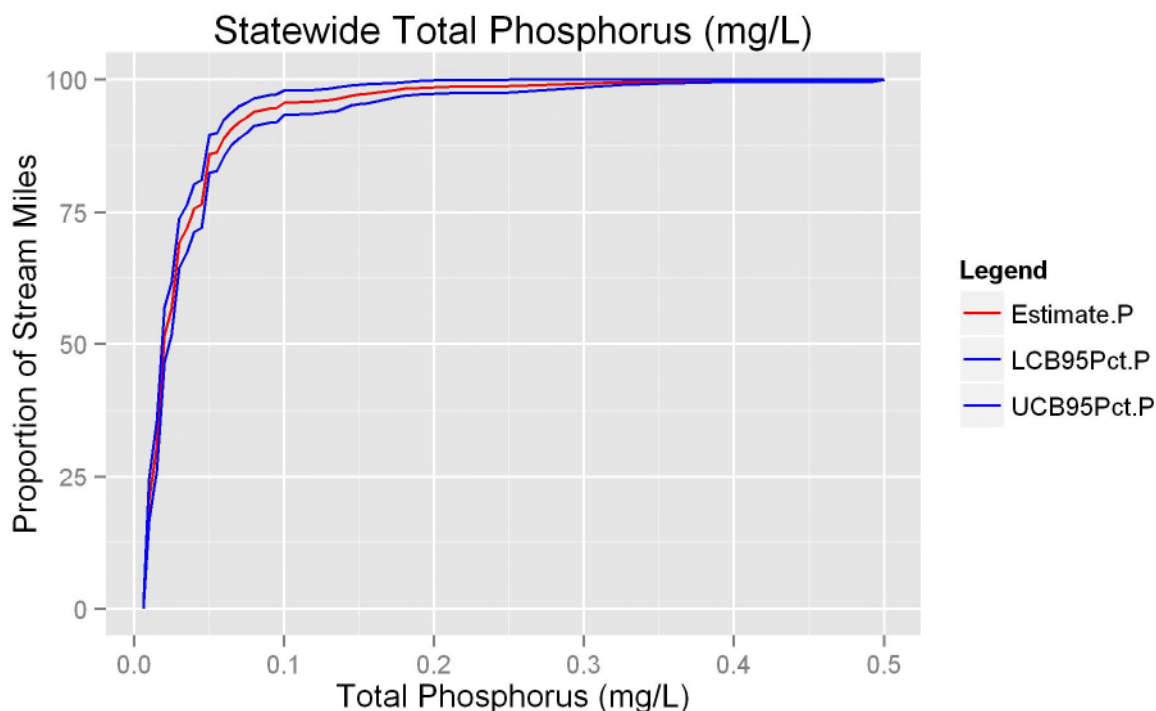


Figure23. **Total Phosphorus Statewide CDF graph.**

Figure 23 is a CDF curve of TP in Virginia. Fifty percent of stream miles in the Commonwealth have TP concentrations less than 0.02 mg/L. Ninety-five percent of streams have TP below 0.065 mg/L. Table 13 presents the percentiles and TP concentrations for Virginia.

Table13. **Statewide Total Phosphorus Population Estimates.**

Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
TP	0.006	1	0.17	0.00	0.47
TP	0.01	102	20.60	16.48	24.72
TP	0.015	137	30.83	26.11	35.55
TP	0.02	235	51.75	46.63	56.87
TP	0.025	263	56.67	51.66	61.69
TP	0.03	315	69.14	64.38	73.90
TP	0.035	333	71.80	67.15	76.44
TP	0.04	363	75.69	71.10	80.28
TP	0.045	369	76.47	71.88	81.06
TP	0.05	401	86.00	82.42	89.57
TP	0.055	403	86.34	82.77	89.90
TP	0.06	422	89.01	85.53	92.49
TP	0.065	427	90.79	87.72	93.86
TP	0.07	434	92.01	89.03	94.99
TP	0.075	436	92.80	90.00	95.61
TP	0.08	441	93.91	91.29	96.53
TP	0.09	445	94.49	91.91	97.08
TP	0.095	446	94.62	92.04	97.19
TP	0.1	450	95.62	93.37	97.87
TP	0.12	452	95.83	93.60	98.07
TP	0.13	454	96.13	93.92	98.33
TP	0.135	455	96.30	94.11	98.49
TP	0.145	456	97.02	95.18	98.85
TP	0.15	457	97.19	95.34	99.03
TP	0.155	458	97.36	95.53	99.18
TP	0.175	459	98.08	96.75	99.41
TP	0.18	460	98.25	96.94	99.55
TP	0.19	461	98.42	97.15	99.69
TP	0.2	462	98.54	97.28	99.80
TP	0.205	463	98.58	97.32	99.84
TP	0.21	464	98.65	97.40	99.91
TP	0.25	465	98.78	97.52	100.00
TP	0.325	466	99.50	99.06	99.94
TP	0.35	467	99.62	99.24	100.00
TP	0.385	468	99.75	99.44	100.00
TP	0.46	469	99.79	99.49	100.00
TP	0.49	470	99.83	99.54	100.00
TP	0.5	471	100.00	100.00	100.00

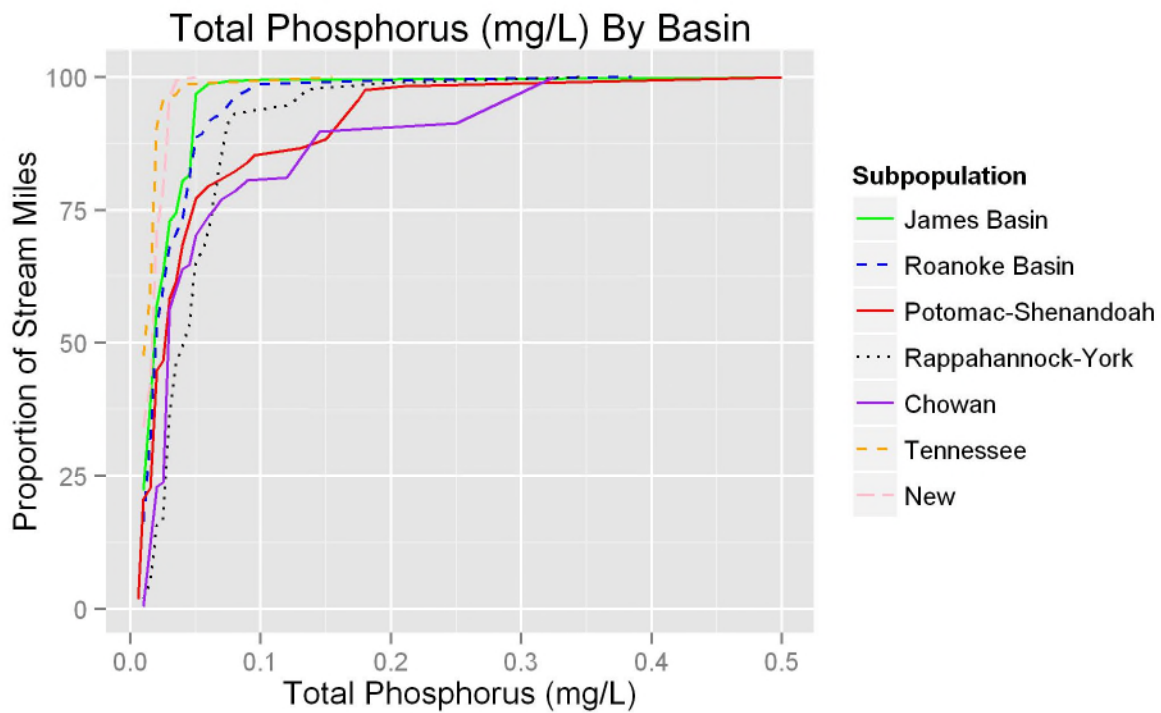


Figure 24. Total Phosphorus by Major Basin CDF graph.

TP concentration CDF curves by super basin are displayed in Figure 24. Fifty percent of stream miles in all basins are below 0.05 mg/L. The super basin TP concentrations vary a bit more at the 75<sup>th</sup> percentile of stream miles. Ninety percent of stream miles in the Tennessee and New River Basins have TP concentrations of 0.025 and 0.03 mg/L, respectively. The Potomac-Shenandoah and Chowan Basins have much higher TP concentrations at the 90<sup>th</sup> percentile (0.17 and 0.25 mg/L, respectively).

Table 14. Total Phosphorus Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	TP	0.01	27	22.19	13.41	30.97
James Basin	TP	0.015	37	38.82	28.60	49.04
James Basin	TP	0.02	64	57.13	46.20	68.06
James Basin	TP	0.025	73	63.31	52.89	73.73
James Basin	TP	0.03	81	72.89	63.47	82.31
James Basin	TP	0.035	86	74.51	65.13	83.89
James Basin	TP	0.04	92	80.54	71.56	89.51
James Basin	TP	0.045	94	81.57	72.65	90.50
James Basin	TP	0.05	104	96.80	95.02	98.57
James Basin	TP	0.06	107	98.80	97.93	99.67
James Basin	TP	0.07	108	98.98	98.18	99.78
James Basin	TP	0.075	109	99.28	98.69	99.87

James Basin	TP	0.1	110	99.46	98.94	99.98
James Basin	TP	0.205	111	99.64	99.19	100.00
James Basin	TP	0.46	112	99.82	99.52	100.00
James Basin	TP	0.49	113	100.00	100.00	100.00
Roanoke Basin	TP	0.01	15	16.31	7.45	25.17
Roanoke Basin	TP	0.015	23	31.95	20.52	43.39
Roanoke Basin	TP	0.02	44	53.00	41.90	64.10
Roanoke Basin	TP	0.025	53	60.45	49.48	71.43
Roanoke Basin	TP	0.03	68	68.60	58.14	79.07
Roanoke Basin	TP	0.035	71	70.50	60.00	81.00
Roanoke Basin	TP	0.04	76	73.38	62.77	83.99
Roanoke Basin	TP	0.05	83	88.61	82.84	94.38
Roanoke Basin	TP	0.055	84	89.40	83.76	95.03
Roanoke Basin	TP	0.06	88	91.74	85.96	97.51
Roanoke Basin	TP	0.065	89	92.52	86.86	98.19
Roanoke Basin	TP	0.07	90	93.09	87.44	98.75
Roanoke Basin	TP	0.08	91	96.42	93.72	99.12
Roanoke Basin	TP	0.09	93	97.53	95.27	99.79
Roanoke Basin	TP	0.1	95	98.64	96.96	100.00
Roanoke Basin	TP	0.19	96	99.43	98.40	100.00
Roanoke Basin	TP	0.385	97	100.00	100.00	100.00
Potomac-Shenandoah	TP	0.006	1	1.76	0.00	4.83
Potomac-Shenandoah	TP	0.01	10	20.72	9.69	31.74
Potomac-Shenandoah	TP	0.015	12	22.72	11.24	34.20
Potomac-Shenandoah	TP	0.02	19	44.87	28.45	61.29
Potomac-Shenandoah	TP	0.025	20	46.63	30.19	63.07
Potomac-Shenandoah	TP	0.03	24	58.31	42.76	73.85
Potomac-Shenandoah	TP	0.035	27	61.52	45.98	77.05
Potomac-Shenandoah	TP	0.04	32	68.50	53.81	83.19
Potomac-Shenandoah	TP	0.05	35	77.09	63.86	90.32
Potomac-Shenandoah	TP	0.06	38	79.52	66.29	92.75
Potomac-Shenandoah	TP	0.07	39	80.80	67.63	93.97
Potomac-Shenandoah	TP	0.08	41	82.25	69.16	95.34
Potomac-Shenandoah	TP	0.09	42	84.01	71.10	96.92
Potomac-Shenandoah	TP	0.095	43	85.29	72.51	98.06
Potomac-Shenandoah	TP	0.13	44	86.56	74.00	99.12
Potomac-Shenandoah	TP	0.15	45	88.32	75.58	100.00
Potomac-Shenandoah	TP	0.175	46	95.76	91.49	100.00
Potomac-Shenandoah	TP	0.18	47	97.52	94.20	100.00
Potomac-Shenandoah	TP	0.21	48	98.24	95.23	100.00
Potomac-Shenandoah	TP	0.5	49	100.00	100.00	100.00
Rappahannock-York	TP	0.01	2	1.93	0.00	4.58
Rappahannock-York	TP	0.015	4	5.03	0.60	9.45
Rappahannock-York	TP	0.02	9	15.70	4.41	26.99
Rappahannock-York	TP	0.025	11	16.72	5.25	28.19
Rappahannock-York	TP	0.03	22	36.19	20.81	51.57
Rappahannock-York	TP	0.035	26	46.12	30.16	62.09
Rappahannock-York	TP	0.04	31	49.28	33.14	65.43
Rappahannock-York	TP	0.045	34	53.51	37.41	69.61
Rappahannock-York	TP	0.05	40	65.63	50.70	80.56
Rappahannock-York	TP	0.055	41	67.18	52.18	82.17
Rappahannock-York	TP	0.06	45	71.30	55.86	86.73
Rappahannock-York	TP	0.065	47	78.23	65.81	90.65

Rappahannock-York	TP	0.07	49	85.42	75.47	95.37
Rappahannock-York	TP	0.075	50	91.97	86.63	97.31
Rappahannock-York	TP	0.08	51	93.10	88.00	98.20
Rappahannock-York	TP	0.12	52	94.65	90.17	99.13
Rappahannock-York	TP	0.13	53	96.20	92.59	99.80
Rappahannock-York	TP	0.135	54	97.75	95.13	100.00
Rappahannock-York	TP	0.2	55	98.87	96.86	100.00
Rappahannock-York	TP	0.35	56	100.00	100.00	100.00
Chowan	TP	0.01	1	0.50	0.00	1.40
Chowan	TP	0.02	9	22.91	4.31	41.50
Chowan	TP	0.025	10	23.76	5.07	42.44
Chowan	TP	0.03	19	56.42	36.75	76.08
Chowan	TP	0.04	26	63.82	44.72	82.93
Chowan	TP	0.045	27	64.67	45.69	83.66
Chowan	TP	0.05	32	70.25	51.51	88.98
Chowan	TP	0.06	36	73.81	55.10	92.52
Chowan	TP	0.065	37	75.31	56.69	93.93
Chowan	TP	0.07	39	77.04	58.51	95.58
Chowan	TP	0.08	40	78.54	60.07	97.01
Chowan	TP	0.09	41	80.60	62.12	99.07
Chowan	TP	0.12	42	81.10	62.59	99.62
Chowan	TP	0.145	43	89.80	76.54	100.00
Chowan	TP	0.25	44	91.30	77.91	100.00
Chowan	TP	0.325	45	100.00	100.00	100.00
Tennessee	TP	0.01	26	47.64	32.83	62.45
Tennessee	TP	0.015	36	59.85	46.16	73.54
Tennessee	TP	0.02	54	90.71	84.85	96.57
Tennessee	TP	0.025	58	95.75	91.94	99.57
Tennessee	TP	0.035	59	96.74	93.32	100.00
Tennessee	TP	0.04	61	98.65	96.49	100.00
Tennessee	TP	0.155	62	100.00	100.00	100.00
New	TP	0.01	21	34.17	18.16	50.18
New	TP	0.015	24	42.71	25.13	60.29
New	TP	0.02	36	71.20	54.97	87.43
New	TP	0.025	38	79.52	65.84	93.20
New	TP	0.03	42	96.16	92.15	100.00
New	TP	0.035	44	99.34	98.15	100.00
New	TP	0.05	45	100.00	100.00	100.00

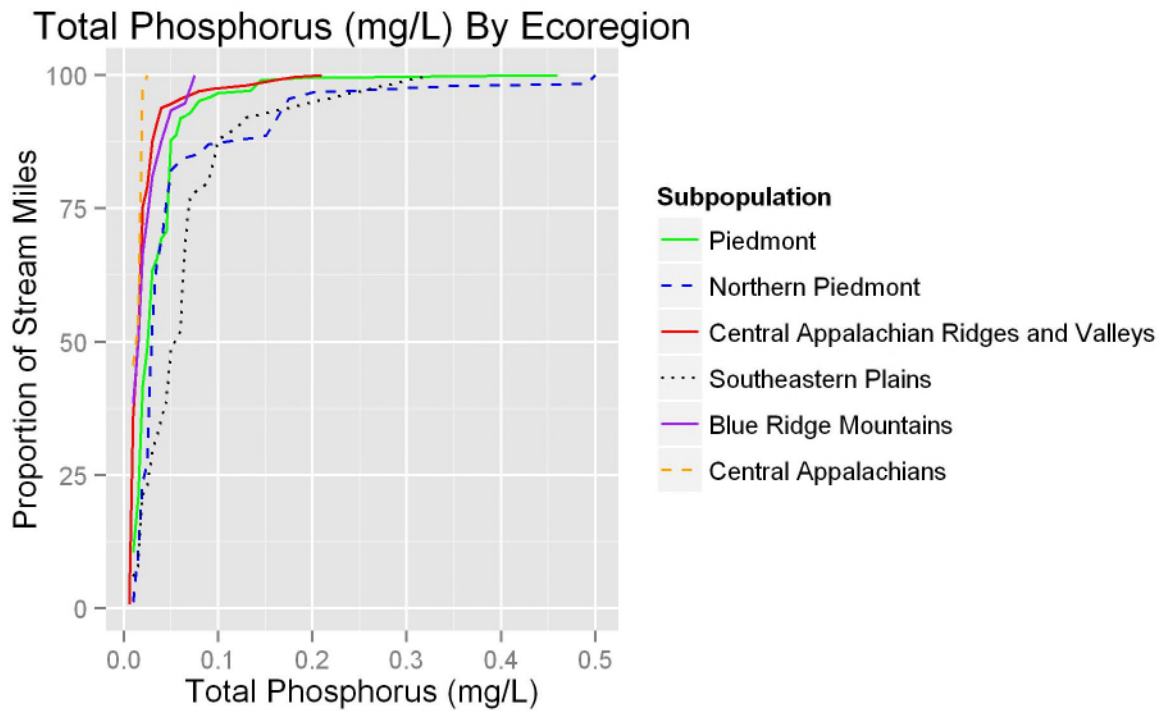


Figure 25. Total Phosphorus by Major Ecoregion (Level III) CDF graph.

Level III Ecoregions by TP concentration CDF curves are shown in Figure 25. The Southeastern Plains show that 50% of stream miles have TP concentrations less than 0.06 mg/L. The 50<sup>th</sup> percentile for the Central Appalachians Ridges and Valleys, Central Appalachians, and Blue Ridge Mountains is 0.015 mg/L. The Piedmont ecoregion's 50<sup>th</sup> percentile is just over 0.025 mg/L. Fifty percent of Northern Piedmont streams are less than 0.03 mg/L. See Table 15 for additional TP information by ecoregion.

Table 15. Total Phosphorus Population Estimates by Major Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	TP	0.01	17	10.52	4.90	16.14
Piedmont	TP	0.015	27	20.78	13.48	28.07
Piedmont	TP	0.02	63	41.77	33.10	50.44
Piedmont	TP	0.025	77	48.74	40.08	57.39
Piedmont	TP	0.03	103	63.44	55.12	71.76
Piedmont	TP	0.035	111	65.58	57.33	73.82
Piedmont	TP	0.04	123	69.40	61.15	77.66
Piedmont	TP	0.045	127	70.70	62.46	78.94
Piedmont	TP	0.05	146	87.73	82.66	92.80
Piedmont	TP	0.055	148	88.65	83.65	93.65
Piedmont	TP	0.06	157	91.91	87.23	96.59
Piedmont	TP	0.065	158	92.24	87.60	96.88
Piedmont	TP	0.07	160	92.91	88.32	97.50

Piedmont	TP	0.08	162	95.18	91.47	98.89
Piedmont	TP	0.09	164	95.83	92.22	99.43
Piedmont	TP	0.1	167	96.59	93.08	100.00
Piedmont	TP	0.135	168	97.05	93.62	100.00
Piedmont	TP	0.145	169	98.98	97.98	99.99
Piedmont	TP	0.19	170	99.44	98.80	100.00
Piedmont	TP	0.205	171	99.55	98.93	100.00
Piedmont	TP	0.385	172	99.89	99.70	100.00
Piedmont	TP	0.46	173	100.00	100.00	100.00
Northern Piedmont	TP	0.01	1	1.19	0.00	3.18
Northern Piedmont	TP	0.015	4	10.47	0.20	20.75
Northern Piedmont	TP	0.02	14	23.64	11.35	35.92
Northern Piedmont	TP	0.025	18	27.04	14.37	39.71
Northern Piedmont	TP	0.03	29	53.98	38.56	69.39
Northern Piedmont	TP	0.035	34	65.13	50.70	79.55
Northern Piedmont	TP	0.04	37	68.82	54.81	82.82
Northern Piedmont	TP	0.05	44	82.08	70.27	93.89
Northern Piedmont	TP	0.06	46	84.13	72.42	95.83
Northern Piedmont	TP	0.08	47	85.32	73.65	96.99
Northern Piedmont	TP	0.09	48	86.97	75.37	98.56
Northern Piedmont	TP	0.15	49	88.61	76.74	100.00
Northern Piedmont	TP	0.175	50	95.56	91.40	99.72
Northern Piedmont	TP	0.2	51	96.76	93.05	100.00
Northern Piedmont	TP	0.35	52	97.95	94.96	100.00
Northern Piedmont	TP	0.49	53	98.36	95.47	100.00
Northern Piedmont	TP	0.5	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	TP	0.006	1	0.79	0.00	2.17
Central Appalachian Ridges and Valleys	TP	0.01	53	35.99	26.60	45.38
Central Appalachian Ridges and Valleys	TP	0.015	66	50.92	40.83	61.02
Central Appalachian Ridges and Valleys	TP	0.02	95	75.44	67.00	83.88
Central Appalachian Ridges and Valleys	TP	0.025	101	78.94	70.75	87.14
Central Appalachian Ridges and Valleys	TP	0.03	107	87.65	82.87	92.43
Central Appalachian Ridges and Valleys	TP	0.035	112	90.93	87.04	94.82
Central Appalachian Ridges and Valleys	TP	0.04	117	93.83	90.96	96.69
Central Appalachian Ridges and Valleys	TP	0.05	118	94.62	92.18	97.05
Central Appalachian Ridges and Valleys	TP	0.06	120	95.52	93.05	97.99
Central Appalachian Ridges and Valleys	TP	0.07	122	96.29	93.99	98.59
Central Appalachian Ridges and Valleys	TP	0.08	124	96.94	94.69	99.19
Central Appalachian Ridges and Valleys	TP	0.095	125	97.52	95.41	99.62
Central Appalachian Ridges and Valleys	TP	0.13	126	98.09	96.27	99.91
Central Appalachian Ridges and Valleys	TP	0.155	127	98.88	97.58	100.00
Central Appalachian Ridges and Valleys	TP	0.18	128	99.67	99.11	100.00
Central Appalachian Ridges and Valleys	TP	0.21	129	100.00	100.00	100.00
Southeastern Plains	TP	0.01	4	6.09	0.32	11.85
Southeastern Plains	TP	0.015	5	7.96	1.51	14.41
Southeastern Plains	TP	0.02	10	21.22	6.92	35.53
Southeastern Plains	TP	0.025	11	23.10	8.66	37.55
Southeastern Plains	TP	0.03	16	29.21	13.89	44.52
Southeastern Plains	TP	0.04	24	35.58	19.32	51.85
Southeastern Plains	TP	0.045	26	38.82	22.09	55.55
Southeastern Plains	TP	0.05	29	48.33	30.43	66.23
Southeastern Plains	TP	0.06	34	52.04	33.00	71.09
Southeastern Plains	TP	0.065	37	68.36	53.48	83.24



Southeastern Plains	TP	0.07	40	77.28	61.05	93.52
Southeastern Plains	TP	0.075	41	78.06	61.79	94.32
Southeastern Plains	TP	0.09	42	79.93	63.63	96.23
Southeastern Plains	TP	0.1	43	87.86	75.37	100.00
Southeastern Plains	TP	0.12	45	90.19	77.76	100.00
Southeastern Plains	TP	0.13	46	92.07	79.85	100.00
Southeastern Plains	TP	0.325	47	100.00	100.00	100.00
Blue Ridge Mountains	TP	0.01	12	38.34	21.20	55.48
Blue Ridge Mountains	TP	0.015	15	49.88	33.65	66.11
Blue Ridge Mountains	TP	0.02	24	66.63	51.27	81.99
Blue Ridge Mountains	TP	0.025	26	73.20	59.21	87.20
Blue Ridge Mountains	TP	0.03	29	81.03	69.30	92.76
Blue Ridge Mountains	TP	0.04	31	87.60	76.38	98.82
Blue Ridge Mountains	TP	0.05	33	93.43	85.81	100.00
Blue Ridge Mountains	TP	0.065	34	94.69	87.40	100.00
Blue Ridge Mountains	TP	0.075	35	100.00	100.00	100.00
Central Appalachians	TP	0.01	15	45.48	26.32	64.63
Central Appalachians	TP	0.015	20	53.06	34.82	71.30
Central Appalachians	TP	0.02	29	97.47	93.13	100.00
Central Appalachians	TP	0.025	30	100.00	100.00	100.00

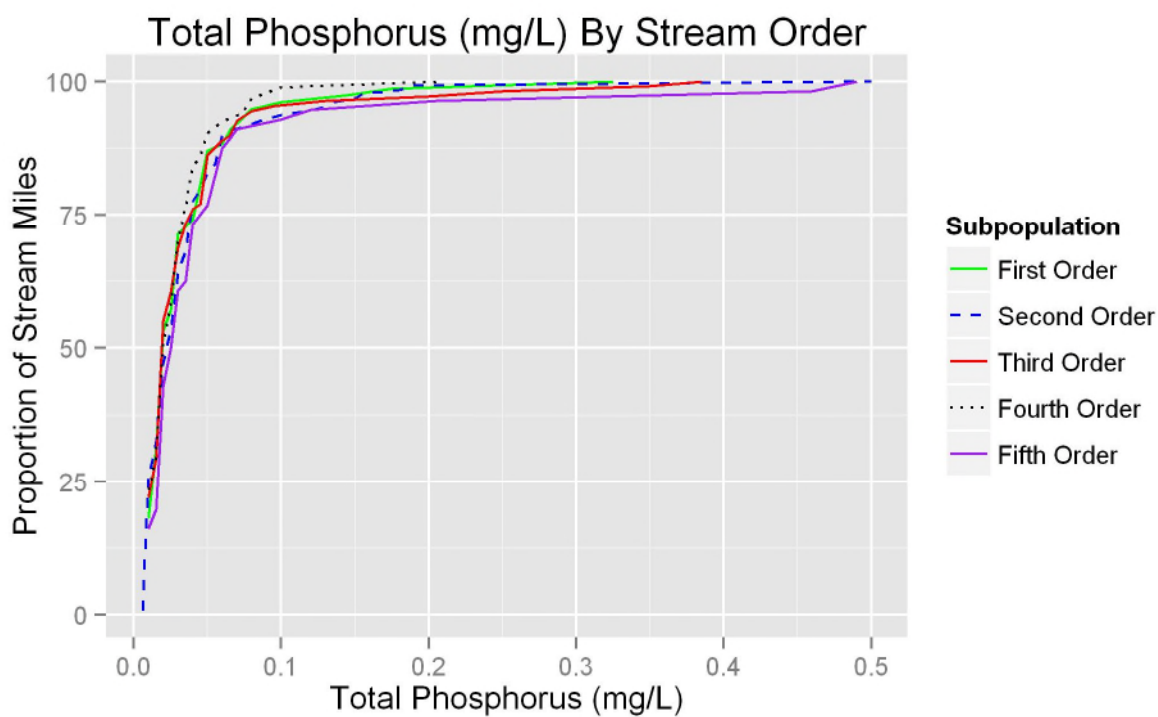


Figure 26. Total Phosphorus by Stream Order CDF graph.

As shown in Figure 26 and Table 16, TP CDFs are similar across first through fifth order streams. Ninety percent of stream miles for all stream orders except fourth order are 0.065 mg/L TP.

Ninety percent of fourth order streams have TP concentrations less than 0.05 mg/L. The 50<sup>th</sup> percentile for all stream orders ranged from 0.02 to 0.025 mg/L TP.

**Table 16. Total Phosphorus Population Estimates by Stream Order.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	TP	0.01	14	18.18	11.24	25.13
First Order	TP	0.015	24	31.17	23.08	39.25
First Order	TP	0.02	41	53.25	44.62	61.88
First Order	TP	0.025	44	57.14	49.02	65.26
First Order	TP	0.03	55	71.43	63.64	79.22
First Order	TP	0.035	56	72.73	65.05	80.41
First Order	TP	0.04	57	74.03	66.27	81.78
First Order	TP	0.05	67	87.01	81.39	92.63
First Order	TP	0.06	68	88.31	82.67	93.95
First Order	TP	0.065	70	90.91	85.57	96.25
First Order	TP	0.07	71	92.21	87.02	97.39
First Order	TP	0.075	72	93.51	88.76	98.26
First Order	TP	0.08	73	94.81	90.45	99.16
First Order	TP	0.1	74	96.10	92.35	99.86
First Order	TP	0.145	75	97.40	94.34	100.00
First Order	TP	0.175	76	98.70	96.60	100.00
First Order	TP	0.325	77	100.00	100.00	100.00
Second Order	TP	0.006	1	0.78	0.00	2.06
Second Order	TP	0.01	33	25.58	19.49	31.67
Second Order	TP	0.015	42	32.56	25.79	39.32
Second Order	TP	0.02	61	47.29	40.05	54.52
Second Order	TP	0.025	69	53.49	46.44	60.54
Second Order	TP	0.03	83	64.34	57.45	71.24
Second Order	TP	0.035	88	68.22	61.61	74.82
Second Order	TP	0.04	100	77.52	71.52	83.52
Second Order	TP	0.045	103	79.84	74.00	85.69
Second Order	TP	0.05	107	82.95	77.59	88.30
Second Order	TP	0.055	109	84.50	79.23	89.76
Second Order	TP	0.06	116	89.92	85.53	94.31
Second Order	TP	0.065	117	90.70	86.49	94.91
Second Order	TP	0.09	120	93.02	89.28	96.77
Second Order	TP	0.1	121	93.80	90.32	97.28
Second Order	TP	0.12	122	94.57	91.22	97.93
Second Order	TP	0.13	123	95.35	92.24	98.46
Second Order	TP	0.135	124	96.12	93.28	98.97
Second Order	TP	0.15	125	96.90	94.31	99.49
Second Order	TP	0.155	126	97.67	95.41	99.94
Second Order	TP	0.18	127	98.45	96.61	100.00
Second Order	TP	0.19	128	99.22	97.89	100.00
Second Order	TP	0.5	129	100.00	100.00	100.00
Third Order	TP	0.01	24	22.02	15.82	28.22
Third Order	TP	0.015	32	29.36	22.78	35.94
Third Order	TP	0.02	60	55.05	49.06	61.03
Third Order	TP	0.025	66	60.55	54.72	66.38
Third Order	TP	0.03	75	68.81	62.98	74.63
Third Order	TP	0.035	80	73.39	67.66	79.13

Third Order	TP	0.04	83	76.15	70.64	81.65
Third Order	TP	0.045	84	77.06	71.74	82.39
Third Order	TP	0.05	94	86.24	81.24	91.23
Third Order	TP	0.06	97	88.99	84.50	93.48
Third Order	TP	0.065	98	89.91	85.48	94.34
Third Order	TP	0.07	101	92.66	88.77	96.55
Third Order	TP	0.08	103	94.50	91.07	97.92
Third Order	TP	0.095	104	95.41	92.05	98.78
Third Order	TP	0.13	105	96.33	93.31	99.36
Third Order	TP	0.2	106	97.25	94.53	99.96
Third Order	TP	0.25	107	98.17	95.88	100.00
Third Order	TP	0.35	108	99.08	97.52	100.00
Third Order	TP	0.385	109	100.00	100.00	100.00
Fourth Order	TP	0.01	22	23.40	17.52	29.29
Fourth Order	TP	0.015	28	29.79	23.93	35.65
Fourth Order	TP	0.02	48	51.06	43.99	58.14
Fourth Order	TP	0.025	55	58.51	51.44	65.58
Fourth Order	TP	0.03	66	70.21	63.08	77.34
Fourth Order	TP	0.035	72	76.60	69.93	83.27
Fourth Order	TP	0.04	79	84.04	78.18	89.90
Fourth Order	TP	0.045	81	86.17	80.62	91.72
Fourth Order	TP	0.05	85	90.43	85.56	95.29
Fourth Order	TP	0.06	87	92.55	88.08	97.02
Fourth Order	TP	0.07	88	93.62	89.47	97.76
Fourth Order	TP	0.075	89	94.68	90.91	98.45
Fourth Order	TP	0.08	91	96.81	93.89	99.73
Fourth Order	TP	0.09	92	97.87	95.26	100.00
Fourth Order	TP	0.1	93	98.94	97.08	100.00
Fourth Order	TP	0.21	94	100.00	100.00	100.00
Fifth Order	TP	0.01	9	16.07	7.99	24.16
Fifth Order	TP	0.015	11	19.64	11.27	28.02
Fifth Order	TP	0.02	24	42.86	34.40	51.32
Fifth Order	TP	0.025	28	50.00	41.12	58.88
Fifth Order	TP	0.03	34	60.71	52.98	68.45
Fifth Order	TP	0.035	35	62.50	54.97	70.03
Fifth Order	TP	0.04	41	73.21	65.26	81.17
Fifth Order	TP	0.05	43	76.79	69.57	84.00
Fifth Order	TP	0.06	49	87.50	82.08	92.92
Fifth Order	TP	0.065	50	89.29	84.88	93.69
Fifth Order	TP	0.07	51	91.07	87.72	94.42
Fifth Order	TP	0.1	52	92.86	88.77	96.95
Fifth Order	TP	0.12	53	94.64	91.76	97.52
Fifth Order	TP	0.205	54	96.43	93.00	99.86
Fifth Order	TP	0.46	55	98.21	95.33	100.00
Fifth Order	TP	0.49	56	100.00	100.00	100.00

## Appendix D. Total Nitrogen Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Total Nitrogen levels over 2 mg/L increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). Total Nitrogen (TN) versus VSCI is shown on the scatterplot in Figure 27. Based on Figure 27, VSCI scores decrease with increasing TN concentrations. Additional exploration of this relationship and the case for this increased risk to aquatic communities are presented in Appendix D.

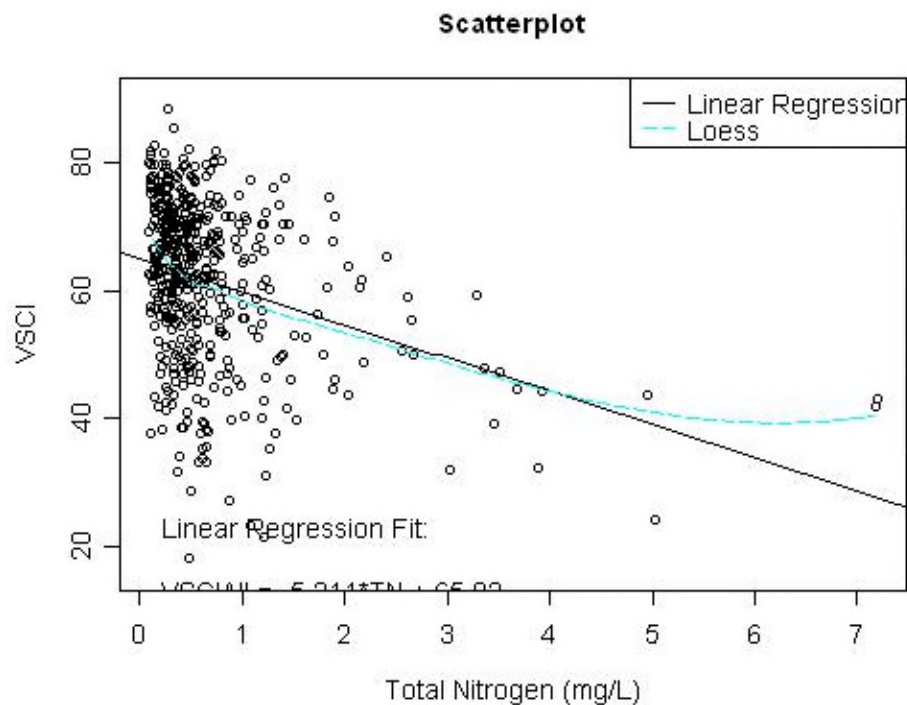


Figure 27. Stressor Gradient Scatterplot Comparing Increasing Total Nitrogen (mg/L) values to Declining VSCI Scores.

### *Total Nitrogen Relative Risk Results*

An optimal TN level of less than 1 mg/L was selected based on least disturbed conditions in Virginia watersheds and is used as a reference filter to select biotic reference sites (VDEQ, 2006). VDEQ estimates 84% of Virginia streams have a Total Nitrogen level below 1 mg/L (Figure 32). TN concentrations over 2 mg/L are considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 28) and scatterplot graphs. An estimated 5.7% of Virginia streams have a Total Nitrogen above 2 mg/L (Figure 29). VDEQ relative risk calculations found that a VSCI score is 3.4 times more likely to be below 50 when the TN is above 2 mg/L than when the TN concentration is below 1 mg/L (Figure 29).

Table 17. Total Nitrogen Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Total Nitrogen (mg/L)	< 1	> 2

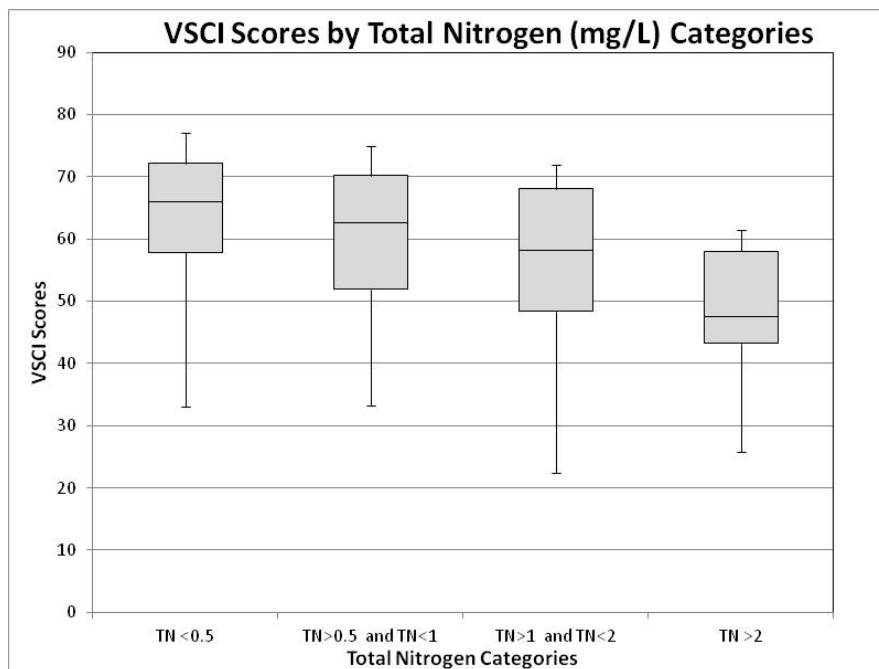


Figure 28. VSCI Scores by Total Nitrogen Categories.

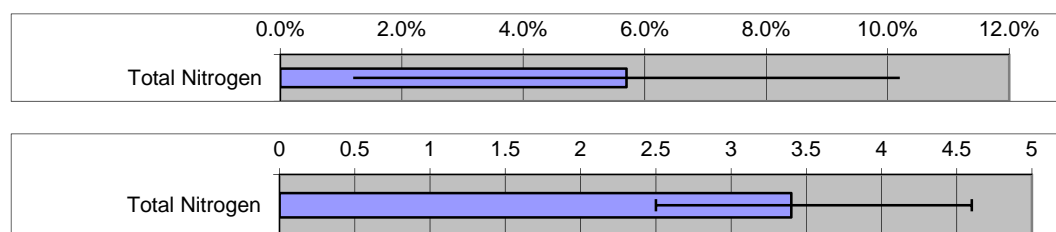


Figure 29. Total Nitrogen Relative Extent and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 22 sites with a Total Nitrogen over 2 mg/L. Eighteen of 22 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the Total Nitrogen is over 2 mg/L is 82% (Figure 29). The probability of the VSCI score being less than 60 when the TN is over 3 mg/L is 100%, regardless of the protection that riparian vegetation and instream habitat provides.

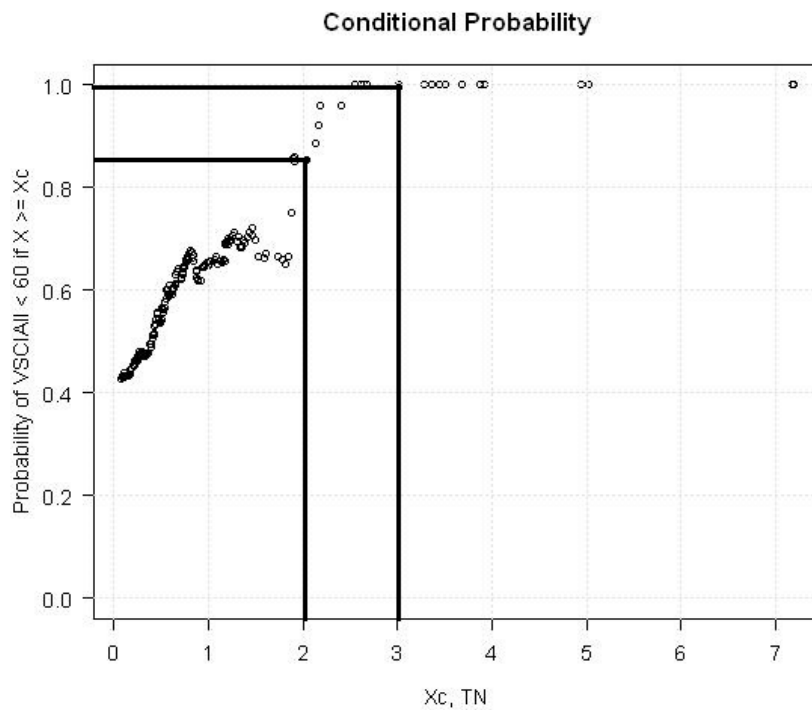


Figure 30. Probability of VSCI less than 60 if Total Nitrogen >2 mg/L and >3 mg/L.

Figure 30 shows TN conditional probability. The probability of streams having an impaired benthic community when TN is greater than 3 mg/L is 100%. The probability of VSCI scores below 60 when TN is greater than 2 mg/L is 85%.

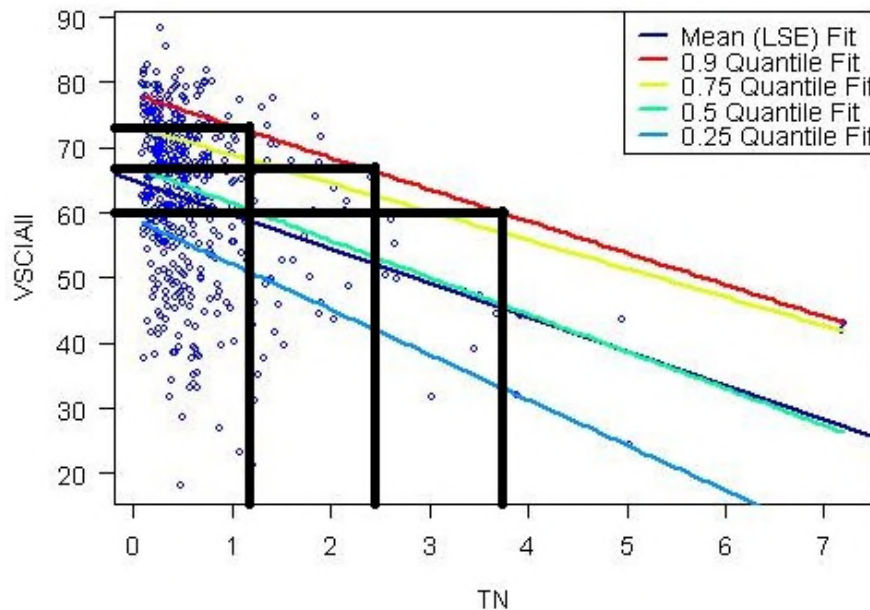


Figure 31. **Quantile Regression VSCI versus Total Nitrogen (mg/L).**

Quantile regression techniques are used to fit a regression to the 90<sup>th</sup> quantile in order to remove the effects of other stressor variables to biological metrics. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to TN values. The 50<sup>th</sup> percentile of percentile of reference crosses at 1.28 mg/L, 25th percentile intersects at 2.51 mg/L, and the 10<sup>th</sup> percentile is equal to 3.74 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend represent number where the aquatic community is already stressed.

### *Total Nitrogen (mg/L) and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from average TN concentrations less than 1 mg/L. Average Total Nitrogen levels above 2 mg/L are probable stressors especially in combination with degraded Total Habitat Scores. When Average TN concentrations exceed 3 mg/L there is a high probability that the VSCI will not pass the minimum attainment threshold of 60.

Table 18. Total Nitrogen (mg/L) concentrations and associated probability of stress to aquatic life (based on VSCI scores).

Total Nitrogen	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 2
Medium	> 1, < 2
Low	> 0.5, < 1
None	< 0.5

### *Total Nitrogen Cumulative Distribution Function curves*

Total Nitrogen cumulative distribution function (CDF) curves are shown in the following four figures (32-35). The CDF curves illustrate TN distribution statewide, by super basin, Level III ecoregion, and stream order. Tables 19-22 correspond to the figures.

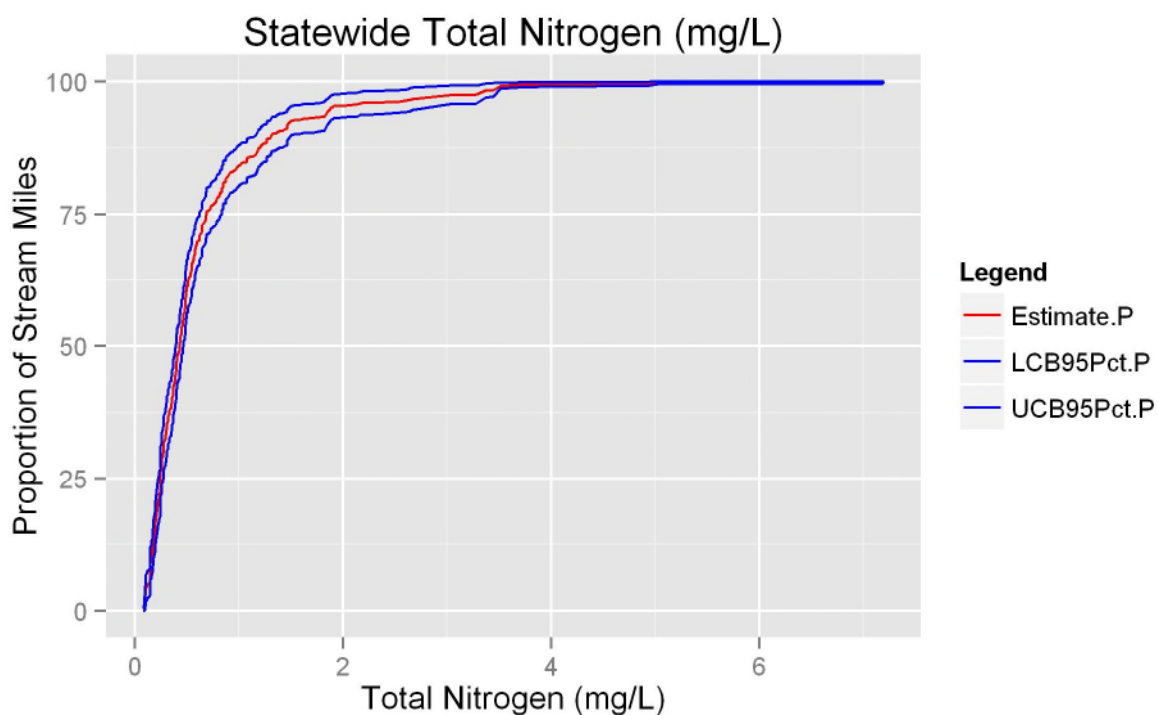


Figure 32. Total Nitrogen Statewide CDF graph.

Figure 32 displays statewide distributions of TN. In Virginia, 50% of stream miles are estimated to have TN concentrations less than 0.43 mg/L. Ninety percent of stream miles have TN concentrations less than 1.32 mg/L. Table 19 corresponds to Figure 32.



Table 19. Statewide Total Nitrogen Population Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	TN	0.08	1	0.17	0.00	0.45
Virginia	TN	0.09	2	0.34	0.00	0.74
Virginia	TN	0.09	3	0.51	0.01	1.01
Virginia	TN	0.10	5	1.36	0.03	2.68
Virginia	TN	0.10	11	2.83	0.98	4.69
Virginia	TN	0.11	13	4.28	1.78	6.77
Virginia	TN	0.11	14	4.45	1.94	6.95
Virginia	TN	0.12	16	4.74	2.21	7.27
Virginia	TN	0.12	17	4.86	2.33	7.40
Virginia	TN	0.13	18	4.99	2.45	7.53
Virginia	TN	0.14	21	5.31	2.76	7.85
Virginia	TN	0.15	38	9.00	5.93	12.07
Virginia	TN	0.16	39	9.13	6.05	12.21
Virginia	TN	0.16	41	10.02	6.78	13.26
Virginia	TN	0.17	44	10.31	7.06	13.55
Virginia	TN	0.18	48	11.89	8.40	15.38
Virginia	TN	0.18	56	13.62	9.95	17.28
Virginia	TN	0.19	60	14.67	10.88	18.46
Virginia	TN	0.20	66	16.75	12.72	20.77
Virginia	TN	0.21	72	18.65	14.40	22.89
Virginia	TN	0.22	78	20.52	16.09	24.96
Virginia	TN	0.23	79	20.59	16.16	25.03
Virginia	TN	0.23	82	21.06	16.61	25.51
Virginia	TN	0.24	84	21.95	17.41	26.49
Virginia	TN	0.24	86	22.29	17.74	26.84
Virginia	TN	0.25	87	22.41	17.86	26.97
Virginia	TN	0.25	102	26.45	21.66	31.24
Virginia	TN	0.26	103	26.62	21.83	31.42
Virginia	TN	0.26	111	28.86	23.89	33.84
Virginia	TN	0.27	113	29.16	24.17	34.14
Virginia	TN	0.27	119	29.85	24.85	34.85
Virginia	TN	0.28	121	31.29	26.25	36.33
Virginia	TN	0.28	127	31.87	26.82	36.92
Virginia	TN	0.29	129	32.16	27.11	37.22
Virginia	TN	0.29	132	32.50	27.45	37.55
Virginia	TN	0.30	141	34.03	28.91	39.15
Virginia	TN	0.31	142	34.16	29.03	39.28
Virginia	TN	0.31	149	35.50	30.36	40.65
Virginia	TN	0.32	150	35.68	30.52	40.83
Virginia	TN	0.32	154	36.81	31.65	41.97
Virginia	TN	0.33	156	37.05	31.90	42.20
Virginia	TN	0.34	158	37.94	32.78	43.10
Virginia	TN	0.34	160	38.18	33.01	43.35
Virginia	TN	0.35	161	38.25	33.08	43.42
Virginia	TN	0.35	168	39.12	33.98	44.26
Virginia	TN	0.36	173	40.37	35.23	45.52
Virginia	TN	0.37	175	40.49	35.34	45.63
Virginia	TN	0.37	183	42.45	37.26	47.63
Virginia	TN	0.38	187	43.37	38.17	48.57
Virginia	TN	0.39	190	44.43	39.21	49.66

Virginia	TN	0.40	191	45.15	39.90	50.41
Virginia	TN	0.40	197	47.13	41.91	52.35
Virginia	TN	0.41	203	48.26	43.05	53.46
Virginia	TN	0.42	209	48.78	43.59	53.96
Virginia	TN	0.43	210	48.90	43.71	54.09
Virginia	TN	0.43	216	50.79	45.55	56.04
Virginia	TN	0.44	217	50.86	45.63	56.10
Virginia	TN	0.44	222	51.97	46.77	57.17
Virginia	TN	0.45	224	52.11	46.90	57.32
Virginia	TN	0.45	234	53.61	48.45	58.77
Virginia	TN	0.46	235	53.74	48.57	58.90
Virginia	TN	0.46	240	54.27	49.11	59.42
Virginia	TN	0.47	241	54.99	49.87	60.10
Virginia	TN	0.47	245	56.12	51.01	61.22
Virginia	TN	0.48	247	56.26	51.15	61.36
Virginia	TN	0.48	250	57.17	52.05	62.29
Virginia	TN	0.49	251	57.30	52.19	62.40
Virginia	TN	0.49	258	59.20	54.16	64.24
Virginia	TN	0.50	267	61.28	56.26	66.29
Virginia	TN	0.51	268	61.32	56.31	66.33
Virginia	TN	0.51	272	62.38	57.38	67.37
Virginia	TN	0.52	275	62.79	57.82	67.77
Virginia	TN	0.53	277	63.04	58.08	68.01
Virginia	TN	0.54	278	63.76	58.86	68.66
Virginia	TN	0.54	282	64.15	59.24	69.06
Virginia	TN	0.55	290	65.57	60.69	70.44
Virginia	TN	0.56	294	66.11	61.25	70.97
Virginia	TN	0.57	296	66.28	61.42	71.13
Virginia	TN	0.57	297	67.00	62.20	71.80
Virginia	TN	0.58	298	67.07	62.26	71.87
Virginia	TN	0.58	304	68.26	63.52	73.00
Virginia	TN	0.59	307	69.19	64.53	73.85
Virginia	TN	0.60	310	69.61	64.95	74.27
Virginia	TN	0.61	312	69.82	65.17	74.47
Virginia	TN	0.62	313	69.89	65.24	74.54
Virginia	TN	0.62	316	70.85	66.27	75.44
Virginia	TN	0.63	317	71.02	66.44	75.61
Virginia	TN	0.64	318	71.15	66.57	75.72
Virginia	TN	0.64	321	71.38	66.81	75.96
Virginia	TN	0.65	322	71.55	66.98	76.13
Virginia	TN	0.65	328	72.85	68.38	77.32
Virginia	TN	0.66	330	73.09	68.63	77.55
Virginia	TN	0.66	332	73.20	68.75	77.66
Virginia	TN	0.67	335	73.61	69.18	78.05
Virginia	TN	0.68	338	73.93	69.51	78.34
Virginia	TN	0.69	343	75.55	71.12	79.97
Virginia	TN	0.71	344	75.67	71.25	80.09
Virginia	TN	0.72	347	75.85	71.44	80.27
Virginia	TN	0.73	348	76.02	71.63	80.42
Virginia	TN	0.73	352	76.38	71.99	80.78
Virginia	TN	0.74	353	76.51	72.12	80.90
Virginia	TN	0.74	354	76.58	72.19	80.97
Virginia	TN	0.75	357	76.81	72.43	81.20

Virginia	TN	0.76	358	76.94	72.56	81.31
Virginia	TN	0.77	359	77.01	72.62	81.39
Virginia	TN	0.77	360	77.08	72.70	81.46
Virginia	TN	0.78	361	77.25	72.88	81.62
Virginia	TN	0.78	365	77.56	73.20	81.91
Virginia	TN	0.79	366	77.68	73.33	82.03
Virginia	TN	0.79	368	78.02	73.69	82.35
Virginia	TN	0.80	370	78.22	73.89	82.54
Virginia	TN	0.81	371	78.29	73.95	82.62
Virginia	TN	0.82	372	79.01	74.75	83.26
Virginia	TN	0.83	374	79.22	74.98	83.46
Virginia	TN	0.84	376	80.01	75.88	84.13
Virginia	TN	0.85	377	80.08	75.96	84.20
Virginia	TN	0.85	380	81.01	76.95	85.07
Virginia	TN	0.87	381	81.05	77.00	85.11
Virginia	TN	0.88	382	81.77	77.82	85.73
Virginia	TN	0.88	383	81.94	77.99	85.90
Virginia	TN	0.89	384	81.99	78.03	85.94
Virginia	TN	0.90	385	82.16	78.20	86.11
Virginia	TN	0.92	386	82.88	79.03	86.72
Virginia	TN	0.94	387	83.00	79.16	86.84
Virginia	TN	0.95	388	83.17	79.34	87.01
Virginia	TN	0.96	389	83.34	79.51	87.18
Virginia	TN	0.97	390	83.41	79.57	87.25
Virginia	TN	0.98	392	83.75	79.92	87.59
Virginia	TN	1.00	396	84.19	80.36	88.01
Virginia	TN	1.01	397	84.31	80.48	88.14
Virginia	TN	1.02	400	84.58	80.75	88.40
Virginia	TN	1.03	401	84.62	80.79	88.44
Virginia	TN	1.04	402	84.69	80.86	88.51
Virginia	TN	1.07	403	84.81	81.00	88.63
Virginia	TN	1.08	404	85.53	81.85	89.22
Virginia	TN	1.10	406	85.77	82.10	89.44
Virginia	TN	1.13	407	85.84	82.17	89.51
Virginia	TN	1.14	408	85.97	82.30	89.63
Virginia	TN	1.16	409	86.14	82.48	89.79
Virginia	TN	1.18	410	86.86	83.32	90.39
Virginia	TN	1.18	413	87.17	83.65	90.69
Virginia	TN	1.19	414	87.29	83.78	90.81
Virginia	TN	1.19	415	87.46	83.96	90.97
Virginia	TN	1.20	416	87.53	84.03	91.03
Virginia	TN	1.21	417	87.70	84.22	91.19
Virginia	TN	1.21	419	87.87	84.39	91.35
Virginia	TN	1.22	420	87.99	84.51	91.48
Virginia	TN	1.23	422	88.24	84.76	91.72
Virginia	TN	1.24	423	88.36	84.88	91.84
Virginia	TN	1.26	424	88.49	85.01	91.96
Virginia	TN	1.27	425	89.21	85.89	92.53
Virginia	TN	1.30	426	89.38	86.07	92.68
Virginia	TN	1.32	427	90.10	86.91	93.29
Virginia	TN	1.33	428	90.14	86.95	93.33
Virginia	TN	1.35	429	90.18	86.99	93.38
Virginia	TN	1.36	430	90.35	87.16	93.54

Virginia	TN	1.37	431	90.48	87.29	93.66
Virginia	TN	1.39	433	90.72	87.54	93.90
Virginia	TN	1.42	434	90.84	87.67	94.01
Virginia	TN	1.44	435	91.01	87.85	94.17
Virginia	TN	1.46	436	91.18	88.03	94.33
Virginia	TN	1.47	437	91.90	88.97	94.83
Virginia	TN	1.50	438	92.62	89.89	95.35
Virginia	TN	1.53	439	92.75	90.02	95.47
Virginia	TN	1.60	440	92.87	90.15	95.59
Virginia	TN	1.62	441	92.99	90.28	95.70
Virginia	TN	1.73	442	93.16	90.47	95.86
Virginia	TN	1.79	443	93.33	90.65	96.02
Virginia	TN	1.82	444	93.50	90.82	96.18
Virginia	TN	1.85	445	94.22	91.72	96.73
Virginia	TN	1.88	446	94.94	92.64	97.25
Virginia	TN	1.89	447	95.12	92.83	97.40
Virginia	TN	1.91	448	95.16	92.87	97.44
Virginia	TN	1.91	449	95.33	93.06	97.59
Virginia	TN	2.04	451	95.54	93.29	97.79
Virginia	TN	2.14	452	95.71	93.48	97.94
Virginia	TN	2.16	453	95.88	93.67	98.09
Virginia	TN	2.19	454	95.95	93.74	98.16
Virginia	TN	2.40	455	96.12	93.93	98.31
Virginia	TN	2.55	456	96.29	94.12	98.46
Virginia	TN	2.62	457	96.42	94.25	98.58
Virginia	TN	2.65	458	96.59	94.44	98.73
Virginia	TN	2.67	459	96.76	94.63	98.88
Virginia	TN	3.02	460	97.48	95.73	99.22
Virginia	TN	3.28	461	97.55	95.81	99.28
Virginia	TN	3.37	462	98.27	96.96	99.57
Virginia	TN	3.45	463	98.44	97.15	99.72
Virginia	TN	3.51	464	99.16	98.62	99.69
Virginia	TN	3.68	465	99.33	98.86	99.80
Virginia	TN	3.88	466	99.45	99.02	99.88
Virginia	TN	3.93	467	99.49	99.07	99.92
Virginia	TN	4.95	468	99.66	99.31	100.00
Virginia	TN	5.02	469	99.79	99.51	100.00
Virginia	TN	7.18	470	99.83	99.54	100.00
Virginia	TN	7.20	471	100.00	100.00	100.00

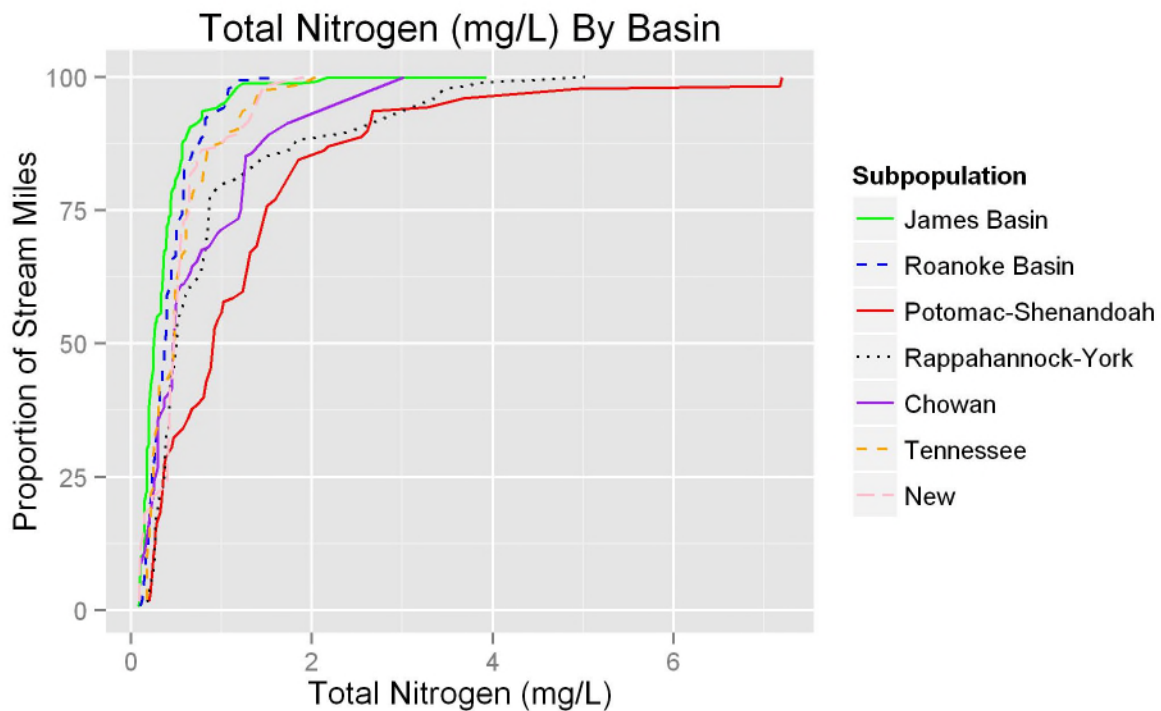


Figure 33. Total Nitrogen by Major Basin CDF graph.

Figure 33 shows the CDF curves for TN by super basin. The Potomac-Shenandoah basin has higher overall TN concentrations as evidenced by the 50<sup>th</sup> percentile near 0.92 mg/L and 90<sup>th</sup> percentile at 2.62 mg/L. Ninety percent of Rappahannock-York streams have TN concentrations less than 2.40 mg/L. The James and Roanoke basins show 50% of streams have TN concentrations less than 0.25 and 0.38 mg/L, respectively. Fifty percent of Chowan Basin stream miles have TN values less than 0.64 mg/L. Table 20 corresponds to Figure 33.

Table 20. Total Nitrogen Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	TN	0.08	1	0.73	0.00	1.89
James Basin	TN	0.09	2	1.47	0.00	3.20
James Basin	TN	0.10	3	4.57	0.00	10.01
James Basin	TN	0.10	6	6.38	0.65	12.10
James Basin	TN	0.11	7	9.48	1.94	17.02
James Basin	TN	0.11	8	10.22	2.58	17.85
James Basin	TN	0.14	9	10.52	2.88	18.16
James Basin	TN	0.15	18	20.61	11.49	29.72
James Basin	TN	0.16	19	21.14	11.97	30.31
James Basin	TN	0.16	20	21.88	12.73	31.02
James Basin	TN	0.17	21	22.06	12.98	31.13
James Basin	TN	0.18	24	28.57	18.47	38.67
James Basin	TN	0.18	27	30.37	20.27	40.48

James Basin	TN	0.19	28	30.90	20.80	41.01
James Basin	TN	0.20	32	38.38	27.66	49.11
James Basin	TN	0.22	36	42.63	31.94	53.32
James Basin	TN	0.23	37	43.36	32.65	54.08
James Basin	TN	0.24	39	44.83	34.12	55.55
James Basin	TN	0.25	44	49.49	39.16	59.82
James Basin	TN	0.26	46	52.77	42.37	63.18
James Basin	TN	0.27	48	53.81	43.38	64.24
James Basin	TN	0.28	50	54.42	44.02	64.81
James Basin	TN	0.29	51	54.95	44.57	65.33
James Basin	TN	0.31	52	55.48	45.14	65.83
James Basin	TN	0.33	53	55.79	45.44	66.13
James Basin	TN	0.34	55	59.63	49.63	69.62
James Basin	TN	0.34	56	59.93	49.94	69.91
James Basin	TN	0.35	60	61.68	51.74	71.61
James Basin	TN	0.36	64	66.36	57.02	75.69
James Basin	TN	0.37	65	66.66	57.34	75.97
James Basin	TN	0.37	66	67.39	58.09	76.70
James Basin	TN	0.38	67	67.57	58.26	76.88
James Basin	TN	0.40	70	71.95	63.51	80.38
James Basin	TN	0.41	72	72.57	64.19	80.94
James Basin	TN	0.42	75	73.78	65.53	82.04
James Basin	TN	0.43	76	73.96	65.74	82.19
James Basin	TN	0.44	77	77.07	69.64	84.50
James Basin	TN	0.45	78	77.37	69.85	84.89
James Basin	TN	0.45	80	78.41	70.83	85.99
James Basin	TN	0.46	81	78.94	71.41	86.48
James Basin	TN	0.48	82	79.24	71.68	86.81
James Basin	TN	0.48	83	79.78	72.20	87.35
James Basin	TN	0.49	85	80.69	73.14	88.25
James Basin	TN	0.52	87	81.76	74.34	89.17
James Basin	TN	0.53	88	82.29	74.95	89.63
James Basin	TN	0.54	90	83.13	75.82	90.43
James Basin	TN	0.55	92	84.40	77.22	91.57
James Basin	TN	0.57	93	84.58	77.42	91.73
James Basin	TN	0.57	94	87.68	81.89	93.47
James Basin	TN	0.60	95	88.42	82.64	94.20
James Basin	TN	0.62	96	89.15	83.48	94.82
James Basin	TN	0.65	98	90.62	85.08	96.17
James Basin	TN	0.71	99	91.15	85.69	96.62
James Basin	TN	0.72	100	91.33	85.88	96.78
James Basin	TN	0.75	101	91.64	86.17	97.10
James Basin	TN	0.78	102	92.17	86.81	97.53
James Basin	TN	0.79	104	93.64	88.60	98.68
James Basin	TN	0.94	105	94.17	89.20	99.15
James Basin	TN	1.00	106	94.91	90.11	99.71
James Basin	TN	1.03	107	95.09	90.30	99.88
James Basin	TN	1.18	108	98.19	96.54	99.85
James Basin	TN	1.23	109	98.73	97.38	100.00
James Basin	TN	1.91	110	98.91	97.59	100.00
James Basin	TN	2.04	111	99.09	97.81	100.00
James Basin	TN	2.16	112	99.82	99.50	100.00
James Basin	TN	3.93	113	100.00	100.00	100.00

Roanoke Basin	TN	0.10	1	0.79	0.00	2.02
Roanoke Basin	TN	0.12	2	1.36	0.00	2.95
Roanoke Basin	TN	0.12	3	1.93	0.19	3.67
Roanoke Basin	TN	0.15	7	6.34	0.38	12.30
Roanoke Basin	TN	0.16	8	9.67	2.09	17.25
Roanoke Basin	TN	0.18	9	10.24	2.57	17.92
Roanoke Basin	TN	0.19	12	14.55	5.62	23.47
Roanoke Basin	TN	0.20	13	15.33	6.33	24.33
Roanoke Basin	TN	0.21	17	20.21	10.20	30.22
Roanoke Basin	TN	0.22	18	21.00	10.90	31.09
Roanoke Basin	TN	0.23	19	21.32	11.21	31.43
Roanoke Basin	TN	0.23	20	21.89	11.73	32.06
Roanoke Basin	TN	0.24	21	25.22	14.24	36.20
Roanoke Basin	TN	0.25	25	27.34	16.45	38.23
Roanoke Basin	TN	0.26	27	28.70	17.95	39.45
Roanoke Basin	TN	0.28	28	32.03	21.01	43.04
Roanoke Basin	TN	0.28	30	33.38	22.24	44.52
Roanoke Basin	TN	0.29	31	34.17	23.03	45.31
Roanoke Basin	TN	0.30	34	35.85	24.62	47.08
Roanoke Basin	TN	0.31	36	36.75	25.49	48.01
Roanoke Basin	TN	0.32	37	37.54	26.18	48.89
Roanoke Basin	TN	0.32	39	41.65	30.18	53.12
Roanoke Basin	TN	0.34	40	42.44	30.87	54.00
Roanoke Basin	TN	0.35	43	44.58	33.17	55.99
Roanoke Basin	TN	0.37	45	48.10	36.57	59.63
Roanoke Basin	TN	0.38	46	51.42	39.92	62.93
Roanoke Basin	TN	0.39	47	52.21	40.85	63.57
Roanoke Basin	TN	0.40	48	55.54	44.27	66.81
Roanoke Basin	TN	0.40	50	59.19	48.40	69.98
Roanoke Basin	TN	0.42	52	60.08	49.36	70.80
Roanoke Basin	TN	0.43	53	60.41	49.61	71.21
Roanoke Basin	TN	0.44	54	60.73	49.96	71.50
Roanoke Basin	TN	0.45	55	61.06	50.27	71.85
Roanoke Basin	TN	0.45	59	65.22	55.16	75.28
Roanoke Basin	TN	0.46	60	66.01	55.87	76.15
Roanoke Basin	TN	0.49	62	66.39	56.24	76.55
Roanoke Basin	TN	0.50	64	70.51	60.62	80.39
Roanoke Basin	TN	0.51	65	70.70	60.81	80.59
Roanoke Basin	TN	0.51	68	72.25	62.36	82.14
Roanoke Basin	TN	0.56	71	74.18	64.39	83.97
Roanoke Basin	TN	0.57	72	74.75	64.96	84.54
Roanoke Basin	TN	0.58	74	78.40	69.12	87.68
Roanoke Basin	TN	0.59	76	82.51	74.52	90.51
Roanoke Basin	TN	0.65	77	83.30	75.31	91.29
Roanoke Basin	TN	0.65	78	83.87	75.93	91.81
Roanoke Basin	TN	0.66	79	84.66	76.84	92.48
Roanoke Basin	TN	0.66	80	84.85	77.05	92.65
Roanoke Basin	TN	0.68	82	85.96	78.31	93.61
Roanoke Basin	TN	0.69	83	86.29	78.64	93.94
Roanoke Basin	TN	0.73	84	86.48	78.83	94.13
Roanoke Basin	TN	0.74	85	87.05	79.44	94.66
Roanoke Basin	TN	0.75	86	87.62	80.08	95.17
Roanoke Basin	TN	0.78	87	88.41	80.96	95.86

Roanoke Basin	TN	0.80	88	88.98	81.62	96.35
Roanoke Basin	TN	0.82	89	92.31	86.62	97.99
Roanoke Basin	TN	0.90	90	93.09	87.48	98.71
Roanoke Basin	TN	0.98	91	93.88	88.42	99.35
Roanoke Basin	TN	1.02	92	94.20	88.69	99.72
Roanoke Basin	TN	1.04	93	94.53	89.03	100.00
Roanoke Basin	TN	1.08	94	97.85	95.81	99.90
Roanoke Basin	TN	1.16	95	98.64	96.98	100.00
Roanoke Basin	TN	1.19	96	99.43	98.40	100.00
Roanoke Basin	TN	1.62	97	100.00	100.00	100.00
Potomac-Shenandoah	TN	0.20	1	1.76	0.00	4.72
Potomac-Shenandoah	TN	0.21	2	3.04	0.00	6.82
Potomac-Shenandoah	TN	0.25	3	10.47	0.00	22.75
Potomac-Shenandoah	TN	0.26	4	12.23	0.00	24.77
Potomac-Shenandoah	TN	0.27	6	14.71	1.99	27.44
Potomac-Shenandoah	TN	0.29	7	16.47	3.54	29.41
Potomac-Shenandoah	TN	0.32	8	18.23	5.36	31.10
Potomac-Shenandoah	TN	0.33	9	19.99	7.55	32.43
Potomac-Shenandoah	TN	0.37	10	27.43	12.53	42.33
Potomac-Shenandoah	TN	0.38	11	28.70	13.90	43.51
Potomac-Shenandoah	TN	0.45	12	30.46	15.71	45.22
Potomac-Shenandoah	TN	0.47	13	32.22	17.16	47.28
Potomac-Shenandoah	TN	0.54	14	33.50	18.24	48.76
Potomac-Shenandoah	TN	0.58	15	34.23	18.88	49.57
Potomac-Shenandoah	TN	0.63	16	35.98	20.51	51.46
Potomac-Shenandoah	TN	0.67	17	37.74	22.59	52.89
Potomac-Shenandoah	TN	0.73	18	38.47	23.22	53.72
Potomac-Shenandoah	TN	0.77	19	39.19	23.87	54.51
Potomac-Shenandoah	TN	0.80	20	39.92	24.51	55.32
Potomac-Shenandoah	TN	0.81	21	40.64	25.01	56.28
Potomac-Shenandoah	TN	0.83	23	42.83	27.61	58.05
Potomac-Shenandoah	TN	0.84	24	43.56	28.21	58.90
Potomac-Shenandoah	TN	0.88	25	45.31	29.67	60.96
Potomac-Shenandoah	TN	0.92	26	52.75	36.43	69.07
Potomac-Shenandoah	TN	0.96	27	54.51	38.36	70.65
Potomac-Shenandoah	TN	1.00	28	55.79	39.55	72.02
Potomac-Shenandoah	TN	1.01	29	57.06	40.80	73.33
Potomac-Shenandoah	TN	1.02	30	57.79	41.47	74.11
Potomac-Shenandoah	TN	1.13	31	58.51	42.15	74.88
Potomac-Shenandoah	TN	1.23	32	59.79	43.34	76.24
Potomac-Shenandoah	TN	1.32	33	67.23	51.72	82.74
Potomac-Shenandoah	TN	1.35	34	67.66	52.10	83.21
Potomac-Shenandoah	TN	1.39	35	68.38	52.85	83.92
Potomac-Shenandoah	TN	1.50	36	75.82	62.86	88.77
Potomac-Shenandoah	TN	1.60	37	77.09	64.41	89.78
Potomac-Shenandoah	TN	1.85	38	84.53	75.67	93.40
Potomac-Shenandoah	TN	2.14	39	86.29	78.13	94.45
Potomac-Shenandoah	TN	2.19	40	87.01	79.00	95.03
Potomac-Shenandoah	TN	2.55	41	88.77	81.37	96.17
Potomac-Shenandoah	TN	2.62	42	90.05	83.19	96.91
Potomac-Shenandoah	TN	2.65	43	91.81	85.83	97.78
Potomac-Shenandoah	TN	2.67	44	93.57	88.56	98.57
Potomac-Shenandoah	TN	3.28	45	94.29	89.58	99.01



Potomac-Shenandoah	TN	3.68	46	96.05	92.18	99.92
Potomac-Shenandoah	TN	4.95	47	97.81	94.88	100.00
Potomac-Shenandoah	TN	7.18	48	98.24	95.23	100.00
Potomac-Shenandoah	TN	7.20	49	100.00	100.00	100.00
Rappahannock-York	TN	0.18	1	1.55	0.00	4.05
Rappahannock-York	TN	0.26	3	9.23	0.30	18.15
Rappahannock-York	TN	0.27	4	10.78	1.56	20.00
Rappahannock-York	TN	0.28	5	17.33	5.25	29.42
Rappahannock-York	TN	0.30	7	19.10	7.08	31.11
Rappahannock-York	TN	0.31	8	20.22	8.08	32.37
Rappahannock-York	TN	0.31	9	21.77	10.30	33.25
Rappahannock-York	TN	0.36	10	23.32	11.63	35.02
Rappahannock-York	TN	0.37	12	24.83	13.29	36.37
Rappahannock-York	TN	0.39	14	32.93	18.83	47.03
Rappahannock-York	TN	0.42	15	33.31	19.20	47.41
Rappahannock-York	TN	0.43	17	41.41	25.56	57.27
Rappahannock-York	TN	0.44	20	43.82	28.16	59.47
Rappahannock-York	TN	0.45	21	44.19	28.53	59.86
Rappahannock-York	TN	0.46	23	45.21	29.54	60.88
Rappahannock-York	TN	0.49	24	46.34	30.91	61.77
Rappahannock-York	TN	0.49	25	47.89	32.52	63.26
Rappahannock-York	TN	0.50	26	48.27	32.83	63.71
Rappahannock-York	TN	0.51	27	54.82	39.72	69.91
Rappahannock-York	TN	0.54	28	55.46	40.24	70.68
Rappahannock-York	TN	0.55	29	56.10	40.98	71.22
Rappahannock-York	TN	0.58	30	57.65	42.53	72.76
Rappahannock-York	TN	0.59	31	58.03	42.91	73.14
Rappahannock-York	TN	0.60	32	59.15	44.04	74.27
Rappahannock-York	TN	0.62	33	59.79	44.71	74.87
Rappahannock-York	TN	0.64	34	60.17	45.16	75.18
Rappahannock-York	TN	0.65	35	60.81	45.85	75.77
Rappahannock-York	TN	0.69	36	61.45	46.53	76.37
Rappahannock-York	TN	0.72	37	62.09	47.22	76.96
Rappahannock-York	TN	0.75	38	62.46	47.59	77.34
Rappahannock-York	TN	0.77	39	63.10	48.28	77.92
Rappahannock-York	TN	0.85	41	71.21	57.47	84.95
Rappahannock-York	TN	0.88	42	77.76	65.11	90.41
Rappahannock-York	TN	0.89	43	78.14	65.48	90.80
Rappahannock-York	TN	0.98	44	79.69	67.47	91.91
Rappahannock-York	TN	1.14	45	80.81	68.92	92.71
Rappahannock-York	TN	1.21	46	81.19	69.31	93.08
Rappahannock-York	TN	1.26	47	82.32	70.65	93.99
Rappahannock-York	TN	1.37	48	83.44	71.81	95.08
Rappahannock-York	TN	1.46	49	84.99	73.61	96.38
Rappahannock-York	TN	1.79	50	86.54	75.43	97.66
Rappahannock-York	TN	1.82	51	88.09	77.01	99.18
Rappahannock-York	TN	2.40	52	89.65	78.84	100.00
Rappahannock-York	TN	3.37	53	96.20	92.81	99.58
Rappahannock-York	TN	3.45	54	97.75	95.13	100.00
Rappahannock-York	TN	3.88	55	98.87	96.94	100.00
Rappahannock-York	TN	5.02	56	100.00	100.00	100.00
Chowan	TN	0.11	1	8.70	0.00	22.46
Chowan	TN	0.15	3	11.00	0.00	24.99

Chowan	TN	0.25	6	22.26	3.67	40.86
Chowan	TN	0.26	7	24.32	5.73	42.91
Chowan	TN	0.28	9	26.06	7.42	44.70
Chowan	TN	0.29	10	26.56	7.99	45.13
Chowan	TN	0.30	12	35.77	14.44	57.09
Chowan	TN	0.32	13	36.61	15.31	57.92
Chowan	TN	0.35	14	37.46	16.16	58.77
Chowan	TN	0.37	15	37.97	16.74	59.19
Chowan	TN	0.37	17	39.66	18.45	60.87
Chowan	TN	0.45	19	41.40	20.51	62.28
Chowan	TN	0.47	20	50.10	29.18	71.02
Chowan	TN	0.50	22	59.30	40.09	78.52
Chowan	TN	0.55	24	61.00	41.96	80.04
Chowan	TN	0.58	25	61.24	42.13	80.35
Chowan	TN	0.64	26	62.74	43.61	81.86
Chowan	TN	0.66	27	63.59	44.50	82.67
Chowan	TN	0.67	28	64.43	45.47	83.40
Chowan	TN	0.72	29	65.28	46.40	84.16
Chowan	TN	0.76	30	66.78	48.13	85.43
Chowan	TN	0.78	32	67.52	48.81	86.23
Chowan	TN	0.85	33	68.02	49.28	86.77
Chowan	TN	0.87	34	68.53	49.75	87.30
Chowan	TN	0.95	35	70.58	51.91	89.26
Chowan	TN	1.00	36	71.43	52.86	90.00
Chowan	TN	1.18	37	73.49	54.94	92.04
Chowan	TN	1.21	38	74.99	56.52	93.46
Chowan	TN	1.22	39	76.48	57.88	95.08
Chowan	TN	1.27	40	85.18	69.97	100.00
Chowan	TN	1.33	41	85.69	70.48	100.00
Chowan	TN	1.44	42	87.74	72.91	100.00
Chowan	TN	1.53	43	89.24	74.59	100.00
Chowan	TN	1.73	44	91.30	76.95	100.00
Chowan	TN	3.02	45	100.00	100.00	100.00
Tennessee	TN	0.17	2	1.97	0.00	4.43
Tennessee	TN	0.18	3	2.52	0.00	5.22
Tennessee	TN	0.18	6	10.58	1.58	19.58
Tennessee	TN	0.21	7	16.30	4.45	28.15
Tennessee	TN	0.22	8	22.02	7.88	36.16
Tennessee	TN	0.25	9	23.00	8.75	37.26
Tennessee	TN	0.25	11	29.71	14.27	45.14
Tennessee	TN	0.26	12	31.06	15.58	46.55
Tennessee	TN	0.27	13	32.04	16.45	47.64
Tennessee	TN	0.27	14	33.40	17.77	49.02
Tennessee	TN	0.29	15	34.38	18.92	49.84
Tennessee	TN	0.30	17	36.06	20.50	51.63
Tennessee	TN	0.31	19	42.34	26.68	58.00
Tennessee	TN	0.38	20	42.67	27.03	58.31
Tennessee	TN	0.41	22	43.79	28.19	59.38
Tennessee	TN	0.44	23	44.77	29.28	60.26
Tennessee	TN	0.46	24	45.75	30.30	61.20
Tennessee	TN	0.46	25	46.74	31.40	62.07
Tennessee	TN	0.47	27	48.65	33.35	63.95
Tennessee	TN	0.48	28	49.20	33.89	64.51

Tennessee	TN	0.49	30	60.64	46.69	74.60
Tennessee	TN	0.50	32	61.76	47.85	75.67
Tennessee	TN	0.52	33	63.11	49.46	76.77
Tennessee	TN	0.53	34	64.10	50.50	77.69
Tennessee	TN	0.55	36	65.64	52.23	79.04
Tennessee	TN	0.56	37	66.62	53.24	80.00
Tennessee	TN	0.60	38	67.60	54.27	80.93
Tennessee	TN	0.61	39	68.96	55.78	82.13
Tennessee	TN	0.62	41	75.23	63.72	86.75
Tennessee	TN	0.64	42	75.79	64.27	87.31
Tennessee	TN	0.66	43	76.35	64.83	87.87
Tennessee	TN	0.67	44	77.70	66.39	89.01
Tennessee	TN	0.68	45	78.26	67.06	89.46
Tennessee	TN	0.69	46	78.59	67.45	89.74
Tennessee	TN	0.73	47	79.57	68.45	90.70
Tennessee	TN	0.79	48	80.56	69.52	91.59
Tennessee	TN	0.84	49	86.28	79.34	93.21
Tennessee	TN	0.85	50	86.83	80.03	93.64
Tennessee	TN	1.02	51	87.82	81.30	94.34
Tennessee	TN	1.10	53	89.73	83.89	95.56
Tennessee	TN	1.18	54	90.29	84.59	95.98
Tennessee	TN	1.19	55	91.27	85.88	96.65
Tennessee	TN	1.21	56	92.62	87.95	97.29
Tennessee	TN	1.24	57	93.60	89.12	98.09
Tennessee	TN	1.36	58	94.96	90.90	99.01
Tennessee	TN	1.39	59	96.31	92.65	99.97
Tennessee	TN	1.42	60	97.29	94.12	100.00
Tennessee	TN	1.89	61	98.65	96.49	100.00
Tennessee	TN	2.04	62	100.00	100.00	100.00
New	TN	0.09	1	1.59	0.00	4.34
New	TN	0.10	2	2.75	0.00	6.15
New	TN	0.10	4	11.07	0.00	22.42
New	TN	0.12	5	12.66	0.96	24.36
New	TN	0.13	6	13.82	2.02	25.61
New	TN	0.14	8	16.13	4.24	28.02
New	TN	0.15	10	18.11	5.88	30.34
New	TN	0.23	11	19.70	7.24	32.16
New	TN	0.24	12	21.29	8.67	33.91
New	TN	0.27	13	21.68	9.06	34.30
New	TN	0.31	14	22.34	9.72	34.96
New	TN	0.40	15	23.93	11.28	36.58
New	TN	0.41	17	31.81	16.32	47.30
New	TN	0.43	18	32.97	17.49	48.45
New	TN	0.43	20	41.29	24.41	58.16
New	TN	0.47	21	48.02	30.83	65.21
New	TN	0.48	23	55.40	37.51	73.29
New	TN	0.50	25	57.65	39.67	75.63
New	TN	0.54	26	64.38	47.74	81.02
New	TN	0.55	27	71.11	55.20	87.02
New	TN	0.58	29	73.09	57.14	89.03
New	TN	0.61	30	73.48	57.52	89.43
New	TN	0.64	31	74.63	58.82	90.45
New	TN	0.65	33	81.75	68.96	94.54

New	TN	0.73	34	83.34	70.94	95.74
New	TN	0.73	35	84.50	72.31	96.68
New	TN	0.74	36	85.15	73.00	97.30
New	TN	0.78	37	86.31	74.44	98.18
New	TN	0.97	38	86.96	75.02	98.91
New	TN	1.00	39	87.62	75.48	99.76
New	TN	1.07	40	88.78	76.85	100.00
New	TN	1.18	41	89.43	77.57	100.00
New	TN	1.20	42	90.09	78.33	100.00
New	TN	1.30	43	91.68	80.14	100.00
New	TN	1.47	44	98.41	95.69	100.00
New	TN	1.91	45	100.00	100.00	100.00

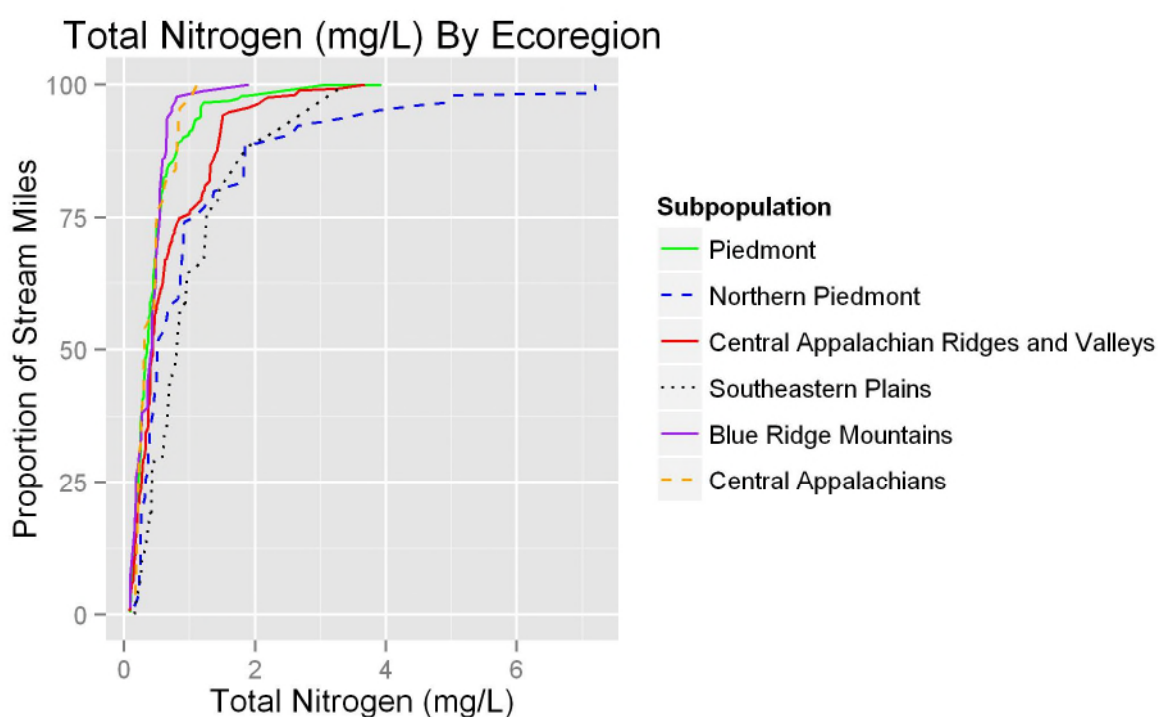


Figure 34. Total Nitrogen by Ecoregion (Level III) CDF graph.

TN CDF curves by Level III ecoregion are shown in Figure 34 and parameter values and estimates are detailed in Table 21. The ecoregion curves are relatively similar at the 50<sup>th</sup> percentile with the exception of the Southeastern Plains (0.80 mg/L). Specifically, 50% of stream miles in the Piedmont show TN concentrations of less than 0.35 mg/L. The Northern Piedmont 50<sup>th</sup> percentile is 0.51 mg/L. Central Appalachian Ridges and Valleys and Blue Ridge Mountains are under 0.44 mg/L at the 50<sup>th</sup> percentile while Central Appalachians are estimated to have 50% of stream miles less than 0.31 mg/L TN.

Table 21. Total Nitrogen Population Estimates by Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P
Piedmont	TN	0.09	1	0.46	0.00
Piedmont	TN	0.10	2	2.40	0.00
Piedmont	TN	0.11	4	6.27	0.78
Piedmont	TN	0.12	5	6.61	1.09
Piedmont	TN	0.12	6	6.94	1.41
Piedmont	TN	0.15	12	12.06	5.72
Piedmont	TN	0.16	13	12.39	6.03
Piedmont	TN	0.16	14	14.33	7.48
Piedmont	TN	0.17	15	14.44	7.63
Piedmont	TN	0.18	16	14.63	7.88
Piedmont	TN	0.18	19	15.88	9.03
Piedmont	TN	0.19	21	18.28	11.01
Piedmont	TN	0.20	23	20.67	12.95
Piedmont	TN	0.21	27	23.74	15.63
Piedmont	TN	0.22	30	26.32	17.90
Piedmont	TN	0.23	31	26.51	18.09
Piedmont	TN	0.23	32	26.85	18.40
Piedmont	TN	0.24	33	28.78	20.07
Piedmont	TN	0.24	35	29.70	20.97
Piedmont	TN	0.25	46	36.17	27.41
Piedmont	TN	0.26	47	36.62	27.86
Piedmont	TN	0.26	50	37.53	28.85
Piedmont	TN	0.28	51	39.47	30.79
Piedmont	TN	0.28	55	40.78	32.08
Piedmont	TN	0.29	56	40.89	32.20
Piedmont	TN	0.30	62	44.11	35.26
Piedmont	TN	0.31	63	44.45	35.59
Piedmont	TN	0.31	66	45.30	36.46
Piedmont	TN	0.32	67	45.76	36.89
Piedmont	TN	0.32	70	48.35	39.55
Piedmont	TN	0.34	72	48.99	40.16
Piedmont	TN	0.35	73	49.18	40.35
Piedmont	TN	0.35	78	51.00	42.23
Piedmont	TN	0.37	80	51.30	42.54
Piedmont	TN	0.37	84	53.73	45.00
Piedmont	TN	0.38	87	56.12	47.46
Piedmont	TN	0.39	88	56.58	47.99
Piedmont	TN	0.40	91	59.04	50.71
Piedmont	TN	0.41	92	59.09	50.75
Piedmont	TN	0.42	96	59.91	51.63
Piedmont	TN	0.43	98	60.56	52.27
Piedmont	TN	0.44	99	60.75	52.47
Piedmont	TN	0.45	101	61.13	52.79
Piedmont	TN	0.45	107	64.35	56.32
Piedmont	TN	0.46	110	65.25	57.20
Piedmont	TN	0.47	111	67.19	59.35
Piedmont	TN	0.48	112	67.38	59.53
Piedmont	TN	0.48	113	67.71	59.85
Piedmont	TN	0.49	115	68.63	60.80
Piedmont	TN	0.50	118	72.97	65.40

Piedmont	TN	0.51	121	73.87	66.40
Piedmont	TN	0.52	122	74.20	66.75
Piedmont	TN	0.54	124	74.73	67.29
Piedmont	TN	0.55	129	76.08	68.74
Piedmont	TN	0.56	132	77.21	69.93
Piedmont	TN	0.57	133	77.54	70.27
Piedmont	TN	0.57	134	79.48	72.62
Piedmont	TN	0.58	136	80.13	73.25
Piedmont	TN	0.59	138	82.53	76.18
Piedmont	TN	0.64	139	82.86	76.52
Piedmont	TN	0.65	140	83.32	76.97
Piedmont	TN	0.65	142	84.11	77.79
Piedmont	TN	0.66	144	84.41	78.10
Piedmont	TN	0.67	145	84.60	78.30
Piedmont	TN	0.68	146	85.06	78.83
Piedmont	TN	0.72	148	85.36	79.14
Piedmont	TN	0.73	149	85.47	79.25
Piedmont	TN	0.75	150	85.80	79.61
Piedmont	TN	0.76	151	86.14	79.97
Piedmont	TN	0.77	152	86.33	80.17
Piedmont	TN	0.78	153	86.66	80.53
Piedmont	TN	0.79	154	87.12	81.04
Piedmont	TN	0.82	155	89.06	83.51
Piedmont	TN	0.88	156	89.52	84.01
Piedmont	TN	0.90	157	89.97	84.49
Piedmont	TN	0.98	158	90.43	84.99
Piedmont	TN	1.00	160	91.08	85.71
Piedmont	TN	1.02	161	91.27	85.88
Piedmont	TN	1.04	162	91.46	86.07
Piedmont	TN	1.08	163	93.40	88.81
Piedmont	TN	1.16	164	93.86	89.32
Piedmont	TN	1.18	165	95.80	92.18
Piedmont	TN	1.19	166	96.25	92.72
Piedmont	TN	1.21	167	96.59	93.10
Piedmont	TN	1.62	168	96.92	93.48
Piedmont	TN	1.73	169	97.38	94.02
Piedmont	TN	1.79	170	97.84	94.55
Piedmont	TN	1.91	171	97.95	94.67
Piedmont	TN	3.02	172	99.89	99.70
Piedmont	TN	3.93	173	100.00	100.00
Northern Piedmont	TN	0.15	1	1.64	0.00
Northern Piedmont	TN	0.19	2	2.84	0.00
Northern Piedmont	TN	0.22	3	4.03	0.99
Northern Piedmont	TN	0.23	4	5.68	1.62
Northern Piedmont	TN	0.25	5	12.63	1.15
Northern Piedmont	TN	0.26	6	19.59	5.47
Northern Piedmont	TN	0.27	7	20.26	6.25
Northern Piedmont	TN	0.31	8	21.91	7.82
Northern Piedmont	TN	0.33	10	24.23	10.57
Northern Piedmont	TN	0.34	11	25.88	12.27
Northern Piedmont	TN	0.35	12	26.55	13.08
Northern Piedmont	TN	0.39	13	33.51	18.23
Northern Piedmont	TN	0.40	14	35.15	19.88

Northern Piedmont	TN	0.41	15	36.35	21.43
Northern Piedmont	TN	0.44	17	38.22	23.93
Northern Piedmont	TN	0.45	19	40.27	25.87
Northern Piedmont	TN	0.47	20	41.91	27.18
Northern Piedmont	TN	0.49	21	43.11	28.66
Northern Piedmont	TN	0.50	22	43.51	29.02
Northern Piedmont	TN	0.51	23	50.46	35.64
Northern Piedmont	TN	0.52	24	51.66	36.95
Northern Piedmont	TN	0.54	25	52.33	37.48
Northern Piedmont	TN	0.58	26	53.01	38.09
Northern Piedmont	TN	0.62	27	53.69	38.80
Northern Piedmont	TN	0.63	28	55.33	40.41
Northern Piedmont	TN	0.64	29	55.74	40.88
Northern Piedmont	TN	0.65	30	56.41	41.61
Northern Piedmont	TN	0.67	31	58.06	43.64
Northern Piedmont	TN	0.73	32	58.74	44.18
Northern Piedmont	TN	0.81	33	59.41	44.60
Northern Piedmont	TN	0.83	34	59.82	45.09
Northern Piedmont	TN	0.88	35	66.77	52.98
Northern Piedmont	TN	0.89	36	67.17	53.38
Northern Piedmont	TN	0.92	37	74.13	62.60
Northern Piedmont	TN	1.02	38	74.80	63.23
Northern Piedmont	TN	1.14	39	76.00	64.80
Northern Piedmont	TN	1.23	40	77.19	65.91
Northern Piedmont	TN	1.26	41	78.39	67.38
Northern Piedmont	TN	1.35	42	78.79	67.71
Northern Piedmont	TN	1.37	43	79.98	68.93
Northern Piedmont	TN	1.82	44	81.63	70.68
Northern Piedmont	TN	1.85	45	88.58	81.82
Northern Piedmont	TN	2.04	46	88.98	82.33
Northern Piedmont	TN	2.55	47	90.63	84.60
Northern Piedmont	TN	2.65	48	92.27	87.17
Northern Piedmont	TN	3.45	49	93.92	89.42
Northern Piedmont	TN	3.88	50	95.11	91.09
Northern Piedmont	TN	4.95	51	96.76	93.26
Northern Piedmont	TN	5.02	52	97.95	95.15
Northern Piedmont	TN	7.18	53	98.36	95.47
Northern Piedmont	TN	7.20	54	100.00	100.00
Central Appalachian Ridges and Valleys	TN	0.08	1	0.79	0.00
Central Appalachian Ridges and Valleys	TN	0.10	2	1.37	0.00
Central Appalachian Ridges and Valleys	TN	0.10	6	4.10	1.19
Central Appalachian Ridges and Valleys	TN	0.11	7	4.89	1.66
Central Appalachian Ridges and Valleys	TN	0.12	8	5.68	2.13
Central Appalachian Ridges and Valleys	TN	0.13	9	6.26	2.63
Central Appalachian Ridges and Valleys	TN	0.14	12	7.74	3.91
Central Appalachian Ridges and Valleys	TN	0.15	18	10.27	5.94
Central Appalachian Ridges and Valleys	TN	0.16	19	11.07	6.66
Central Appalachian Ridges and Valleys	TN	0.18	20	14.41	8.10
Central Appalachian Ridges and Valleys	TN	0.18	22	15.56	9.24
Central Appalachian Ridges and Valleys	TN	0.19	23	15.76	9.42
Central Appalachian Ridges and Valleys	TN	0.20	26	20.47	12.98
Central Appalachian Ridges and Valleys	TN	0.21	27	20.66	13.17
Central Appalachian Ridges and Valleys	TN	0.22	28	20.99	13.47

Central Appalachian Ridges and Valleys	TN	0.23	29	21.78	14.19
Central Appalachian Ridges and Valleys	TN	0.24	30	22.57	14.94
Central Appalachian Ridges and Valleys	TN	0.25	31	23.15	15.46
Central Appalachian Ridges and Valleys	TN	0.25	32	23.48	15.85
Central Appalachian Ridges and Valleys	TN	0.26	34	24.84	16.99
Central Appalachian Ridges and Valleys	TN	0.27	38	26.95	18.89
Central Appalachian Ridges and Valleys	TN	0.28	39	27.27	19.16
Central Appalachian Ridges and Valleys	TN	0.29	41	28.64	20.38
Central Appalachian Ridges and Valleys	TN	0.29	42	29.43	21.08
Central Appalachian Ridges and Valleys	TN	0.30	43	29.62	21.25
Central Appalachian Ridges and Valleys	TN	0.31	45	30.28	21.88
Central Appalachian Ridges and Valleys	TN	0.32	46	31.07	22.64
Central Appalachian Ridges and Valleys	TN	0.34	47	34.41	25.52
Central Appalachian Ridges and Valleys	TN	0.36	49	35.32	26.31
Central Appalachian Ridges and Valleys	TN	0.37	51	39.45	29.86
Central Appalachian Ridges and Valleys	TN	0.38	52	39.65	30.04
Central Appalachian Ridges and Valleys	TN	0.40	53	43.00	32.99
Central Appalachian Ridges and Valleys	TN	0.40	55	47.13	37.18
Central Appalachian Ridges and Valleys	TN	0.41	56	47.71	37.75
Central Appalachian Ridges and Valleys	TN	0.42	57	48.50	38.61
Central Appalachian Ridges and Valleys	TN	0.43	58	48.69	38.85
Central Appalachian Ridges and Valleys	TN	0.44	60	52.62	42.99
Central Appalachian Ridges and Valleys	TN	0.45	61	52.94	43.32
Central Appalachian Ridges and Valleys	TN	0.47	62	56.29	46.85
Central Appalachian Ridges and Valleys	TN	0.47	63	56.62	47.16
Central Appalachian Ridges and Valleys	TN	0.48	64	56.94	47.50
Central Appalachian Ridges and Valleys	TN	0.49	67	57.52	48.12
Central Appalachian Ridges and Valleys	TN	0.50	70	58.50	49.02
Central Appalachian Ridges and Valleys	TN	0.51	71	58.69	49.21
Central Appalachian Ridges and Valleys	TN	0.53	73	59.84	50.44
Central Appalachian Ridges and Valleys	TN	0.54	74	60.42	50.94
Central Appalachian Ridges and Valleys	TN	0.55	75	60.75	51.25
Central Appalachian Ridges and Valleys	TN	0.56	76	61.32	51.79
Central Appalachian Ridges and Valleys	TN	0.57	77	61.51	52.01
Central Appalachian Ridges and Valleys	TN	0.58	79	62.50	53.03
Central Appalachian Ridges and Valleys	TN	0.62	82	66.96	57.70
Central Appalachian Ridges and Valleys	TN	0.65	83	67.16	57.91
Central Appalachian Ridges and Valleys	TN	0.66	84	67.48	58.23
Central Appalachian Ridges and Valleys	TN	0.67	85	68.28	59.04
Central Appalachian Ridges and Valleys	TN	0.68	87	68.93	59.72
Central Appalachian Ridges and Valleys	TN	0.69	89	69.45	60.27
Central Appalachian Ridges and Valleys	TN	0.71	90	70.02	60.89
Central Appalachian Ridges and Valleys	TN	0.73	91	70.60	61.48
Central Appalachian Ridges and Valleys	TN	0.74	92	71.17	62.10
Central Appalachian Ridges and Valleys	TN	0.74	93	71.50	62.44
Central Appalachian Ridges and Valleys	TN	0.77	94	71.83	62.72
Central Appalachian Ridges and Valleys	TN	0.78	95	72.62	63.60
Central Appalachian Ridges and Valleys	TN	0.79	96	73.41	64.53
Central Appalachian Ridges and Valleys	TN	0.80	97	73.74	64.80
Central Appalachian Ridges and Valleys	TN	0.83	98	74.53	65.67
Central Appalachian Ridges and Valleys	TN	0.84	99	74.85	65.97
Central Appalachian Ridges and Valleys	TN	1.00	101	75.76	66.81
Central Appalachian Ridges and Valleys	TN	1.01	102	76.33	67.38



Central Appalachian Ridges and Valleys	TN	1.03	103	76.52	67.58
Central Appalachian Ridges and Valleys	TN	1.07	104	77.10	68.25
Central Appalachian Ridges and Valleys	TN	1.10	105	77.43	68.58
Central Appalachian Ridges and Valleys	TN	1.13	106	77.75	68.89
Central Appalachian Ridges and Valleys	TN	1.18	108	78.40	69.56
Central Appalachian Ridges and Valleys	TN	1.19	109	78.98	70.16
Central Appalachian Ridges and Valleys	TN	1.21	110	79.77	71.01
Central Appalachian Ridges and Valleys	TN	1.23	111	80.35	71.62
Central Appalachian Ridges and Valleys	TN	1.24	112	80.92	72.19
Central Appalachian Ridges and Valleys	TN	1.30	113	81.71	73.07
Central Appalachian Ridges and Valleys	TN	1.32	114	85.06	77.09
Central Appalachian Ridges and Valleys	TN	1.36	115	85.85	77.95
Central Appalachian Ridges and Valleys	TN	1.39	117	86.97	79.09
Central Appalachian Ridges and Valleys	TN	1.42	118	87.54	79.71
Central Appalachian Ridges and Valleys	TN	1.47	119	90.89	84.85
Central Appalachian Ridges and Valleys	TN	1.50	120	94.24	91.00
Central Appalachian Ridges and Valleys	TN	1.60	121	94.81	91.69
Central Appalachian Ridges and Valleys	TN	1.89	122	95.61	92.78
Central Appalachian Ridges and Valleys	TN	2.04	123	96.40	93.89
Central Appalachian Ridges and Valleys	TN	2.14	124	97.19	95.10
Central Appalachian Ridges and Valleys	TN	2.19	125	97.52	95.41
Central Appalachian Ridges and Valleys	TN	2.62	126	98.09	96.25
Central Appalachian Ridges and Valleys	TN	2.67	127	98.88	97.57
Central Appalachian Ridges and Valleys	TN	3.28	128	99.21	98.04
Central Appalachian Ridges and Valleys	TN	3.68	129	100.00	100.00
Southeastern Plains	TN	0.15	1	0.22	0.00
Southeastern Plains	TN	0.26	2	8.15	0.00
Southeastern Plains	TN	0.27	3	10.02	0.00
Southeastern Plains	TN	0.28	4	10.24	0.00
Southeastern Plains	TN	0.30	5	11.61	0.00
Southeastern Plains	TN	0.36	7	15.36	1.59
Southeastern Plains	TN	0.37	9	17.18	3.53
Southeastern Plains	TN	0.39	10	19.05	4.67
Southeastern Plains	TN	0.42	11	19.51	5.07
Southeastern Plains	TN	0.43	12	27.44	9.17
Southeastern Plains	TN	0.44	13	28.22	9.89
Southeastern Plains	TN	0.45	14	28.43	10.09
Southeastern Plains	TN	0.46	15	29.21	10.82
Southeastern Plains	TN	0.50	16	29.67	11.25
Southeastern Plains	TN	0.58	17	29.89	11.43
Southeastern Plains	TN	0.59	18	30.34	11.84
Southeastern Plains	TN	0.60	20	33.58	14.85
Southeastern Plains	TN	0.65	21	35.46	16.67
Southeastern Plains	TN	0.69	23	44.16	24.22
Southeastern Plains	TN	0.72	24	44.93	25.00
Southeastern Plains	TN	0.75	26	46.16	26.20
Southeastern Plains	TN	0.78	28	46.84	26.80
Southeastern Plains	TN	0.85	31	57.11	37.45
Southeastern Plains	TN	0.87	32	57.56	37.90
Southeastern Plains	TN	0.94	33	58.93	39.31
Southeastern Plains	TN	0.95	34	60.80	41.12
Southeastern Plains	TN	0.96	35	62.68	43.29
Southeastern Plains	TN	0.98	36	64.55	44.93

Southeastern Plains	TN	1.18	37	66.43	46.77
Southeastern Plains	TN	1.21	38	66.89	47.24
Southeastern Plains	TN	1.22	39	68.25	48.43
Southeastern Plains	TN	1.27	40	76.18	58.20
Southeastern Plains	TN	1.33	41	76.64	58.69
Southeastern Plains	TN	1.44	42	78.51	60.80
Southeastern Plains	TN	1.46	43	80.39	62.81
Southeastern Plains	TN	1.88	44	88.32	74.88
Southeastern Plains	TN	2.16	45	90.19	77.15
Southeastern Plains	TN	2.40	46	92.07	79.43
Southeastern Plains	TN	3.37	47	100.00	100.00
Blue Ridge Mountains	TN	0.09	1	1.26	0.00
Blue Ridge Mountains	TN	0.10	3	7.83	0.00
Blue Ridge Mountains	TN	0.15	6	15.65	3.93
Blue Ridge Mountains	TN	0.18	7	20.97	7.63
Blue Ridge Mountains	TN	0.18	8	26.28	10.70
Blue Ridge Mountains	TN	0.20	9	27.54	11.80
Blue Ridge Mountains	TN	0.25	10	32.85	16.58
Blue Ridge Mountains	TN	0.28	11	38.16	21.73
Blue Ridge Mountains	TN	0.35	12	39.08	22.77
Blue Ridge Mountains	TN	0.36	13	44.39	28.72
Blue Ridge Mountains	TN	0.41	14	49.70	33.39
Blue Ridge Mountains	TN	0.43	15	50.62	34.28
Blue Ridge Mountains	TN	0.43	17	57.19	40.62
Blue Ridge Mountains	TN	0.48	18	62.50	45.86
Blue Ridge Mountains	TN	0.49	19	67.81	52.79
Blue Ridge Mountains	TN	0.50	20	69.07	54.08
Blue Ridge Mountains	TN	0.54	21	74.38	61.02
Blue Ridge Mountains	TN	0.55	23	80.61	68.22
Blue Ridge Mountains	TN	0.58	24	85.92	75.71
Blue Ridge Mountains	TN	0.61	25	86.23	75.98
Blue Ridge Mountains	TN	0.64	26	87.14	77.06
Blue Ridge Mountains	TN	0.65	27	92.45	87.34
Blue Ridge Mountains	TN	0.66	28	93.71	89.03
Blue Ridge Mountains	TN	0.73	29	94.97	90.99
Blue Ridge Mountains	TN	0.73	30	95.88	92.28
Blue Ridge Mountains	TN	0.78	31	96.79	93.64
Blue Ridge Mountains	TN	0.80	32	97.71	95.14
Blue Ridge Mountains	TN	0.97	33	98.23	95.84
Blue Ridge Mountains	TN	1.20	34	98.74	96.61
Blue Ridge Mountains	TN	1.91	35	100.00	100.00
Central Appalachians	TN	0.17	2	3.67	0.00
Central Appalachians	TN	0.18	3	4.71	0.00
Central Appalachians	TN	0.18	5	9.07	1.44
Central Appalachians	TN	0.21	6	19.74	3.16
Central Appalachians	TN	0.22	7	30.42	10.57
Central Appalachians	TN	0.25	8	32.25	12.06
Central Appalachians	TN	0.26	9	34.78	14.67
Central Appalachians	TN	0.27	10	36.61	16.08
Central Appalachians	TN	0.27	11	39.14	18.37
Central Appalachians	TN	0.29	12	40.97	20.62
Central Appalachians	TN	0.30	13	43.50	22.64
Central Appalachians	TN	0.31	14	54.17	32.32

Central Appalachians	TN	0.41	16	56.25	34.50
Central Appalachians	TN	0.46	17	58.09	36.48
Central Appalachians	TN	0.46	18	59.92	38.46
Central Appalachians	TN	0.47	19	62.45	41.01
Central Appalachians	TN	0.48	20	63.49	41.97
Central Appalachians	TN	0.49	21	74.16	56.00
Central Appalachians	TN	0.52	22	76.69	59.04
Central Appalachians	TN	0.60	23	78.52	60.80
Central Appalachians	TN	0.61	24	81.05	63.95
Central Appalachians	TN	0.64	25	82.09	64.87
Central Appalachians	TN	0.79	26	83.92	66.77
Central Appalachians	TN	0.84	27	94.60	88.75
Central Appalachians	TN	0.85	28	95.64	90.23
Central Appalachians	TN	1.02	29	97.47	93.13
Central Appalachians	TN	1.10	30	100.00	100.00

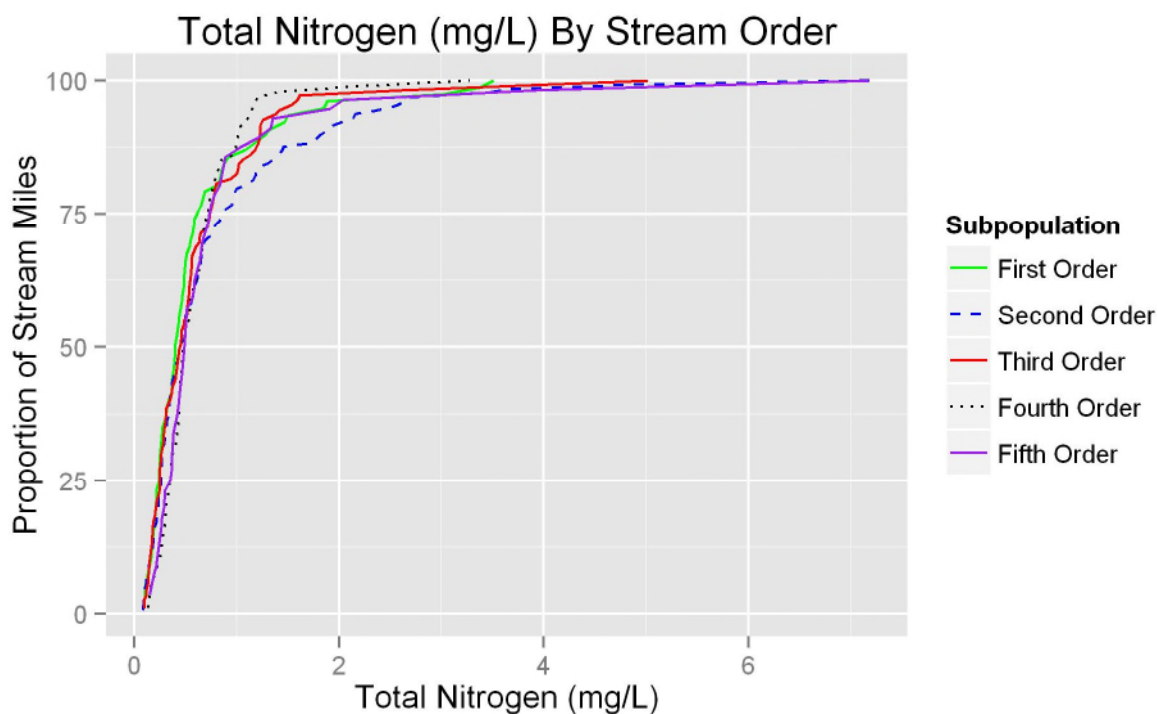


Figure 35. Total Nitrogen by Stream Order CDF graph.

TN CDFs by stream order are shown in Figure 35. Table 22 corresponds to the CDFs in Figure 35. TN concentrations are similar across stream orders until approximately the 70<sup>th</sup> percentile. Seventy percent of first order streams have TNs less than 0.55 mg/L. Second order streams have TN concentrations less than 0.73 mg/L. Seventy percent of third, fourth, and fifth order streams have TN concentrations less than 0.64, 0.68, and 0.69 mg/L TN, respectively.

Table 22. Total Nitrogen Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	TN	0.10	1	1.30	0.00	3.43
First Order	TN	0.10	2	2.60	0.00	5.74
First Order	TN	0.11	4	5.19	0.90	9.49
First Order	TN	0.15	7	9.09	4.23	13.96
First Order	TN	0.16	8	10.39	5.08	15.70
First Order	TN	0.18	10	12.99	7.24	18.74
First Order	TN	0.18	11	14.29	8.15	20.42
First Order	TN	0.19	12	15.58	9.25	21.92
First Order	TN	0.20	14	18.18	11.39	24.98
First Order	TN	0.21	16	20.78	13.59	27.97
First Order	TN	0.22	18	23.38	15.79	30.97
First Order	TN	0.24	19	24.68	17.28	32.07
First Order	TN	0.25	23	29.87	21.96	37.78
First Order	TN	0.26	25	32.47	24.28	40.66
First Order	TN	0.28	27	35.06	26.42	43.71
First Order	TN	0.30	28	36.36	27.52	45.20
First Order	TN	0.31	29	37.66	28.76	46.56
First Order	TN	0.32	30	38.96	29.85	48.07
First Order	TN	0.34	31	40.26	31.29	49.23
First Order	TN	0.36	32	41.56	32.64	50.48
First Order	TN	0.37	34	44.16	35.08	53.23
First Order	TN	0.38	35	45.45	36.27	54.64
First Order	TN	0.39	36	46.75	37.74	55.77
First Order	TN	0.40	37	48.05	38.91	57.20
First Order	TN	0.40	39	50.65	41.80	59.50
First Order	TN	0.41	40	51.95	43.17	60.72
First Order	TN	0.43	42	54.55	45.60	63.50
First Order	TN	0.44	43	55.84	47.14	64.55
First Order	TN	0.45	44	57.14	48.58	65.70
First Order	TN	0.47	45	58.44	49.92	66.96
First Order	TN	0.47	46	59.74	51.12	68.36
First Order	TN	0.48	47	61.04	52.34	69.74
First Order	TN	0.49	49	63.64	55.10	72.17
First Order	TN	0.50	51	66.23	57.80	74.67
First Order	TN	0.51	52	67.53	59.04	76.03
First Order	TN	0.54	53	68.83	60.55	77.12
First Order	TN	0.55	54	70.13	61.86	78.40
First Order	TN	0.57	55	71.43	63.27	79.59
First Order	TN	0.58	56	72.73	64.82	80.63
First Order	TN	0.59	57	74.03	66.40	81.65
First Order	TN	0.62	58	75.32	67.78	82.87
First Order	TN	0.65	59	76.62	69.42	83.83
First Order	TN	0.69	61	79.22	71.79	86.66
First Order	TN	0.82	62	80.52	73.33	87.71
First Order	TN	0.84	63	81.82	74.99	88.65
First Order	TN	0.85	64	83.12	76.39	89.85
First Order	TN	0.88	65	84.42	77.65	91.18
First Order	TN	0.92	66	85.71	79.01	92.42
First Order	TN	1.08	67	87.01	80.64	93.39
First Order	TN	1.18	68	88.31	82.34	94.28

First Order	TN	1.27	69	89.61	83.99	95.23
First Order	TN	1.32	70	90.91	85.50	96.32
First Order	TN	1.47	71	92.21	87.23	97.19
First Order	TN	1.50	72	93.51	88.94	98.07
First Order	TN	1.85	73	94.81	90.75	98.86
First Order	TN	1.88	74	96.10	92.38	99.82
First Order	TN	3.02	75	97.40	94.38	100.00
First Order	TN	3.37	76	98.70	96.64	100.00
First Order	TN	3.51	77	100.00	100.00	100.00
Second Order	TN	0.08	1	0.78	0.00	2.10
Second Order	TN	0.09	2	1.55	0.00	3.42
Second Order	TN	0.09	3	2.33	0.07	4.59
Second Order	TN	0.10	6	4.65	1.44	7.86
Second Order	TN	0.11	7	5.43	2.01	8.84
Second Order	TN	0.12	8	6.20	2.70	9.70
Second Order	TN	0.15	13	10.08	5.96	14.20
Second Order	TN	0.16	14	10.85	6.69	15.01
Second Order	TN	0.18	17	13.18	8.42	17.94
Second Order	TN	0.19	18	13.95	9.04	18.87
Second Order	TN	0.20	21	16.28	10.99	21.57
Second Order	TN	0.21	22	17.05	11.64	22.47
Second Order	TN	0.22	23	17.83	12.28	23.38
Second Order	TN	0.23	25	19.38	13.73	25.03
Second Order	TN	0.24	26	20.16	14.50	25.81
Second Order	TN	0.24	28	21.71	15.95	27.46
Second Order	TN	0.25	30	23.26	17.35	29.16
Second Order	TN	0.26	31	24.03	18.12	29.94
Second Order	TN	0.26	34	26.36	20.10	32.61
Second Order	TN	0.27	35	27.13	20.74	33.52
Second Order	TN	0.27	38	29.46	22.88	36.03
Second Order	TN	0.28	39	30.23	23.62	36.84
Second Order	TN	0.29	40	31.01	24.28	37.74
Second Order	TN	0.29	41	31.78	25.00	38.56
Second Order	TN	0.30	43	33.33	26.50	40.17
Second Order	TN	0.31	44	34.11	27.27	40.95
Second Order	TN	0.32	45	34.88	28.01	41.75
Second Order	TN	0.32	47	36.43	29.48	43.38
Second Order	TN	0.33	48	37.21	30.14	44.28
Second Order	TN	0.34	49	37.98	30.97	45.00
Second Order	TN	0.34	50	38.76	31.66	45.86
Second Order	TN	0.35	53	41.09	34.00	48.17
Second Order	TN	0.36	55	42.64	35.32	49.96
Second Order	TN	0.37	56	43.41	36.18	50.64
Second Order	TN	0.39	58	44.96	37.72	52.20
Second Order	TN	0.40	60	46.51	39.47	53.55
Second Order	TN	0.42	61	47.29	40.32	54.25
Second Order	TN	0.43	63	48.84	41.91	55.76
Second Order	TN	0.45	65	50.39	43.46	57.31
Second Order	TN	0.46	66	51.16	44.27	58.05
Second Order	TN	0.47	68	52.71	45.75	59.67
Second Order	TN	0.49	70	54.26	47.24	61.29
Second Order	TN	0.50	72	55.81	48.94	62.69
Second Order	TN	0.51	73	56.59	49.77	63.41

Second Order	TN	0.52	74	57.36	50.58	64.15
Second Order	TN	0.55	75	58.14	51.33	64.95
Second Order	TN	0.56	76	58.91	52.18	65.65
Second Order	TN	0.58	78	60.47	53.73	67.20
Second Order	TN	0.59	79	61.24	54.62	67.86
Second Order	TN	0.60	80	62.02	55.33	68.70
Second Order	TN	0.61	81	62.79	56.15	69.43
Second Order	TN	0.62	82	63.57	57.02	70.11
Second Order	TN	0.63	83	64.34	57.72	70.96
Second Order	TN	0.65	84	65.12	58.51	71.72
Second Order	TN	0.65	86	66.67	60.06	73.27
Second Order	TN	0.66	87	67.44	60.88	74.01
Second Order	TN	0.67	89	68.99	62.44	75.55
Second Order	TN	0.68	90	69.77	63.36	76.18
Second Order	TN	0.73	91	70.54	64.26	76.83
Second Order	TN	0.78	92	71.32	65.11	77.53
Second Order	TN	0.79	94	72.87	66.93	78.81
Second Order	TN	0.83	95	73.64	67.71	79.57
Second Order	TN	0.85	96	74.42	68.48	80.36
Second Order	TN	0.88	97	75.19	69.16	81.23
Second Order	TN	0.90	98	75.97	70.04	81.90
Second Order	TN	0.95	99	76.74	70.71	82.78
Second Order	TN	0.96	100	77.52	71.53	83.50
Second Order	TN	0.98	102	79.07	73.34	84.80
Second Order	TN	1.00	103	79.84	74.26	85.43
Second Order	TN	1.10	104	80.62	75.16	86.08
Second Order	TN	1.16	105	81.40	76.09	86.70
Second Order	TN	1.18	106	82.17	76.86	87.48
Second Order	TN	1.19	107	82.95	77.70	88.19
Second Order	TN	1.21	108	83.72	78.62	88.82
Second Order	TN	1.30	109	84.50	79.55	89.44
Second Order	TN	1.36	110	85.27	80.36	90.19
Second Order	TN	1.39	111	86.05	81.17	90.92
Second Order	TN	1.44	112	86.82	82.07	91.57
Second Order	TN	1.46	113	87.60	82.89	92.30
Second Order	TN	1.73	114	88.37	83.85	92.90
Second Order	TN	1.79	115	89.15	84.79	93.50
Second Order	TN	1.82	116	89.92	85.64	94.21
Second Order	TN	1.89	117	90.70	86.59	94.81
Second Order	TN	1.91	118	91.47	87.57	95.38
Second Order	TN	2.04	119	92.25	88.55	95.95
Second Order	TN	2.14	120	93.02	89.49	96.56
Second Order	TN	2.16	121	93.80	90.52	97.07
Second Order	TN	2.40	122	94.57	91.58	97.57
Second Order	TN	2.55	123	95.35	92.43	98.27
Second Order	TN	2.65	124	96.12	93.42	98.83
Second Order	TN	2.67	125	96.90	94.51	99.29
Second Order	TN	3.45	126	97.67	95.64	99.71
Second Order	TN	3.68	127	98.45	96.91	99.99
Second Order	TN	4.95	128	99.22	97.89	100.00
Second Order	TN	7.20	129	100.00	100.00	100.00
Third Order	TN	0.10	1	0.92	0.00	2.50
Third Order	TN	0.10	3	2.75	0.14	5.36

Third Order	TN	0.12	4	3.67	0.60	6.74
Third Order	TN	0.12	5	4.59	1.34	7.83
Third Order	TN	0.13	6	5.50	1.89	9.11
Third Order	TN	0.14	8	7.34	3.49	11.19
Third Order	TN	0.15	11	10.09	5.54	14.65
Third Order	TN	0.16	12	11.01	6.21	15.80
Third Order	TN	0.17	14	12.84	7.56	18.13
Third Order	TN	0.18	18	16.51	10.82	22.21
Third Order	TN	0.19	19	17.43	11.53	23.33
Third Order	TN	0.20	20	18.35	12.43	24.27
Third Order	TN	0.21	22	20.18	13.95	26.41
Third Order	TN	0.22	23	21.10	14.82	27.38
Third Order	TN	0.23	24	22.02	15.62	28.41
Third Order	TN	0.25	25	22.94	16.41	29.46
Third Order	TN	0.25	30	27.52	20.77	34.27
Third Order	TN	0.26	32	29.36	22.47	36.24
Third Order	TN	0.27	33	30.28	23.26	37.29
Third Order	TN	0.28	35	32.11	25.00	39.22
Third Order	TN	0.29	36	33.03	25.98	40.08
Third Order	TN	0.29	37	33.94	26.92	40.97
Third Order	TN	0.30	39	35.78	28.52	43.04
Third Order	TN	0.31	40	36.70	29.28	44.11
Third Order	TN	0.31	42	38.53	31.18	45.88
Third Order	TN	0.35	44	40.37	33.04	47.69
Third Order	TN	0.36	45	41.28	33.99	48.58
Third Order	TN	0.37	46	42.20	34.86	49.54
Third Order	TN	0.38	47	43.12	35.74	50.50
Third Order	TN	0.40	48	44.04	36.70	51.37
Third Order	TN	0.41	50	45.87	38.48	53.26
Third Order	TN	0.42	51	46.79	39.55	54.02
Third Order	TN	0.43	52	47.71	40.38	55.04
Third Order	TN	0.44	54	49.54	42.21	56.88
Third Order	TN	0.45	55	50.46	42.97	57.95
Third Order	TN	0.46	56	51.38	43.77	58.98
Third Order	TN	0.46	58	53.21	45.58	60.84
Third Order	TN	0.48	59	54.13	46.45	61.81
Third Order	TN	0.49	60	55.05	47.31	62.78
Third Order	TN	0.51	61	55.96	48.10	63.83
Third Order	TN	0.52	63	57.80	50.11	65.48
Third Order	TN	0.53	65	59.63	52.08	67.19
Third Order	TN	0.54	67	61.47	53.88	69.06
Third Order	TN	0.55	69	63.30	55.90	70.71
Third Order	TN	0.56	72	66.06	58.87	73.24
Third Order	TN	0.57	73	66.97	59.80	74.14
Third Order	TN	0.60	75	68.81	61.87	75.74
Third Order	TN	0.64	76	69.72	62.80	76.65
Third Order	TN	0.64	77	70.64	63.68	77.60
Third Order	TN	0.65	78	71.56	64.69	78.43
Third Order	TN	0.71	79	72.48	65.77	79.18
Third Order	TN	0.73	81	74.31	67.78	80.84
Third Order	TN	0.74	82	75.23	68.88	81.58
Third Order	TN	0.75	83	76.15	70.00	82.29
Third Order	TN	0.76	84	77.06	70.88	83.25

Third Order	TN	0.78	86	78.90	72.99	84.81
Third Order	TN	0.79	87	79.82	73.93	85.70
Third Order	TN	0.80	88	80.73	75.04	86.43
Third Order	TN	0.94	89	81.65	76.14	87.17
Third Order	TN	1.00	90	82.57	77.05	88.08
Third Order	TN	1.01	91	83.49	78.11	88.86
Third Order	TN	1.02	92	84.40	79.24	89.57
Third Order	TN	1.07	93	85.32	80.37	90.27
Third Order	TN	1.14	94	86.24	81.19	91.29
Third Order	TN	1.19	95	87.16	82.33	91.98
Third Order	TN	1.21	96	88.07	83.45	92.70
Third Order	TN	1.22	97	88.99	84.40	93.58
Third Order	TN	1.23	99	90.83	86.65	95.00
Third Order	TN	1.24	100	91.74	87.73	95.76
Third Order	TN	1.26	101	92.66	88.71	96.61
Third Order	TN	1.37	102	93.58	89.78	97.37
Third Order	TN	1.42	103	94.50	91.07	97.92
Third Order	TN	1.53	104	95.41	92.32	98.51
Third Order	TN	1.60	105	96.33	93.29	99.37
Third Order	TN	1.62	106	97.25	94.64	99.86
Third Order	TN	2.62	107	98.17	96.03	100.00
Third Order	TN	3.88	108	99.08	97.46	100.00
Third Order	TN	5.02	109	100.00	100.00	100.00
Fourth Order	TN	0.14	1	1.06	0.00	2.79
Fourth Order	TN	0.15	4	4.26	1.30	7.21
Fourth Order	TN	0.18	6	6.38	2.50	10.27
Fourth Order	TN	0.22	8	8.51	4.26	12.77
Fourth Order	TN	0.23	9	9.57	4.98	14.17
Fourth Order	TN	0.25	10	10.64	5.98	15.30
Fourth Order	TN	0.27	12	12.77	7.66	17.88
Fourth Order	TN	0.28	14	14.89	9.90	19.89
Fourth Order	TN	0.30	16	17.02	11.63	22.41
Fourth Order	TN	0.31	19	20.21	14.23	26.19
Fourth Order	TN	0.32	20	21.28	15.02	27.53
Fourth Order	TN	0.33	21	22.34	15.84	28.84
Fourth Order	TN	0.34	22	23.40	16.81	30.00
Fourth Order	TN	0.35	23	24.47	17.72	31.21
Fourth Order	TN	0.35	24	25.53	18.88	32.19
Fourth Order	TN	0.36	25	26.60	20.08	33.11
Fourth Order	TN	0.37	26	27.66	21.13	34.19
Fourth Order	TN	0.37	28	29.79	23.21	36.37
Fourth Order	TN	0.40	29	30.85	24.15	37.55
Fourth Order	TN	0.41	31	32.98	25.99	39.97
Fourth Order	TN	0.42	33	35.11	28.21	42.01
Fourth Order	TN	0.43	34	36.17	29.09	43.25
Fourth Order	TN	0.44	35	37.23	30.19	44.28
Fourth Order	TN	0.44	37	39.36	31.98	46.74
Fourth Order	TN	0.45	39	41.49	34.31	48.66
Fourth Order	TN	0.45	42	44.68	37.63	51.73
Fourth Order	TN	0.46	43	45.74	38.63	52.86
Fourth Order	TN	0.47	44	46.81	39.50	54.11
Fourth Order	TN	0.48	46	48.94	41.60	56.28
Fourth Order	TN	0.48	47	50.00	42.61	57.39



Fourth Order	TN	0.50	50	53.19	45.53	60.86
Fourth Order	TN	0.54	52	55.32	47.65	62.99
Fourth Order	TN	0.55	56	59.57	51.75	67.40
Fourth Order	TN	0.58	57	60.64	52.72	68.56
Fourth Order	TN	0.58	58	61.70	53.73	69.67
Fourth Order	TN	0.62	59	62.77	54.82	70.72
Fourth Order	TN	0.62	60	63.83	55.91	71.74
Fourth Order	TN	0.64	61	64.89	57.09	72.70
Fourth Order	TN	0.65	62	65.96	58.34	73.58
Fourth Order	TN	0.66	63	67.02	59.54	74.50
Fourth Order	TN	0.66	64	68.09	60.72	75.45
Fourth Order	TN	0.67	65	69.15	61.89	76.41
Fourth Order	TN	0.68	67	71.28	64.26	78.29
Fourth Order	TN	0.69	69	73.40	66.66	80.15
Fourth Order	TN	0.72	71	75.53	68.91	82.16
Fourth Order	TN	0.73	72	76.60	69.97	83.22
Fourth Order	TN	0.74	73	77.66	71.27	84.05
Fourth Order	TN	0.75	74	78.72	72.56	84.89
Fourth Order	TN	0.77	75	79.79	73.54	86.04
Fourth Order	TN	0.77	76	80.85	74.88	86.82
Fourth Order	TN	0.80	77	81.91	75.87	87.96
Fourth Order	TN	0.81	78	82.98	76.90	89.06
Fourth Order	TN	0.84	79	84.04	78.05	90.04
Fourth Order	TN	0.85	80	85.11	79.25	90.96
Fourth Order	TN	0.97	81	86.17	80.29	92.05
Fourth Order	TN	1.00	83	88.30	82.76	93.84
Fourth Order	TN	1.02	85	90.43	85.29	95.56
Fourth Order	TN	1.04	86	91.49	86.69	96.29
Fourth Order	TN	1.10	87	92.55	88.07	97.03
Fourth Order	TN	1.13	88	93.62	89.26	97.97
Fourth Order	TN	1.18	90	95.74	92.24	99.25
Fourth Order	TN	1.20	91	96.81	93.75	99.86
Fourth Order	TN	1.39	92	97.87	95.39	100.00
Fourth Order	TN	2.19	93	98.94	97.16	100.00
Fourth Order	TN	3.28	94	100.00	100.00	100.00
Fifth Order	TN	0.15	2	3.57	0.00	7.89
Fifth Order	TN	0.17	3	5.36	0.17	10.54
Fifth Order	TN	0.19	4	7.14	1.11	13.18
Fifth Order	TN	0.21	5	8.93	2.49	15.37
Fifth Order	TN	0.25	8	14.29	6.20	22.37
Fifth Order	TN	0.26	9	16.07	7.96	24.18
Fifth Order	TN	0.27	10	17.86	9.41	26.31
Fifth Order	TN	0.29	11	19.64	10.97	28.31
Fifth Order	TN	0.30	13	23.21	14.38	32.05
Fifth Order	TN	0.35	14	25.00	16.07	33.93
Fifth Order	TN	0.37	15	26.79	18.34	35.23
Fifth Order	TN	0.37	17	30.36	21.48	39.23
Fifth Order	TN	0.38	19	33.93	25.31	42.55
Fifth Order	TN	0.42	21	37.50	28.97	46.03
Fifth Order	TN	0.43	22	39.29	30.34	48.23
Fifth Order	TN	0.45	24	42.86	33.38	52.33
Fifth Order	TN	0.46	25	44.64	35.24	54.04
Fifth Order	TN	0.49	28	50.00	40.59	59.41

Fifth Order	TN	0.50	30	53.57	43.43	63.72
Fifth Order	TN	0.51	31	55.36	45.53	65.18
Fifth Order	TN	0.51	32	57.14	47.76	66.52
Fifth Order	TN	0.57	33	58.93	49.75	68.11
Fifth Order	TN	0.58	34	60.71	51.54	69.89
Fifth Order	TN	0.59	35	62.50	53.25	71.75
Fifth Order	TN	0.61	36	64.29	55.47	73.10
Fifth Order	TN	0.64	37	66.07	57.19	74.95
Fifth Order	TN	0.65	38	67.86	59.35	76.37
Fifth Order	TN	0.66	39	69.64	61.50	77.79
Fifth Order	TN	0.69	40	71.43	63.91	78.94
Fifth Order	TN	0.72	41	73.21	65.34	81.09
Fifth Order	TN	0.73	42	75.00	67.39	82.61
Fifth Order	TN	0.75	43	76.79	69.65	83.92
Fifth Order	TN	0.78	44	78.57	71.33	85.82
Fifth Order	TN	0.83	45	80.36	72.90	87.81
Fifth Order	TN	0.85	46	82.14	74.58	89.71
Fifth Order	TN	0.87	47	83.93	76.63	91.23
Fifth Order	TN	0.89	48	85.71	78.98	92.45
Fifth Order	TN	1.03	49	87.50	81.57	93.43
Fifth Order	TN	1.21	50	89.29	84.10	94.47
Fifth Order	TN	1.33	51	91.07	86.78	95.37
Fifth Order	TN	1.35	52	92.86	88.76	96.96
Fifth Order	TN	1.91	53	94.64	90.14	99.14
Fifth Order	TN	2.04	54	96.43	92.25	100.00
Fifth Order	TN	3.93	55	98.21	95.30	100.00
Fifth Order	TN	7.18	56	100.00	100.00	100.00

## Appendix E. Specific Conductivity Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by specific conductivity) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Specific conductivity over 500 uS/cm increases the likelihood of having a low VSCI score (VSCI < 60). The case for this increased risk to the aquatic community is presented in this appendix. Figure 36 shows a scatterplot of specific conductivity by VSCI score. Increasing specific conductivity appears to correlate with decreasing VSCI scores. This relationship is further explored throughout Appendix E.

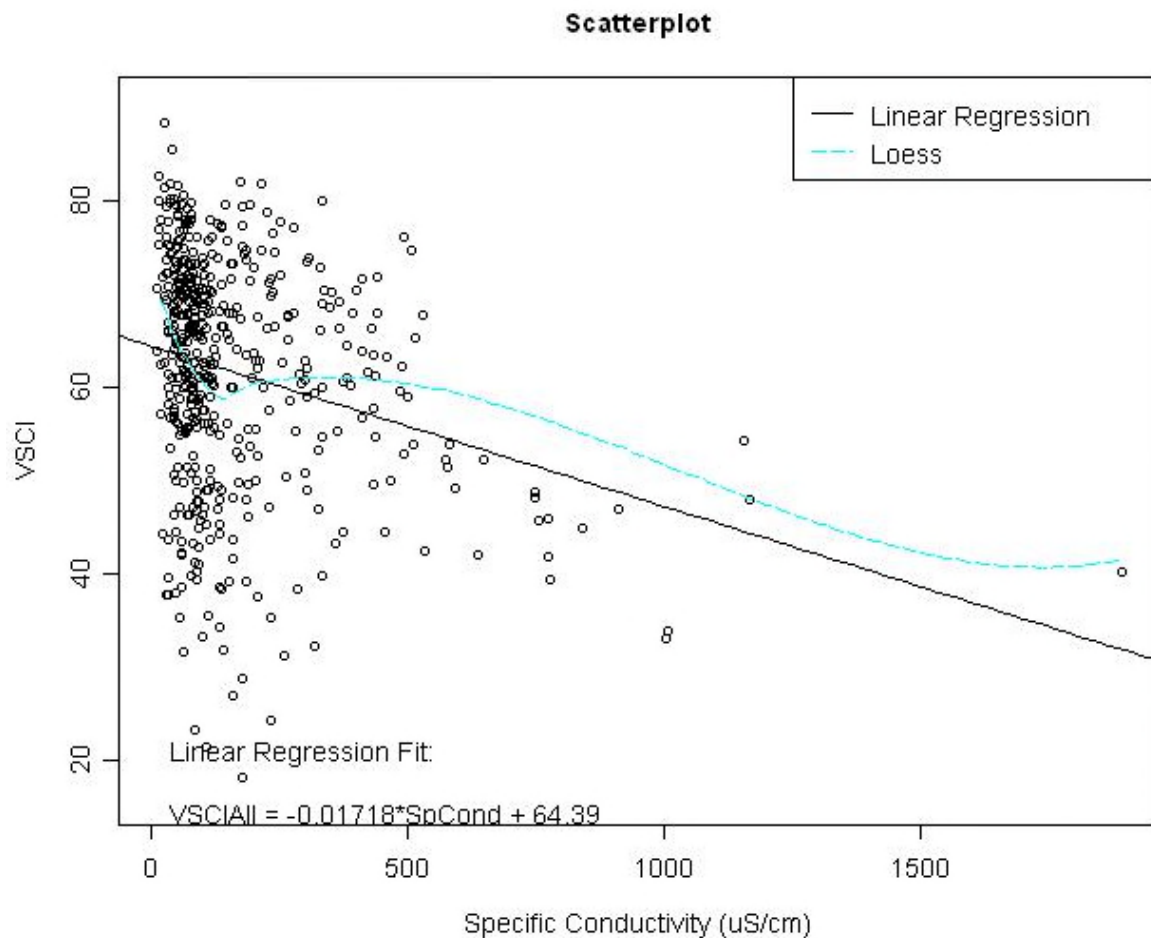


Figure 36. Stressor Gradient Scatterplot Increasing Specific Conductivity (uS/cm) values to Declining VSCI Scores.

### *Specific Conductivity Relative Risk Results*

An optimal level of less than 350 uS/cm Specific Conductivity was selected based on the low risk to aquatic life. VDEQ estimates 94.5% of Virginia streams have a Specific Conductivity below

350 (Table 23). Specific Conductivity above 500 uS/cm was considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 37) and scatter plot graphs. An estimated 5.5% of Virginia streams have Specific Conductivity above 500 uS/cm relative risk calculations found that a VSCI score is 2.8 times more likely to be below 50 when the Specific Conductivity is above 500 uS/cm than when the Specific Conductivity is below 350 uS/cm (Figure 38).

Table 23. Specific Conductivity Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Specific Conductivity (uS/cm)	<350	>500

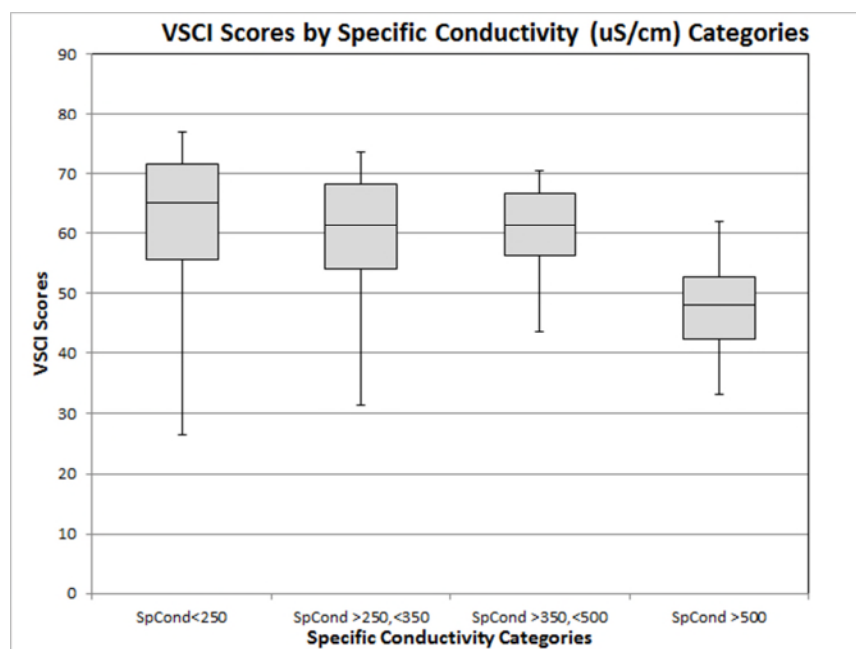


Figure 37. VSCI Scores by Specific Conductivity Categories.



Figure 38. Specific Conductivity Relative Extent (Specific Conductivity >500 uS/cm) and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 25 sites with specific conductivity over 500  $\mu\text{S}/\text{cm}$ . Twenty-two of 25 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the specific conductivity is above 500  $\mu\text{S}/\text{cm}$  is around 90% (Figure 39).

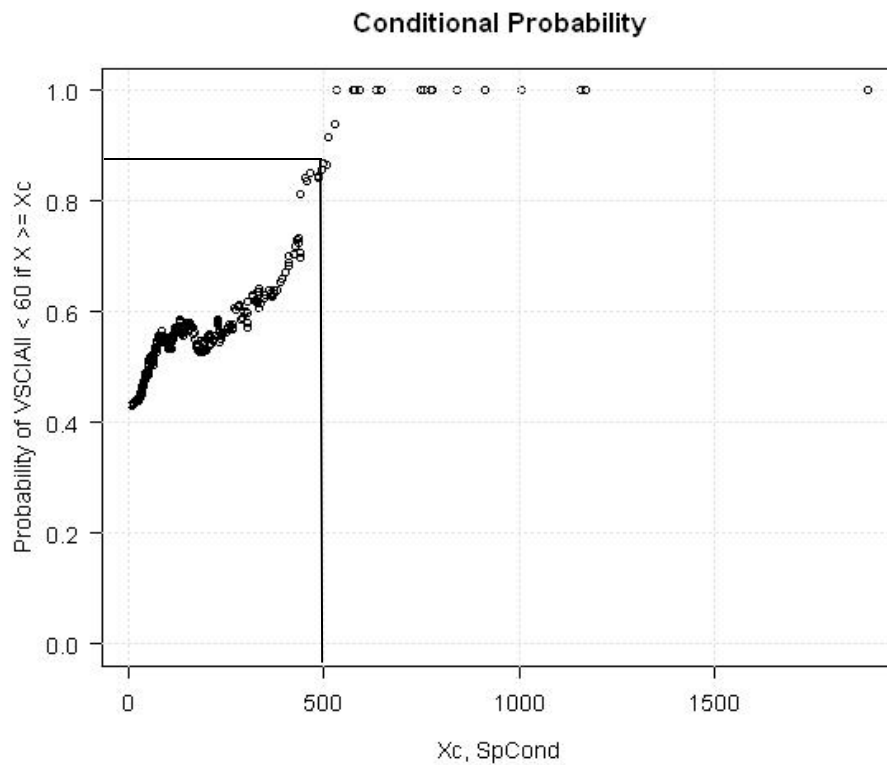


Figure 39. Probability of VSCI less than 60 if Specific Conductivity >500  $\mu\text{S}/\text{cm}$ .

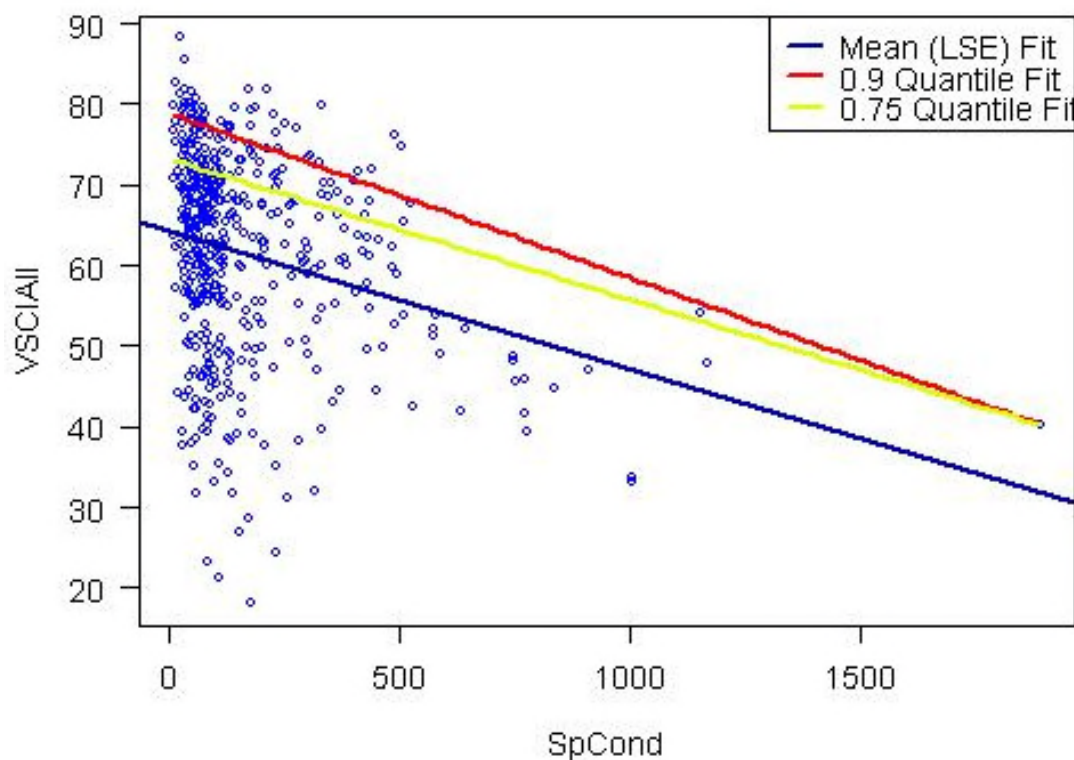


Figure 40. Quantile Regression VSCI versus Specific Conductivity (uS/cm).

In Figure 40, the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to specific conductivity uS/cm values. The 50<sup>th</sup> percentile of percentile of reference crosses at 340 uS/cm, 25th percentile intersects at 633 uS/cm, and the 10<sup>th</sup> percentile is equal to 927 uS/cm. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed.

### *Specific Conductivity and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from specific conductivity concentrations below 350 uS/cm (Table 24). Streams with specific conductivity above 500 uS/cm do not support health benthic communities and are associated with VSCI scores less than 60.

Table 24. Specific Conductivity (uS/cm) concentrations and associated probability of stress to aquatic life (based on VSCI scores).

Specific Conductivity	
Probability of Stress to Aquatic Life	Electrical Conductivity (uS/cm)
High	> 500
Medium	> 350, < 500
Low	> 250, < 350
None	< 250

### *Specific Conductivity Cumulative Distribution Function curves*

Specific conductivity cumulative distribution function (CDF) curves allow VDEQ staff to view the distribution of specific conductivity statewide, by major basin, major ecoregion (level III), and stream order (Figures 41-44). Tables 25-28 correspond to the aforementioned figures.

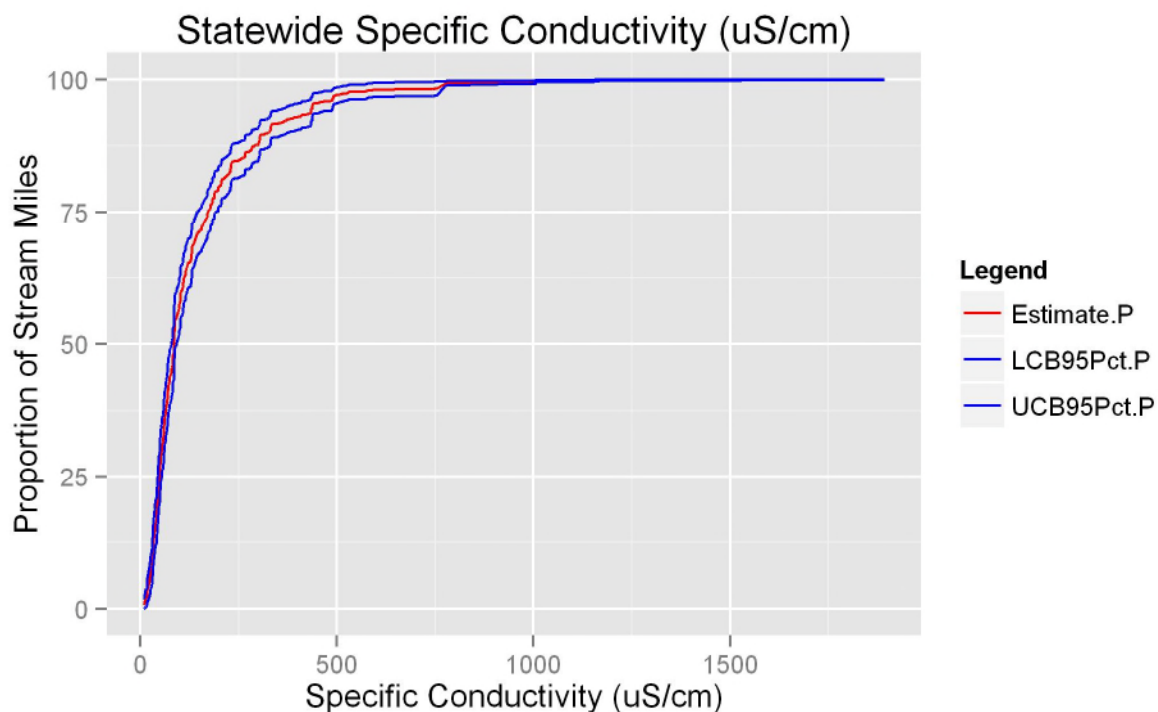


Figure 41. Specific Conductivity Statewide CDF graph.

Figure 41 displays specific conductivity across the Commonwealth. Fifty percent of stream miles have specific conductivity concentrations less than 86 uS/cm. Ninety percent of streams have specific conductivity concentrations less than 328.5 uS/cm.

Table 25. **Statewide Specific Conductivity (SpCond) Estimates.**

Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
SpCond	9.55	1	0.71	0.00	1.76
SpCond	9.80	2	0.88	0.00	1.96
SpCond	13.00	4	1.76	0.14	3.37
SpCond	13.75	5	1.92	0.31	3.54
SpCond	15.50	6	2.09	0.48	3.71
SpCond	17.00	7	2.21	0.63	3.80
SpCond	18.00	9	3.63	1.34	5.93
SpCond	22.50	11	5.06	2.30	7.81
SpCond	24.00	12	5.77	2.79	8.74
SpCond	26.00	14	6.64	3.52	9.77
SpCond	26.50	15	6.81	3.67	9.95
SpCond	28.50	16	7.52	4.25	10.80
SpCond	28.57	17	7.69	4.41	10.97
SpCond	28.63	18	7.86	4.56	11.16
SpCond	29.00	19	8.03	4.72	11.33
SpCond	30.25	20	8.15	4.83	11.46
SpCond	30.40	21	8.32	5.00	11.63
SpCond	31.50	22	9.03	5.56	12.49
SpCond	31.55	23	9.19	5.72	12.67
SpCond	31.65	24	9.90	6.30	13.51
SpCond	32.00	26	10.19	6.58	13.81
SpCond	32.25	27	10.90	7.20	14.61
SpCond	32.50	28	11.07	7.35	14.79
SpCond	33.00	30	11.95	8.12	15.78
SpCond	34.00	34	13.07	9.14	16.99
SpCond	34.25	35	13.23	9.30	17.17
SpCond	34.75	36	13.36	9.43	17.29
SpCond	35.00	38	14.19	10.11	18.27
SpCond	35.25	39	14.31	10.23	18.39
SpCond	35.60	40	14.43	10.34	18.52
SpCond	37.28	41	14.60	10.50	18.70
SpCond	37.50	42	14.72	10.62	18.82
SpCond	37.90	43	14.89	10.79	18.99
SpCond	38.00	46	15.68	11.49	19.88
SpCond	39.85	47	16.39	12.15	20.63
SpCond	40.03	48	16.46	12.22	20.70
SpCond	40.80	49	16.58	12.34	20.83
SpCond	41.60	50	17.29	12.95	21.64
SpCond	42.00	52	17.58	13.23	21.94
SpCond	42.50	54	18.42	13.97	22.86
SpCond	43.00	55	18.58	14.13	23.03
SpCond	43.30	56	18.75	14.32	23.18
SpCond	43.40	57	19.46	14.99	23.94
SpCond	43.50	59	19.75	15.26	24.24
SpCond	44.00	60	20.46	15.88	25.04
SpCond	44.70	61	20.58	16.00	25.17
SpCond	44.90	62	20.71	16.12	25.29
SpCond	45.75	64	21.58	16.91	26.26
SpCond	46.00	66	22.42	17.67	27.16
SpCond	46.20	67	22.49	17.74	27.24
SpCond	46.45	68	23.20	18.33	28.07



SpCond	46.60	69	23.27	18.40	28.13
SpCond	47.05	70	23.33	18.46	28.21
SpCond	48.00	73	24.24	19.32	29.15
SpCond	48.20	74	24.40	19.49	29.32
SpCond	48.50	75	24.47	19.56	29.39
SpCond	49.00	77	24.71	19.80	29.62
SpCond	49.25	78	24.88	19.99	29.77
SpCond	50.00	79	25.59	20.65	30.53
SpCond	50.15	80	26.30	21.30	31.30
SpCond	50.50	83	27.35	22.32	32.37
SpCond	50.85	84	27.47	22.45	32.48
SpCond	51.65	85	28.18	23.15	33.20
SpCond	52.00	86	28.89	23.85	33.93
SpCond	52.50	88	29.18	24.14	34.22
SpCond	53.01	89	29.25	24.21	34.28
SpCond	53.10	90	29.32	24.28	34.35
SpCond	53.50	91	29.39	24.35	34.42
SpCond	53.80	92	29.55	24.53	34.58
SpCond	54.00	93	29.72	24.70	34.74
SpCond	54.25	94	29.76	24.74	34.78
SpCond	54.50	95	29.93	24.93	34.93
SpCond	54.70	96	30.00	24.99	35.01
SpCond	54.90	97	30.71	25.66	35.76
SpCond	55.70	98	30.88	25.85	35.91
SpCond	56.00	99	31.05	26.01	36.08
SpCond	56.15	100	31.21	26.18	36.25
SpCond	57.50	102	31.45	26.42	36.48
SpCond	57.75	103	31.49	26.46	36.52
SpCond	57.90	104	31.53	26.50	36.56
SpCond	58.00	105	31.66	26.62	36.69
SpCond	58.20	106	32.37	27.35	37.38
SpCond	59.00	107	32.49	27.47	37.50
SpCond	59.10	108	32.61	27.59	37.63
SpCond	59.50	112	33.63	28.58	38.67
SpCond	59.90	113	33.79	28.76	38.83
SpCond	60.50	114	34.50	29.43	39.58
SpCond	60.55	115	34.55	29.47	39.62
SpCond	60.65	116	34.71	29.65	39.77
SpCond	61.14	117	34.88	29.82	39.94
SpCond	62.00	120	35.88	30.82	40.95
SpCond	62.15	121	36.05	31.00	41.10
SpCond	62.30	122	36.12	31.07	41.17
SpCond	62.50	123	36.19	31.14	41.23
SpCond	63.00	125	36.43	31.38	41.47
SpCond	63.50	126	36.55	31.49	41.61
SpCond	64.00	127	36.72	31.65	41.78
SpCond	64.50	128	36.88	31.82	41.94
SpCond	64.90	129	37.05	32.00	42.11
SpCond	65.00	130	37.22	32.16	42.28
SpCond	65.40	131	37.26	32.21	42.31
SpCond	65.50	132	37.97	32.88	43.06
SpCond	66.00	133	38.14	33.05	43.22
SpCond	66.00	135	38.38	33.30	43.47
SpCond	67.00	136	38.55	33.46	43.64
SpCond	67.30	137	38.62	33.52	43.71
SpCond	67.71	138	38.74	33.66	43.82
SpCond	68.00	139	38.78	33.70	43.86
SpCond	68.10	140	38.95	33.87	44.03
SpCond	68.50	141	39.07	33.99	44.16
SpCond	68.70	142	39.19	34.11	44.28
SpCond	69.00	145	39.65	34.56	44.75

SpCond	70.00	147	40.49	35.36	45.61
SpCond	70.50	149	41.32	36.16	46.47
SpCond	70.60	150	41.36	36.20	46.51
SpCond	70.85	151	42.07	36.91	47.23
SpCond	71.00	153	42.18	37.02	47.34
SpCond	71.50	155	42.37	37.22	47.52
SpCond	72.00	156	42.44	37.29	47.59
SpCond	73.00	158	42.58	37.43	47.74
SpCond	73.06	159	42.75	37.60	47.89
SpCond	73.50	160	42.82	37.67	47.96
SpCond	73.85	161	42.99	37.85	48.12
SpCond	74.40	162	43.06	37.92	48.19
SpCond	74.55	163	43.22	38.08	48.36
SpCond	75.00	167	43.55	38.42	48.68
SpCond	75.20	168	43.67	38.53	48.81
SpCond	75.50	171	43.93	38.79	49.07
SpCond	76.50	172	44.10	38.96	49.24
SpCond	76.60	173	44.17	39.03	49.30
SpCond	77.00	174	44.33	39.20	49.47
SpCond	77.48	175	44.37	39.24	49.51
SpCond	77.50	176	44.44	39.31	49.58
SpCond	77.65	177	44.61	39.47	49.75
SpCond	78.50	178	44.63	39.49	49.77
SpCond	79.50	181	44.94	39.79	50.09
SpCond	79.90	182	45.06	39.92	50.20
SpCond	80.00	184	45.35	40.23	50.47
SpCond	80.50	185	45.47	40.35	50.59
SpCond	80.55	186	45.51	40.40	50.63
SpCond	80.60	187	45.64	40.53	50.74
SpCond	81.00	188	45.68	40.57	50.78
SpCond	82.00	191	45.91	40.82	51.00
SpCond	82.14	192	46.08	40.98	51.17
SpCond	82.40	193	46.20	41.11	51.29
SpCond	83.00	196	47.12	42.04	52.19
SpCond	83.50	199	48.07	42.99	53.15
SpCond	84.50	200	48.19	43.11	53.28
SpCond	84.55	201	48.26	43.18	53.34
SpCond	85.00	202	48.33	43.25	53.41
SpCond	85.85	203	49.04	43.97	54.12
SpCond	86.00	205	50.46	45.39	55.54
SpCond	86.05	207	50.70	45.63	55.77
SpCond	86.50	208	51.41	46.33	56.49
SpCond	86.60	209	52.12	47.00	57.24
SpCond	86.89	210	52.19	47.08	57.30
SpCond	86.90	211	52.23	47.12	57.34
SpCond	87.00	213	52.42	47.32	57.52
SpCond	88.00	214	52.59	47.50	57.68
SpCond	88.20	215	53.30	48.26	58.34
SpCond	88.50	219	54.37	49.34	59.40
SpCond	90.00	222	54.65	49.61	59.68
SpCond	90.50	223	54.82	49.79	59.84
SpCond	90.59	224	54.86	49.83	59.88
SpCond	91.78	225	54.90	49.87	59.92
SpCond	92.00	227	54.98	49.96	60.00
SpCond	92.40	228	55.05	50.03	60.07
SpCond	92.50	229	55.22	50.21	60.22
SpCond	93.00	230	55.34	50.33	60.35
SpCond	93.50	231	55.41	50.40	60.42
SpCond	95.25	232	56.12	51.14	61.09
SpCond	96.30	233	56.19	51.21	61.16
SpCond	97.30	234	56.31	51.34	61.28

SpCond	97.45	235	56.48	51.51	61.44
SpCond	97.60	236	56.60	51.63	61.57
SpCond	98.50	239	56.78	51.81	61.75
SpCond	99.00	240	56.85	51.88	61.82
SpCond	99.05	241	56.97	52.01	61.94
SpCond	100.00	242	57.68	52.73	62.64
SpCond	100.55	243	57.81	52.86	62.76
SpCond	100.75	244	57.88	52.93	62.83
SpCond	101.00	245	57.92	52.97	62.87
SpCond	101.50	246	57.99	53.04	62.93
SpCond	102.50	248	58.76	53.87	63.66
SpCond	102.95	249	58.93	54.05	63.82
SpCond	103.00	251	59.10	54.22	63.97
SpCond	103.20	252	59.81	54.99	64.62
SpCond	103.50	253	59.97	55.18	64.77
SpCond	104.00	254	60.04	55.24	64.84
SpCond	105.00	255	60.11	55.32	64.91
SpCond	106.70	256	60.28	55.49	65.07
SpCond	107.35	257	60.40	55.62	65.18
SpCond	107.50	259	60.61	55.84	65.39
SpCond	109.00	260	60.78	56.01	65.55
SpCond	109.17	261	61.49	56.76	66.22
SpCond	109.50	262	61.61	56.89	66.33
SpCond	109.70	263	61.73	57.01	66.46
SpCond	110.00	264	61.77	57.05	66.50
SpCond	110.20	265	61.90	57.18	66.61
SpCond	111.00	266	62.61	57.92	67.30
SpCond	111.50	267	62.65	57.96	67.34
SpCond	112.00	268	62.82	58.13	67.50
SpCond	112.50	269	62.84	58.15	67.52
SpCond	113.50	270	62.88	58.19	67.56
SpCond	114.00	271	62.95	58.27	67.63
SpCond	114.90	272	63.11	58.43	67.80
SpCond	115.00	274	63.32	58.64	68.00
SpCond	115.30	275	63.45	58.76	68.13
SpCond	115.50	278	63.78	59.10	68.45
SpCond	116.00	279	63.94	59.28	68.61
SpCond	117.00	281	64.11	59.45	68.77
SpCond	117.50	282	64.28	59.62	68.93
SpCond	118.00	284	64.57	59.90	69.23
SpCond	119.50	285	64.69	60.03	69.35
SpCond	120.50	286	64.86	60.20	69.51
SpCond	121.00	288	65.15	60.50	69.79
SpCond	122.00	289	65.21	60.57	69.86
SpCond	125.00	290	65.38	60.76	70.01
SpCond	126.50	291	65.45	60.82	70.08
SpCond	129.50	294	66.40	61.86	70.94
SpCond	130.00	295	66.52	61.99	71.06
SpCond	130.50	297	66.81	62.28	71.34
SpCond	131.00	299	67.05	62.52	71.58
SpCond	131.50	300	67.76	63.30	72.22
SpCond	132.50	302	68.51	64.17	72.85
SpCond	135.00	304	68.72	64.39	73.05
SpCond	135.50	305	68.84	64.51	73.17
SpCond	136.00	306	68.96	64.64	73.29
SpCond	137.00	308	69.15	64.82	73.49
SpCond	140.00	309	69.86	65.65	74.08
SpCond	141.00	311	70.20	65.99	74.41
SpCond	142.30	312	70.27	66.06	74.48
SpCond	145.50	313	70.98	66.84	75.12
SpCond	147.50	314	71.05	66.91	75.19

SpCond	148.00	315	71.17	67.03	75.31
SpCond	149.00	316	71.21	67.07	75.35
SpCond	150.50	317	71.38	67.23	75.53
SpCond	151.50	318	71.45	67.29	75.60
SpCond	154.00	319	71.62	67.42	75.81
SpCond	155.00	320	71.66	67.47	75.85
SpCond	155.50	321	71.73	67.54	75.91
SpCond	156.50	323	72.02	67.83	76.21
SpCond	157.00	325	72.23	68.04	76.42
SpCond	157.90	326	72.39	68.22	76.57
SpCond	159.50	327	72.44	68.26	76.61
SpCond	160.00	328	72.60	68.43	76.77
SpCond	164.50	329	73.31	69.17	77.46
SpCond	165.50	331	73.51	69.36	77.65
SpCond	170.40	332	74.22	70.17	78.26
SpCond	171.00	333	74.93	70.77	79.08
SpCond	172.00	334	75.09	70.95	79.24
SpCond	173.00	335	75.16	71.02	79.31
SpCond	173.50	336	75.33	71.19	79.47
SpCond	175.00	337	75.50	71.37	79.63
SpCond	176.50	338	75.57	71.44	79.69
SpCond	177.15	339	75.61	71.49	79.73
SpCond	177.50	340	75.73	71.61	79.85
SpCond	178.50	341	76.44	72.41	80.48
SpCond	178.70	342	76.51	72.47	80.55
SpCond	182.50	343	76.55	72.51	80.59
SpCond	182.60	344	76.72	72.68	80.75
SpCond	183.50	345	76.89	72.86	80.92
SpCond	183.95	346	77.60	73.63	81.56
SpCond	184.05	347	77.64	73.67	81.61
SpCond	188.00	348	77.76	73.80	81.72
SpCond	188.50	349	77.93	73.97	81.89
SpCond	189.20	350	78.64	74.74	82.54
SpCond	190.30	351	78.81	74.91	82.71
SpCond	191.50	352	78.88	74.98	82.78
SpCond	192.50	353	78.95	75.04	82.85
SpCond	196.50	354	79.01	75.11	82.92
SpCond	198.50	355	79.72	75.92	83.53
SpCond	200.60	356	79.79	75.99	83.60
SpCond	202.00	357	79.92	76.11	83.72
SpCond	202.50	358	79.99	76.18	83.79
SpCond	204.50	359	80.05	76.25	83.86
SpCond	205.00	360	80.18	76.38	83.97
SpCond	205.25	361	80.22	76.42	84.01
SpCond	205.50	362	80.34	76.55	84.13
SpCond	206.50	363	81.05	77.33	84.76
SpCond	207.00	364	81.17	77.46	84.89
SpCond	209.25	365	81.29	77.58	85.01
SpCond	213.50	366	81.36	77.65	85.07
SpCond	213.80	367	81.43	77.72	85.14
SpCond	216.00	368	81.60	77.89	85.31
SpCond	224.00	369	82.31	78.74	85.88
SpCond	226.50	370	82.35	78.79	85.92
SpCond	227.00	371	82.52	78.96	86.08
SpCond	228.00	372	82.56	79.00	86.12
SpCond	230.00	373	83.27	79.80	86.74
SpCond	231.45	374	83.39	79.92	86.86
SpCond	231.50	375	84.10	80.77	87.44
SpCond	232.00	377	84.34	81.02	87.66
SpCond	235.00	378	84.51	81.19	87.83
SpCond	237.85	379	84.58	81.26	87.90

SpCond	238.05	380	84.62	81.30	87.94
SpCond	240.90	381	84.66	81.34	87.98
SpCond	249.50	382	84.78	81.46	88.10
SpCond	252.25	383	84.90	81.58	88.23
SpCond	255.50	384	85.03	81.70	88.35
SpCond	257.00	385	85.15	81.83	88.46
SpCond	263.50	386	85.32	82.01	88.62
SpCond	265.10	387	85.36	82.05	88.66
SpCond	265.20	388	85.52	82.22	88.83
SpCond	267.00	389	86.23	83.02	89.45
SpCond	268.50	390	86.30	83.09	89.52
SpCond	276.00	391	86.43	83.21	89.64
SpCond	277.40	392	86.50	83.28	89.71
SpCond	282.00	393	86.66	83.44	89.88
SpCond	285.00	394	87.37	84.25	90.50
SpCond	289.00	395	87.44	84.32	90.57
SpCond	292.00	396	87.61	84.49	90.73
SpCond	297.21	397	87.65	84.54	90.77
SpCond	299.50	398	87.69	84.58	90.81
SpCond	300.00	399	87.81	84.71	90.92
SpCond	302.00	400	88.52	85.63	91.42
SpCond	304.00	402	88.71	85.80	91.63
SpCond	304.50	403	89.42	86.67	92.18
SpCond	306.05	404	89.59	86.86	92.33
SpCond	316.50	405	89.66	86.91	92.41
SpCond	318.00	406	89.78	87.04	92.52
SpCond	323.15	407	89.90	87.17	92.64
SpCond	323.90	408	89.97	87.23	92.71
SpCond	328.50	409	90.14	87.42	92.86
SpCond	329.00	410	90.31	87.58	93.03
SpCond	331.20	412	90.50	87.78	93.22
SpCond	332.00	413	90.62	87.91	93.34
SpCond	332.50	414	91.33	88.82	93.84
SpCond	334.00	415	91.45	88.95	93.96
SpCond	336.50	416	91.58	89.08	94.08
SpCond	347.50	417	91.65	89.14	94.15
SpCond	351.00	418	91.77	89.26	94.28
SpCond	357.85	419	91.94	89.44	94.43
SpCond	362.50	420	92.06	89.57	94.55
SpCond	366.00	421	92.10	89.61	94.59
SpCond	367.50	422	92.22	89.73	94.71
SpCond	372.50	423	92.39	89.91	94.86
SpCond	373.10	424	92.46	89.99	94.93
SpCond	381.50	426	92.65	90.17	95.13
SpCond	388.55	427	92.72	90.23	95.21
SpCond	391.00	428	92.84	90.36	95.33
SpCond	400.50	429	93.01	90.53	95.49
SpCond	408.70	430	93.13	90.64	95.62
SpCond	409.50	431	93.30	90.82	95.78
SpCond	410.00	432	93.34	90.86	95.82
SpCond	423.00	433	93.46	90.99	95.93
SpCond	427.50	434	93.58	91.11	96.06
SpCond	432.50	435	93.71	91.24	96.17
SpCond	433.00	436	93.75	91.28	96.21
SpCond	433.50	437	93.82	91.35	96.28
SpCond	434.50	438	94.53	92.29	96.77
SpCond	437.50	439	94.60	92.35	96.84
SpCond	438.50	440	95.31	93.39	97.22
SpCond	441.00	441	95.47	93.56	97.39
SpCond	452.95	442	95.64	93.75	97.54
SpCond	457.00	443	95.71	93.82	97.60

SpCond	466.00	444	95.88	94.00	97.75
SpCond	485.00	445	95.95	94.07	97.82
SpCond	487.00	446	96.02	94.15	97.89
SpCond	492.00	448	96.90	95.42	98.37
SpCond	497.50	449	97.02	95.56	98.47
SpCond	507.00	450	97.19	95.75	98.62
SpCond	512.00	451	97.23	95.79	98.66
SpCond	512.50	452	97.30	95.86	98.73
SpCond	528.00	453	97.46	96.06	98.87
SpCond	531.00	454	97.63	96.26	99.01
SpCond	574.50	455	97.75	96.39	99.12
SpCond	577.00	456	97.88	96.52	99.23
SpCond	580.00	457	97.95	96.59	99.30
SpCond	590.00	458	98.01	96.67	99.36
SpCond	634.95	459	98.06	96.71	99.40
SpCond	646.00	460	98.12	96.78	99.47
SpCond	746.50	461	98.17	96.82	99.51
SpCond	747.00	462	98.23	96.90	99.57
SpCond	753.50	463	98.30	96.97	99.63
SpCond	772.50	465	99.14	98.67	99.61
SpCond	778.50	466	99.26	98.83	99.68
SpCond	839.00	467	99.38	99.02	99.74
SpCond	910.00	468	99.45	99.10	99.80
SpCond	1003.50	469	99.52	99.14	99.90
SpCond	1006.00	470	99.69	99.46	99.91
SpCond	1156.00	471	99.81	99.61	100.00
SpCond	1167.00	472	99.88	99.68	100.00
SpCond	1892.00	473	100.00	100.00	100.00

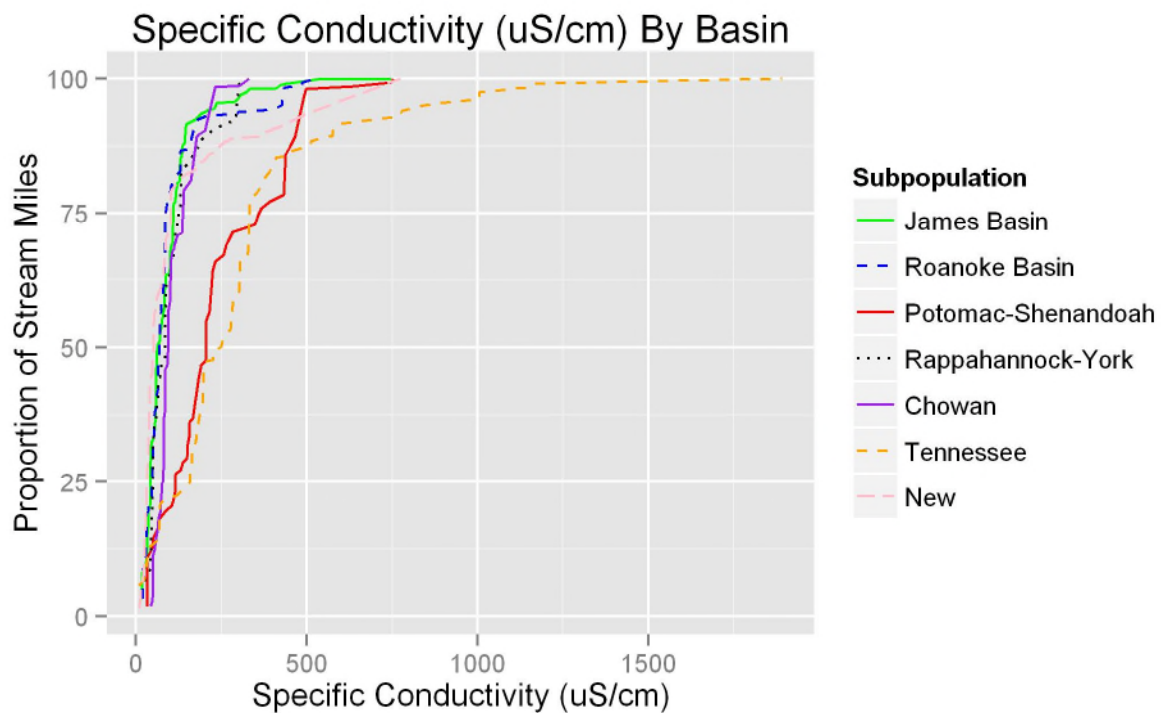


Figure 42. Specific Conductivity by Major Basin CDF graph.

Figure 42 and Table 26 show specific conductivity by major river basin (super basin). The 50<sup>th</sup> percentile is similar for all of the basins except the Potomac-Shenandoah and Tennessee (205 uS/cm and 249.5 uS/cm, respectively).

Table 26. **Specific Conductivity (SpCond) Estimates by Major Basin.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	SpCond	13.00	1	3.11	0.00	8.16
James Basin	SpCond	13.75	2	3.84	0.00	8.86
James Basin	SpCond	15.50	3	4.57	0.00	9.62
James Basin	SpCond	17.00	4	5.11	0.23	9.98
James Basin	SpCond	18.00	5	8.21	1.08	15.35
James Basin	SpCond	26.00	6	8.95	1.85	16.05
James Basin	SpCond	28.57	7	9.68	2.49	16.87
James Basin	SpCond	31.55	8	10.42	3.11	17.73
James Basin	SpCond	32.00	9	11.15	3.74	18.57
James Basin	SpCond	33.00	10	14.26	5.82	22.70
James Basin	SpCond	34.00	11	14.56	6.20	22.92
James Basin	SpCond	34.25	12	15.30	6.85	23.74
James Basin	SpCond	35.00	13	15.83	7.35	24.31
James Basin	SpCond	35.25	14	16.36	7.84	24.89
James Basin	SpCond	38.00	17	19.83	10.43	29.23
James Basin	SpCond	40.03	18	20.13	10.71	29.55
James Basin	SpCond	40.80	19	20.66	11.21	30.12
James Basin	SpCond	42.00	20	21.40	11.89	30.91
James Basin	SpCond	42.50	21	24.50	14.13	34.88
James Basin	SpCond	43.00	22	25.24	14.82	35.66
James Basin	SpCond	43.40	23	28.34	17.72	38.97
James Basin	SpCond	43.50	24	28.88	18.20	39.56
James Basin	SpCond	44.00	25	31.98	20.75	43.21
James Basin	SpCond	46.00	26	32.52	21.27	43.76
James Basin	SpCond	50.85	27	33.05	21.84	44.26
James Basin	SpCond	52.50	28	33.58	22.34	44.83
James Basin	SpCond	53.50	29	33.89	22.64	45.13
James Basin	SpCond	53.80	30	34.62	23.35	45.89
James Basin	SpCond	56.00	31	35.36	24.04	46.67
James Basin	SpCond	56.15	32	36.09	24.76	47.42
James Basin	SpCond	58.20	33	39.20	28.02	50.37
James Basin	SpCond	59.10	34	39.73	28.53	50.93
James Basin	SpCond	59.50	36	43.14	31.96	54.32
James Basin	SpCond	60.50	37	46.24	35.06	57.42
James Basin	SpCond	62.00	38	49.35	38.42	60.28
James Basin	SpCond	62.50	39	49.65	38.73	60.58
James Basin	SpCond	64.00	40	50.39	39.48	61.29
James Basin	SpCond	68.10	41	51.12	40.23	62.01
James Basin	SpCond	70.00	42	51.66	40.86	62.45
James Basin	SpCond	70.50	43	52.19	41.38	62.99
James Basin	SpCond	71.50	45	53.03	42.30	63.75
James Basin	SpCond	73.85	46	53.76	43.11	64.41
James Basin	SpCond	75.00	47	54.29	43.64	64.94
James Basin	SpCond	76.50	48	55.03	44.40	65.66
James Basin	SpCond	76.60	49	55.33	44.71	65.95
James Basin	SpCond	79.50	50	55.63	45.00	66.27
James Basin	SpCond	79.90	51	56.17	45.57	66.76
James Basin	SpCond	80.60	52	56.70	46.19	67.21
James Basin	SpCond	82.00	53	57.00	46.51	67.50
James Basin	SpCond	83.00	54	57.18	46.72	67.65
James Basin	SpCond	83.50	56	60.82	50.55	71.09
James Basin	SpCond	85.00	57	61.13	50.86	71.39

James Basin	SpCond	87.00	58	61.66	51.52	71.80
James Basin	SpCond	88.00	59	62.39	52.31	72.48
James Basin	SpCond	88.50	61	63.43	53.44	73.42
James Basin	SpCond	96.30	62	63.73	53.76	73.71
James Basin	SpCond	98.50	64	64.00	54.00	74.00
James Basin	SpCond	99.05	65	64.53	54.58	74.48
James Basin	SpCond	100.00	66	67.64	57.96	77.32
James Basin	SpCond	100.75	67	67.94	58.25	77.64
James Basin	SpCond	101.00	68	68.12	58.43	77.81
James Basin	SpCond	103.50	69	68.86	59.32	78.39
James Basin	SpCond	105.00	70	69.16	59.66	78.66
James Basin	SpCond	107.50	71	69.34	59.84	78.83
James Basin	SpCond	109.00	72	70.07	60.62	79.52
James Basin	SpCond	109.17	73	73.18	64.44	81.91
James Basin	SpCond	109.50	74	73.71	65.01	82.41
James Basin	SpCond	111.00	75	76.82	68.77	84.87
James Basin	SpCond	113.50	76	77.00	68.96	85.03
James Basin	SpCond	115.00	78	77.91	70.01	85.81
James Basin	SpCond	117.50	79	78.65	70.80	86.49
James Basin	SpCond	118.00	80	79.38	71.54	87.22
James Basin	SpCond	119.50	81	79.91	72.12	87.71
James Basin	SpCond	120.50	82	80.65	72.96	88.33
James Basin	SpCond	126.50	83	80.95	73.26	88.64
James Basin	SpCond	129.50	84	84.06	77.90	90.21
James Basin	SpCond	130.00	85	84.59	78.49	90.69
James Basin	SpCond	131.00	86	85.32	79.30	91.35
James Basin	SpCond	132.50	87	85.50	79.51	91.50
James Basin	SpCond	135.00	88	86.24	80.40	92.08
James Basin	SpCond	135.50	89	86.77	80.96	92.59
James Basin	SpCond	136.00	90	87.31	81.54	93.07
James Basin	SpCond	137.00	91	87.61	81.86	93.36
James Basin	SpCond	142.30	92	87.91	82.15	93.67
James Basin	SpCond	145.50	93	91.02	87.42	94.61
James Basin	SpCond	148.00	94	91.55	88.07	95.03
James Basin	SpCond	155.00	95	91.73	88.29	95.17
James Basin	SpCond	175.00	96	92.46	89.29	95.64
James Basin	SpCond	177.15	97	92.64	89.50	95.79
James Basin	SpCond	190.30	98	93.38	90.52	96.24
James Basin	SpCond	205.00	99	93.91	91.24	96.59
James Basin	SpCond	213.50	100	94.22	91.62	96.81
James Basin	SpCond	228.00	101	94.39	91.81	96.98
James Basin	SpCond	232.00	102	94.70	92.11	97.28
James Basin	SpCond	235.00	103	95.43	93.03	97.84
James Basin	SpCond	289.00	104	95.73	93.38	98.09
James Basin	SpCond	300.00	105	96.27	94.15	98.39
James Basin	SpCond	306.05	106	97.00	95.33	98.67
James Basin	SpCond	323.15	107	97.54	95.86	99.21
James Basin	SpCond	334.00	108	98.07	96.60	99.54
James Basin	SpCond	410.00	109	98.25	96.72	99.78
James Basin	SpCond	423.00	110	98.78	97.58	99.99
James Basin	SpCond	437.50	111	99.09	97.83	100.00
James Basin	SpCond	531.00	112	99.82	99.51	100.00
James Basin	SpCond	746.50	113	100.00	100.00	100.00
Roanoke Basin	SpCond	18.00	1	3.22	0.00	8.30
Roanoke Basin	SpCond	22.50	3	9.66	1.67	17.64
Roanoke Basin	SpCond	28.63	4	10.42	2.33	18.51
Roanoke Basin	SpCond	29.00	5	11.18	3.03	19.34
Roanoke Basin	SpCond	30.25	6	11.73	3.54	19.93
Roanoke Basin	SpCond	30.40	7	12.49	4.28	20.71
Roanoke Basin	SpCond	31.65	8	15.71	6.57	24.85
Roanoke Basin	SpCond	32.25	9	18.93	9.09	28.77



Roanoke Basin	SpCond	37.28	10	19.69	9.76	29.63
Roanoke Basin	SpCond	37.90	11	20.46	10.53	30.38
Roanoke Basin	SpCond	42.50	12	21.01	11.20	30.82
Roanoke Basin	SpCond	44.70	13	21.56	11.84	31.29
Roanoke Basin	SpCond	44.90	14	22.12	12.36	31.87
Roanoke Basin	SpCond	45.75	15	25.33	14.79	35.87
Roanoke Basin	SpCond	48.00	16	28.55	17.55	39.56
Roanoke Basin	SpCond	49.00	17	28.87	17.87	39.86
Roanoke Basin	SpCond	49.25	18	29.63	18.83	40.43
Roanoke Basin	SpCond	50.50	19	32.85	21.83	43.86
Roanoke Basin	SpCond	53.01	20	33.16	22.19	44.13
Roanoke Basin	SpCond	53.10	21	33.48	22.52	44.43
Roanoke Basin	SpCond	54.00	22	34.24	23.34	45.13
Roanoke Basin	SpCond	54.90	23	37.46	26.39	48.52
Roanoke Basin	SpCond	55.70	24	38.22	27.32	49.11
Roanoke Basin	SpCond	57.50	25	38.53	27.65	49.42
Roanoke Basin	SpCond	57.90	26	38.72	27.85	49.59
Roanoke Basin	SpCond	59.50	27	39.03	28.17	49.89
Roanoke Basin	SpCond	59.90	28	39.79	29.05	50.53
Roanoke Basin	SpCond	60.55	29	39.98	29.24	50.71
Roanoke Basin	SpCond	61.14	30	40.74	30.01	51.47
Roanoke Basin	SpCond	62.00	31	41.50	30.69	52.32
Roanoke Basin	SpCond	63.50	32	42.05	31.15	52.96
Roanoke Basin	SpCond	65.40	33	42.24	31.37	53.11
Roanoke Basin	SpCond	65.50	34	45.46	34.39	56.53
Roanoke Basin	SpCond	66.00	35	46.22	35.22	57.22
Roanoke Basin	SpCond	66.00	36	46.77	35.83	57.71
Roanoke Basin	SpCond	67.71	37	47.33	36.54	58.12
Roanoke Basin	SpCond	68.70	38	47.88	37.11	58.65
Roanoke Basin	SpCond	69.00	40	49.19	38.33	60.06
Roanoke Basin	SpCond	70.00	41	52.41	41.30	63.53
Roanoke Basin	SpCond	70.85	42	55.63	44.76	66.51
Roanoke Basin	SpCond	73.06	43	56.39	45.61	67.18
Roanoke Basin	SpCond	74.40	44	56.71	45.89	67.52
Roanoke Basin	SpCond	75.20	45	57.26	46.42	68.10
Roanoke Basin	SpCond	75.50	46	58.02	47.15	68.90
Roanoke Basin	SpCond	77.50	47	58.34	47.50	69.18
Roanoke Basin	SpCond	77.65	48	59.10	48.13	70.07
Roanoke Basin	SpCond	80.00	50	60.41	49.74	71.09
Roanoke Basin	SpCond	80.50	51	60.97	50.28	71.65
Roanoke Basin	SpCond	81.00	52	61.15	50.49	71.81
Roanoke Basin	SpCond	82.00	54	61.89	51.30	72.48
Roanoke Basin	SpCond	82.14	55	62.65	52.02	73.28
Roanoke Basin	SpCond	82.40	56	63.21	52.64	73.77
Roanoke Basin	SpCond	83.50	57	63.76	53.18	74.34
Roanoke Basin	SpCond	84.50	58	64.31	53.70	74.92
Roanoke Basin	SpCond	85.85	59	67.53	57.28	77.78
Roanoke Basin	SpCond	86.00	61	73.97	64.91	83.03
Roanoke Basin	SpCond	86.05	62	74.73	65.71	83.75
Roanoke Basin	SpCond	86.89	63	75.04	66.06	84.03
Roanoke Basin	SpCond	86.90	64	75.23	66.26	84.20
Roanoke Basin	SpCond	87.00	65	75.54	66.59	84.49
Roanoke Basin	SpCond	90.50	66	76.31	67.49	85.12
Roanoke Basin	SpCond	91.78	67	76.49	67.68	85.30
Roanoke Basin	SpCond	92.50	68	77.25	68.54	85.97
Roanoke Basin	SpCond	97.45	69	78.01	69.34	86.68
Roanoke Basin	SpCond	97.60	70	78.57	69.91	87.23
Roanoke Basin	SpCond	99.00	71	78.88	70.23	87.53
Roanoke Basin	SpCond	102.50	72	79.19	70.57	87.82
Roanoke Basin	SpCond	102.95	73	79.96	71.46	88.45
Roanoke Basin	SpCond	106.70	74	80.72	72.30	89.14

Roanoke Basin	SpCond	110.20	75	81.27	72.91	89.63
Roanoke Basin	SpCond	115.30	76	81.82	73.52	90.13
Roanoke Basin	SpCond	129.50	78	82.90	74.76	91.04
Roanoke Basin	SpCond	130.50	79	83.45	75.16	91.75
Roanoke Basin	SpCond	131.50	80	86.67	79.76	93.58
Roanoke Basin	SpCond	155.50	81	86.99	80.12	93.85
Roanoke Basin	SpCond	157.90	82	87.75	81.04	94.46
Roanoke Basin	SpCond	170.40	83	90.97	86.64	95.29
Roanoke Basin	SpCond	172.00	84	91.73	87.64	95.82
Roanoke Basin	SpCond	183.50	85	92.49	88.61	96.37
Roanoke Basin	SpCond	205.50	86	93.04	89.30	96.78
Roanoke Basin	SpCond	240.90	87	93.23	89.45	97.01
Roanoke Basin	SpCond	265.10	88	93.41	89.62	97.20
Roanoke Basin	SpCond	297.21	89	93.60	89.81	97.39
Roanoke Basin	SpCond	299.50	90	93.79	89.97	97.60
Roanoke Basin	SpCond	366.00	91	93.97	90.16	97.79
Roanoke Basin	SpCond	408.70	92	94.53	90.42	98.63
Roanoke Basin	SpCond	427.50	93	95.08	90.82	99.33
Roanoke Basin	SpCond	434.50	94	98.30	96.90	99.70
Roanoke Basin	SpCond	457.00	95	98.61	97.27	99.96
Roanoke Basin	SpCond	485.00	96	98.92	97.60	100.00
Roanoke Basin	SpCond	487.00	97	99.24	98.02	100.00
Roanoke Basin	SpCond	528.00	98	100.00	100.00	100.00
Potomac-Shenandoah	SpCond	32.50	1	1.76	0.00	4.64
Potomac-Shenandoah	SpCond	34.00	3	10.95	0.23	21.67
Potomac-Shenandoah	SpCond	49.00	4	12.71	2.08	23.34
Potomac-Shenandoah	SpCond	50.50	5	14.47	3.38	25.56
Potomac-Shenandoah	SpCond	63.00	6	16.23	4.80	27.66
Potomac-Shenandoah	SpCond	67.00	7	17.99	6.15	29.83
Potomac-Shenandoah	SpCond	90.00	8	19.75	7.53	31.97
Potomac-Shenandoah	SpCond	104.00	9	20.47	8.21	32.74
Potomac-Shenandoah	SpCond	109.70	10	21.75	9.47	34.04
Potomac-Shenandoah	SpCond	114.90	11	23.51	10.78	36.24
Potomac-Shenandoah	SpCond	115.50	12	24.79	12.11	37.46
Potomac-Shenandoah	SpCond	116.00	13	26.55	14.06	39.03
Potomac-Shenandoah	SpCond	131.00	14	27.27	14.72	39.83
Potomac-Shenandoah	SpCond	137.00	15	28.55	15.62	41.48
Potomac-Shenandoah	SpCond	147.50	16	29.27	16.21	42.34
Potomac-Shenandoah	SpCond	149.00	17	29.70	16.50	42.90
Potomac-Shenandoah	SpCond	150.50	18	31.46	17.80	45.13
Potomac-Shenandoah	SpCond	151.50	19	32.19	18.31	46.07
Potomac-Shenandoah	SpCond	156.50	20	33.95	19.64	48.25
Potomac-Shenandoah	SpCond	157.00	22	36.13	21.53	50.73
Potomac-Shenandoah	SpCond	165.50	23	36.86	22.11	51.61
Potomac-Shenandoah	SpCond	183.95	24	44.29	28.15	60.44
Potomac-Shenandoah	SpCond	188.50	25	46.05	29.59	62.52
Potomac-Shenandoah	SpCond	191.50	26	46.78	30.39	63.17
Potomac-Shenandoah	SpCond	204.50	27	47.50	30.99	64.01
Potomac-Shenandoah	SpCond	206.50	28	54.94	38.02	71.86
Potomac-Shenandoah	SpCond	216.00	29	56.70	39.59	73.81
Potomac-Shenandoah	SpCond	224.00	30	64.13	48.52	79.75
Potomac-Shenandoah	SpCond	232.00	31	65.89	50.57	81.22
Potomac-Shenandoah	SpCond	257.00	32	67.17	51.93	82.41
Potomac-Shenandoah	SpCond	263.50	33	68.93	53.79	84.07
Potomac-Shenandoah	SpCond	268.50	34	69.65	54.42	84.89
Potomac-Shenandoah	SpCond	282.00	35	71.41	56.01	86.82
Potomac-Shenandoah	SpCond	316.50	36	72.14	56.54	87.73
Potomac-Shenandoah	SpCond	347.50	37	72.86	57.14	88.59
Potomac-Shenandoah	SpCond	357.85	38	74.62	58.92	90.32
Potomac-Shenandoah	SpCond	367.50	39	75.90	60.12	91.67
Potomac-Shenandoah	SpCond	391.00	40	77.18	61.40	92.95

Potomac-Shenandoah	SpCond	432.50	41	78.45	62.69	94.22
Potomac-Shenandoah	SpCond	438.50	42	85.89	73.47	98.31
Potomac-Shenandoah	SpCond	452.95	43	87.65	75.42	99.88
Potomac-Shenandoah	SpCond	466.00	44	89.41	77.41	100.00
Potomac-Shenandoah	SpCond	492.00	45	96.84	93.73	99.95
Potomac-Shenandoah	SpCond	497.50	46	98.12	96.17	100.00
Potomac-Shenandoah	SpCond	634.95	47	98.55	96.69	100.00
Potomac-Shenandoah	SpCond	747.00	48	99.28	97.97	100.00
Potomac-Shenandoah	SpCond	753.50	49	100.00	100.00	100.00
Rappahannock-York	SpCond	26.00	1	6.55	0.00	15.38
Rappahannock-York	SpCond	35.60	2	7.68	0.00	16.68
Rappahannock-York	SpCond	42.00	3	8.80	0.00	17.96
Rappahannock-York	SpCond	43.30	4	10.35	2.18	18.53
Rappahannock-York	SpCond	46.45	5	16.91	3.52	30.29
Rappahannock-York	SpCond	46.60	6	17.55	4.17	30.92
Rappahannock-York	SpCond	47.05	7	18.19	4.85	31.52
Rappahannock-York	SpCond	48.20	8	19.74	6.51	32.96
Rappahannock-York	SpCond	48.50	9	20.37	7.12	33.62
Rappahannock-York	SpCond	50.15	10	26.93	11.40	42.46
Rappahannock-York	SpCond	50.50	11	28.48	12.85	44.10
Rappahannock-York	SpCond	51.65	12	35.03	19.31	50.75
Rappahannock-York	SpCond	54.25	13	35.41	19.69	51.13
Rappahannock-York	SpCond	57.75	14	35.79	20.09	51.49
Rappahannock-York	SpCond	59.00	15	36.91	21.26	52.57
Rappahannock-York	SpCond	60.65	16	38.46	22.85	54.08
Rappahannock-York	SpCond	62.30	17	39.10	23.48	54.72
Rappahannock-York	SpCond	64.50	18	40.65	24.98	56.33
Rappahannock-York	SpCond	64.90	19	42.20	26.69	57.72
Rappahannock-York	SpCond	65.00	20	43.75	28.15	59.36
Rappahannock-York	SpCond	68.00	21	44.13	28.53	59.74
Rappahannock-York	SpCond	70.60	22	44.51	28.90	60.12
Rappahannock-York	SpCond	71.00	23	44.89	29.27	60.51
Rappahannock-York	SpCond	73.50	24	45.53	29.96	61.10
Rappahannock-York	SpCond	75.00	25	46.65	30.96	62.35
Rappahannock-York	SpCond	75.50	26	47.29	31.65	62.93
Rappahannock-York	SpCond	86.05	27	47.93	32.29	63.57
Rappahannock-York	SpCond	86.50	28	54.48	39.08	69.89
Rappahannock-York	SpCond	88.50	29	61.04	45.72	76.36
Rappahannock-York	SpCond	90.00	30	61.68	46.43	76.92
Rappahannock-York	SpCond	92.00	31	62.05	46.84	77.27
Rappahannock-York	SpCond	97.30	32	63.18	48.32	78.04
Rappahannock-York	SpCond	101.50	33	63.82	49.18	78.46
Rappahannock-York	SpCond	103.00	35	65.32	50.94	79.71
Rappahannock-York	SpCond	107.50	36	66.87	52.64	81.11
Rappahannock-York	SpCond	112.00	37	68.42	54.42	82.43
Rappahannock-York	SpCond	114.00	38	69.06	55.12	83.01
Rappahannock-York	SpCond	115.50	40	70.99	57.24	84.74
Rappahannock-York	SpCond	117.00	41	71.37	57.66	85.08
Rappahannock-York	SpCond	121.00	42	72.50	58.99	86.01
Rappahannock-York	SpCond	122.00	43	73.14	59.70	86.57
Rappahannock-York	SpCond	125.00	44	74.69	61.46	87.91
Rappahannock-York	SpCond	130.50	45	76.24	63.34	89.13
Rappahannock-York	SpCond	132.50	46	82.79	74.36	91.21
Rappahannock-York	SpCond	154.00	47	84.34	75.08	93.60
Rappahannock-York	SpCond	159.50	48	84.72	75.50	93.94
Rappahannock-York	SpCond	165.50	49	85.84	76.86	94.83
Rappahannock-York	SpCond	182.60	50	87.39	78.51	96.28
Rappahannock-York	SpCond	188.00	51	88.52	79.71	97.32
Rappahannock-York	SpCond	209.25	52	89.65	80.70	98.59
Rappahannock-York	SpCond	231.45	53	90.77	81.82	99.72
Rappahannock-York	SpCond	292.00	54	92.32	83.52	100.00

Rappahannock-York	SpCond	302.00	55	98.87	96.86	100.00
Rappahannock-York	SpCond	318.00	56	100.00	100.00	100.00
Chowan	SpCond	43.50	1	1.89	0.00	5.04
Chowan	SpCond	46.20	2	2.67	0.00	6.19
Chowan	SpCond	48.00	3	3.45	0.00	7.28
Chowan	SpCond	50.00	4	11.46	0.00	23.16
Chowan	SpCond	54.70	5	12.24	0.47	24.01
Chowan	SpCond	57.50	6	14.13	2.34	25.92
Chowan	SpCond	62.00	7	15.51	3.56	27.46
Chowan	SpCond	63.00	8	16.29	4.06	28.52
Chowan	SpCond	66.00	9	17.66	5.10	30.23
Chowan	SpCond	67.30	10	18.44	5.77	31.12
Chowan	SpCond	71.00	11	19.23	6.48	31.97
Chowan	SpCond	72.00	12	20.01	7.20	32.82
Chowan	SpCond	73.00	14	21.60	8.52	34.68
Chowan	SpCond	75.00	16	22.53	9.55	35.50
Chowan	SpCond	75.50	17	22.75	9.72	35.78
Chowan	SpCond	77.00	18	24.64	11.23	38.06
Chowan	SpCond	78.50	19	24.86	11.43	38.30
Chowan	SpCond	79.50	20	26.76	12.53	40.99
Chowan	SpCond	80.55	21	27.22	12.95	41.49
Chowan	SpCond	83.00	23	37.12	20.49	53.75
Chowan	SpCond	84.55	24	37.90	21.30	54.50
Chowan	SpCond	86.60	25	45.91	26.97	64.84
Chowan	SpCond	90.00	26	46.37	27.43	65.30
Chowan	SpCond	92.00	27	46.83	27.97	65.69
Chowan	SpCond	93.00	28	48.21	29.39	67.02
Chowan	SpCond	93.50	29	48.99	30.28	67.69
Chowan	SpCond	95.25	30	56.99	37.14	76.85
Chowan	SpCond	98.50	31	58.37	38.35	78.38
Chowan	SpCond	102.50	32	66.37	47.66	85.08
Chowan	SpCond	107.35	33	67.75	49.32	86.17
Chowan	SpCond	110.00	34	68.21	49.76	86.66
Chowan	SpCond	111.50	35	68.67	50.25	87.10
Chowan	SpCond	112.50	36	68.89	50.45	87.34
Chowan	SpCond	121.00	37	70.79	52.36	89.22
Chowan	SpCond	135.00	38	71.25	52.80	89.70
Chowan	SpCond	140.00	39	79.26	62.41	96.10
Chowan	SpCond	160.00	40	81.15	64.37	97.93
Chowan	SpCond	178.50	41	89.15	76.97	100.00
Chowan	SpCond	182.50	42	89.62	77.41	100.00
Chowan	SpCond	202.50	43	90.40	78.25	100.00
Chowan	SpCond	231.50	44	98.40	96.19	100.00
Chowan	SpCond	304.00	45	98.62	96.43	100.00
Chowan	SpCond	332.00	46	100.00	100.00	100.00
Tennessee	SpCond	9.55	1	5.72	0.00	13.88
Tennessee	SpCond	26.50	2	7.07	0.00	15.53
Tennessee	SpCond	35.00	3	12.79	0.48	25.11
Tennessee	SpCond	58.00	4	13.78	1.35	26.21
Tennessee	SpCond	69.00	5	15.13	2.57	27.69
Tennessee	SpCond	70.50	6	20.85	6.47	35.23
Tennessee	SpCond	79.50	7	21.41	7.19	35.63
Tennessee	SpCond	118.00	8	22.39	8.09	36.69
Tennessee	SpCond	141.00	9	23.74	9.43	38.06
Tennessee	SpCond	156.50	10	24.73	10.66	38.80
Tennessee	SpCond	164.50	11	30.45	15.00	45.90
Tennessee	SpCond	173.00	12	31.01	15.69	46.32
Tennessee	SpCond	173.50	13	32.36	17.18	47.54
Tennessee	SpCond	176.50	14	32.92	17.90	47.94
Tennessee	SpCond	189.20	15	38.64	23.08	54.19
Tennessee	SpCond	192.50	16	39.19	23.61	54.78

Tennessee	SpCond	196.50	17	39.75	24.30	55.21
Tennessee	SpCond	198.50	18	45.47	30.19	60.75
Tennessee	SpCond	202.00	19	46.46	31.22	61.69
Tennessee	SpCond	207.00	20	47.44	32.30	62.58
Tennessee	SpCond	226.50	21	47.77	32.72	62.82
Tennessee	SpCond	227.00	22	49.12	34.41	63.84
Tennessee	SpCond	249.50	23	50.10	35.45	64.76
Tennessee	SpCond	252.25	24	51.09	36.46	65.72
Tennessee	SpCond	265.20	25	52.44	38.03	66.85
Tennessee	SpCond	276.00	26	53.42	39.06	67.78
Tennessee	SpCond	285.00	27	59.14	45.14	73.15
Tennessee	SpCond	304.00	28	60.50	46.37	74.63
Tennessee	SpCond	304.50	29	66.22	53.67	78.77
Tennessee	SpCond	323.90	30	66.78	54.27	79.28
Tennessee	SpCond	328.50	31	68.13	56.10	80.15
Tennessee	SpCond	329.00	32	69.48	57.59	81.37
Tennessee	SpCond	331.20	34	71.02	59.37	82.68
Tennessee	SpCond	332.50	35	76.74	67.64	85.85
Tennessee	SpCond	336.50	36	77.73	68.88	86.57
Tennessee	SpCond	351.00	37	78.71	70.05	87.37
Tennessee	SpCond	362.50	38	79.69	71.37	88.01
Tennessee	SpCond	372.50	39	81.04	73.25	88.84
Tennessee	SpCond	381.50	40	82.03	74.42	89.64
Tennessee	SpCond	388.55	41	82.59	74.99	90.18
Tennessee	SpCond	400.50	42	83.94	76.62	91.26
Tennessee	SpCond	409.50	43	85.29	78.51	92.07
Tennessee	SpCond	433.00	44	85.62	78.90	92.34
Tennessee	SpCond	433.50	45	86.18	79.62	92.74
Tennessee	SpCond	507.00	46	87.53	81.52	93.55
Tennessee	SpCond	512.00	47	87.86	81.92	93.81
Tennessee	SpCond	512.50	48	88.42	82.60	94.25
Tennessee	SpCond	574.50	49	89.40	83.85	94.95
Tennessee	SpCond	577.00	50	90.39	85.20	95.57
Tennessee	SpCond	580.00	51	90.94	85.93	95.96
Tennessee	SpCond	590.00	52	91.50	86.63	96.38
Tennessee	SpCond	646.00	53	92.06	87.39	96.73
Tennessee	SpCond	772.50	54	93.04	88.75	97.34
Tennessee	SpCond	778.50	55	94.03	90.24	97.81
Tennessee	SpCond	839.00	56	95.01	91.85	98.16
Tennessee	SpCond	910.00	57	95.57	92.60	98.53
Tennessee	SpCond	1003.50	58	96.12	92.94	99.31
Tennessee	SpCond	1006.00	59	97.48	95.60	99.35
Tennessee	SpCond	1156.00	60	98.46	96.79	100.00
Tennessee	SpCond	1167.00	61	99.02	97.43	100.00
Tennessee	SpCond	1892.00	62	100.00	100.00	100.00
New	SpCond	9.80	1	1.59	0.00	4.16
New	SpCond	13.00	2	3.18	0.00	7.03
New	SpCond	24.00	3	9.91	0.00	21.04
New	SpCond	28.50	4	16.64	2.74	30.54
New	SpCond	31.50	5	23.37	7.67	39.07
New	SpCond	32.00	6	24.52	8.76	40.29
New	SpCond	33.00	7	26.12	10.14	42.10
New	SpCond	34.00	8	27.71	11.73	43.69
New	SpCond	34.75	9	28.86	12.63	45.10
New	SpCond	37.50	10	30.02	13.58	46.46
New	SpCond	39.85	11	36.75	19.34	54.16
New	SpCond	41.60	12	43.48	25.29	61.66
New	SpCond	45.75	13	45.07	27.02	63.12
New	SpCond	48.00	14	46.23	28.39	64.06
New	SpCond	52.00	15	52.95	35.77	70.14
New	SpCond	52.50	16	54.55	37.44	71.65

New	SpCond	54.50	17	56.14	39.27	73.01
New	SpCond	59.50	18	57.73	40.61	74.84
New	SpCond	62.15	19	59.32	42.51	76.13
New	SpCond	68.50	20	60.48	43.44	77.51
New	SpCond	74.55	21	62.07	45.40	78.73
New	SpCond	77.48	22	62.46	45.88	79.04
New	SpCond	88.20	23	69.19	54.23	84.14
New	SpCond	88.50	24	70.34	55.33	85.35
New	SpCond	90.59	25	70.73	55.76	85.70
New	SpCond	92.40	26	71.39	56.39	86.38
New	SpCond	100.55	27	72.54	57.58	87.50
New	SpCond	103.20	28	79.27	67.55	90.99
New	SpCond	117.00	29	80.43	68.79	92.06
New	SpCond	141.00	30	82.02	70.59	93.45
New	SpCond	177.50	31	83.17	72.02	94.33
New	SpCond	178.70	32	83.83	72.57	95.09
New	SpCond	184.05	33	84.22	72.96	95.48
New	SpCond	200.60	34	84.88	73.68	96.07
New	SpCond	205.25	35	85.26	74.08	96.44
New	SpCond	213.80	36	85.92	74.67	97.17
New	SpCond	237.85	37	86.58	75.24	97.91
New	SpCond	238.05	38	86.96	75.65	98.28
New	SpCond	255.50	39	88.12	76.81	99.43
New	SpCond	277.40	40	88.78	77.45	100.00
New	SpCond	373.10	41	89.43	78.17	100.00
New	SpCond	381.50	42	90.09	78.59	100.00
New	SpCond	441.00	43	91.68	80.21	100.00
New	SpCond	492.00	44	93.27	82.01	100.00
New	SpCond	772.50	45	100.00	100.00	100.00

### Specific Conductivity (uS/cm) By Ecoregion

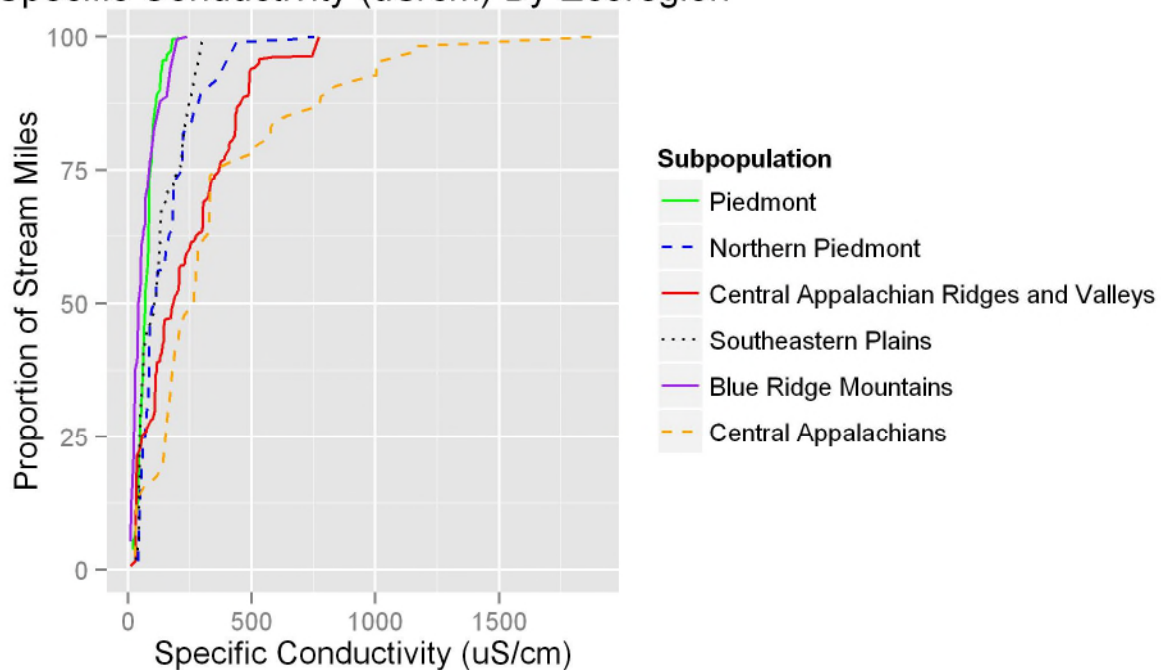


Figure 43. Specific Conductivity by Major Ecoregion (Level III) CDF graph.

Figure 43 and Table 27 present CDF curves for specific conductivity by ecoregion. The Central Appalachians and Central Appalachian Ridges and Valleys have the highest overall specific conductivity concentrations as evidenced by their respective 50<sup>th</sup> percentiles of 265 and 184 uS/cm. Ninety percent of streams in the Central Appalachians have specific conductivity concentrations of less than 839 uS/cm. The Central Appalachian Ridges and Valleys 90<sup>th</sup> percentile is around 490 uS/cm.

Table 27. Specific Conductivity Population Estimates by Major Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	SpCond	18.00	2	3.73	0.00	8.06
Piedmont	SpCond	22.50	3	5.60	0.56	10.64
Piedmont	SpCond	26.00	4	6.04	1.06	11.02
Piedmont	SpCond	28.63	5	6.48	1.45	11.52
Piedmont	SpCond	30.25	6	6.80	1.74	11.86
Piedmont	SpCond	30.40	7	7.24	2.17	12.32
Piedmont	SpCond	31.65	8	9.11	3.44	14.78
Piedmont	SpCond	32.25	9	10.98	4.81	17.14
Piedmont	SpCond	34.00	10	11.16	4.99	17.32
Piedmont	SpCond	37.28	11	11.60	5.39	17.81
Piedmont	SpCond	37.90	12	12.04	5.85	18.24
Piedmont	SpCond	38.00	14	12.26	6.09	18.43
Piedmont	SpCond	40.03	15	12.44	6.26	18.62
Piedmont	SpCond	40.80	16	12.76	6.56	18.97
Piedmont	SpCond	42.00	17	13.08	6.86	19.31
Piedmont	SpCond	42.50	19	15.27	8.53	22.01
Piedmont	SpCond	43.40	20	17.13	10.15	24.12
Piedmont	SpCond	44.00	21	19.00	11.59	26.41
Piedmont	SpCond	44.90	22	19.32	11.90	26.74
Piedmont	SpCond	45.75	23	21.19	13.39	28.99
Piedmont	SpCond	46.20	24	21.37	13.56	29.18
Piedmont	SpCond	46.60	25	21.55	13.74	29.36
Piedmont	SpCond	48.00	27	23.60	15.53	31.67
Piedmont	SpCond	49.00	28	23.78	15.72	31.85
Piedmont	SpCond	49.25	29	24.22	16.26	32.18
Piedmont	SpCond	50.00	30	26.09	17.92	34.26
Piedmont	SpCond	50.50	32	28.40	20.13	36.66
Piedmont	SpCond	50.85	33	28.72	20.47	36.97
Piedmont	SpCond	52.50	34	29.04	20.78	37.29
Piedmont	SpCond	53.01	35	29.22	20.99	37.45
Piedmont	SpCond	53.10	36	29.40	21.17	37.63
Piedmont	SpCond	53.80	37	29.84	21.65	38.04
Piedmont	SpCond	54.70	38	30.03	21.82	38.23
Piedmont	SpCond	54.90	39	31.89	23.54	40.25
Piedmont	SpCond	55.70	40	32.33	24.05	40.62
Piedmont	SpCond	57.50	42	32.96	24.69	41.23
Piedmont	SpCond	57.75	43	33.07	24.80	41.33
Piedmont	SpCond	57.90	44	33.17	24.92	41.43
Piedmont	SpCond	58.20	45	35.04	26.84	43.24
Piedmont	SpCond	59.00	46	35.36	27.16	43.56
Piedmont	SpCond	59.10	47	35.68	27.48	43.89
Piedmont	SpCond	59.50	48	35.86	27.68	44.05
Piedmont	SpCond	59.90	49	36.31	28.17	44.44
Piedmont	SpCond	60.50	50	38.17	29.92	46.42
Piedmont	SpCond	60.55	51	38.28	30.03	46.53
Piedmont	SpCond	61.14	52	38.72	30.48	46.97



Piedmont	SpCond	62.00	55	41.35	33.19	49.51
Piedmont	SpCond	62.50	56	41.53	33.37	49.69
Piedmont	SpCond	63.00	57	41.71	33.52	49.91
Piedmont	SpCond	63.50	58	42.03	33.80	50.27
Piedmont	SpCond	64.90	59	42.48	34.26	50.69
Piedmont	SpCond	65.00	60	42.92	34.71	51.12
Piedmont	SpCond	65.40	61	43.02	34.84	51.21
Piedmont	SpCond	65.50	62	44.89	36.63	53.16
Piedmont	SpCond	66.00	63	45.33	37.10	53.56
Piedmont	SpCond	66.00	65	45.97	37.75	54.20
Piedmont	SpCond	67.30	66	46.16	37.92	54.39
Piedmont	SpCond	67.71	67	46.48	38.31	54.65
Piedmont	SpCond	68.10	68	46.92	38.75	55.08
Piedmont	SpCond	68.70	69	47.24	39.09	55.39
Piedmont	SpCond	69.00	71	48.00	39.81	56.19
Piedmont	SpCond	70.00	73	50.19	41.94	58.44
Piedmont	SpCond	70.50	74	50.51	42.25	58.76
Piedmont	SpCond	70.85	75	52.38	44.21	60.54
Piedmont	SpCond	71.00	76	52.56	44.39	60.73
Piedmont	SpCond	71.50	77	52.74	44.59	60.89
Piedmont	SpCond	72.00	78	52.92	44.77	61.08
Piedmont	SpCond	73.00	79	53.24	45.08	61.41
Piedmont	SpCond	73.06	80	53.68	45.56	61.81
Piedmont	SpCond	74.40	81	53.87	45.73	62.00
Piedmont	SpCond	75.00	82	53.97	45.85	62.10
Piedmont	SpCond	75.20	83	54.29	46.15	62.44
Piedmont	SpCond	75.50	84	54.74	46.57	62.90
Piedmont	SpCond	76.60	85	54.92	46.76	63.07
Piedmont	SpCond	77.00	86	55.36	47.21	63.51
Piedmont	SpCond	77.50	87	55.54	47.41	63.67
Piedmont	SpCond	77.65	88	55.98	47.81	64.15
Piedmont	SpCond	79.50	90	56.61	48.38	64.83
Piedmont	SpCond	79.90	91	56.93	48.72	65.14
Piedmont	SpCond	80.00	93	57.69	49.58	65.79
Piedmont	SpCond	80.50	94	58.01	49.90	66.12
Piedmont	SpCond	80.55	95	58.12	50.01	66.23
Piedmont	SpCond	80.60	96	58.44	50.37	66.51
Piedmont	SpCond	81.00	97	58.55	50.49	66.60
Piedmont	SpCond	82.00	99	58.97	50.95	67.00
Piedmont	SpCond	82.14	100	59.42	51.37	67.46
Piedmont	SpCond	82.40	101	59.74	51.73	67.75
Piedmont	SpCond	83.00	104	62.15	54.35	69.95
Piedmont	SpCond	83.50	106	64.34	56.62	72.05
Piedmont	SpCond	84.50	107	64.66	56.92	72.40
Piedmont	SpCond	84.55	108	64.84	57.11	72.57
Piedmont	SpCond	85.00	109	65.02	57.30	72.75
Piedmont	SpCond	85.85	110	66.89	59.34	74.44
Piedmont	SpCond	86.00	112	70.62	63.40	77.85
Piedmont	SpCond	86.05	113	71.06	63.86	78.27
Piedmont	SpCond	86.60	114	72.93	65.66	80.20
Piedmont	SpCond	86.89	115	73.11	65.85	80.37
Piedmont	SpCond	86.90	116	73.22	65.97	80.47
Piedmont	SpCond	87.00	118	73.72	66.51	80.93
Piedmont	SpCond	88.00	119	74.16	66.99	81.34
Piedmont	SpCond	88.50	120	74.61	67.49	81.72
Piedmont	SpCond	90.00	122	74.90	67.80	82.00
Piedmont	SpCond	90.50	123	75.34	68.29	82.38
Piedmont	SpCond	91.78	124	75.45	68.40	82.49
Piedmont	SpCond	92.50	125	75.89	68.89	82.89
Piedmont	SpCond	93.00	126	76.21	69.18	83.23
Piedmont	SpCond	93.50	127	76.39	69.36	83.42



Piedmont	SpCond	95.25	128	78.26	71.57	84.95
Piedmont	SpCond	96.30	129	78.44	71.75	85.12
Piedmont	SpCond	97.45	130	78.88	72.24	85.52
Piedmont	SpCond	97.60	131	79.20	72.55	85.85
Piedmont	SpCond	98.50	133	79.36	72.69	86.03
Piedmont	SpCond	99.00	134	79.54	72.89	86.20
Piedmont	SpCond	99.05	135	79.86	73.24	86.49
Piedmont	SpCond	100.00	136	81.73	75.47	87.99
Piedmont	SpCond	101.00	137	81.84	75.58	88.09
Piedmont	SpCond	102.50	139	83.88	78.24	89.53
Piedmont	SpCond	102.95	140	84.33	78.75	89.91
Piedmont	SpCond	103.50	141	84.77	79.26	90.28
Piedmont	SpCond	105.00	142	84.95	79.46	90.44
Piedmont	SpCond	106.70	143	85.39	79.93	90.85
Piedmont	SpCond	107.35	144	85.71	80.29	91.13
Piedmont	SpCond	107.50	145	85.82	80.40	91.23
Piedmont	SpCond	109.50	146	86.14	80.76	91.52
Piedmont	SpCond	109.70	147	86.46	81.05	91.87
Piedmont	SpCond	110.20	148	86.78	81.40	92.16
Piedmont	SpCond	111.50	149	86.89	81.52	92.26
Piedmont	SpCond	112.00	150	87.33	82.01	92.65
Piedmont	SpCond	114.00	151	87.51	82.20	92.83
Piedmont	SpCond	115.00	153	88.06	82.77	93.35
Piedmont	SpCond	115.30	154	88.38	83.05	93.71
Piedmont	SpCond	115.50	155	88.70	83.36	94.05
Piedmont	SpCond	118.00	156	89.15	83.81	94.48
Piedmont	SpCond	119.50	157	89.47	84.17	94.77
Piedmont	SpCond	129.50	159	90.09	84.81	95.37
Piedmont	SpCond	130.50	161	90.85	85.51	96.19
Piedmont	SpCond	131.00	162	91.29	85.97	96.62
Piedmont	SpCond	131.50	163	93.16	88.64	97.68
Piedmont	SpCond	132.50	164	93.27	88.75	97.78
Piedmont	SpCond	135.00	165	93.71	89.25	98.17
Piedmont	SpCond	140.00	166	95.58	92.40	98.75
Piedmont	SpCond	155.00	167	95.68	92.51	98.85
Piedmont	SpCond	155.50	168	95.86	92.71	99.02
Piedmont	SpCond	156.50	169	96.31	93.23	99.38
Piedmont	SpCond	157.90	170	96.75	93.77	99.73
Piedmont	SpCond	172.00	171	97.19	94.31	100.00
Piedmont	SpCond	175.00	172	97.63	94.84	100.00
Piedmont	SpCond	178.50	173	99.50	98.84	100.00
Piedmont	SpCond	202.50	174	99.68	99.11	100.00
Piedmont	SpCond	205.50	175	100.00	100.00	100.00
Northern Piedmont	SpCond	42.00	1	1.64	0.00	4.24
Northern Piedmont	SpCond	43.00	2	3.29	0.00	6.98
Northern Piedmont	SpCond	43.30	3	4.93	0.48	9.39
Northern Piedmont	SpCond	43.50	4	6.13	1.10	11.16
Northern Piedmont	SpCond	46.00	5	7.32	1.96	12.69
Northern Piedmont	SpCond	47.05	6	8.00	2.49	13.51
Northern Piedmont	SpCond	50.15	7	14.96	3.78	26.13
Northern Piedmont	SpCond	53.50	8	15.63	4.46	26.81
Northern Piedmont	SpCond	59.50	10	23.26	9.82	36.71
Northern Piedmont	SpCond	67.00	11	24.91	11.14	38.68
Northern Piedmont	SpCond	70.60	12	25.31	11.56	39.06
Northern Piedmont	SpCond	71.00	13	25.71	11.94	39.48
Northern Piedmont	SpCond	71.50	14	26.91	13.21	40.61
Northern Piedmont	SpCond	73.50	15	27.59	13.94	41.23
Northern Piedmont	SpCond	75.50	16	28.26	14.69	41.84
Northern Piedmont	SpCond	76.50	17	29.91	16.28	43.53
Northern Piedmont	SpCond	82.00	18	30.59	17.00	44.17
Northern Piedmont	SpCond	83.50	19	31.78	18.28	45.28

Northern Piedmont	SpCond	86.50	20	38.73	23.85	53.62
Northern Piedmont	SpCond	88.50	21	45.69	30.34	61.04
Northern Piedmont	SpCond	90.00	22	47.33	31.80	62.87
Northern Piedmont	SpCond	92.00	23	47.73	32.24	63.23
Northern Piedmont	SpCond	97.30	24	48.93	33.68	64.18
Northern Piedmont	SpCond	101.50	25	49.61	34.63	64.59
Northern Piedmont	SpCond	103.00	26	50.80	36.08	65.53
Northern Piedmont	SpCond	113.50	27	51.20	36.54	65.87
Northern Piedmont	SpCond	114.90	28	52.85	37.96	67.73
Northern Piedmont	SpCond	115.50	29	53.25	38.43	68.07
Northern Piedmont	SpCond	120.50	30	54.90	40.23	69.56
Northern Piedmont	SpCond	121.00	31	56.09	41.60	70.58
Northern Piedmont	SpCond	149.00	32	56.49	41.87	71.11
Northern Piedmont	SpCond	150.50	33	58.14	43.27	73.00
Northern Piedmont	SpCond	151.50	34	58.81	43.74	73.88
Northern Piedmont	SpCond	157.00	36	60.86	45.52	76.21
Northern Piedmont	SpCond	165.50	38	62.73	47.51	77.96
Northern Piedmont	SpCond	182.60	39	64.38	49.09	79.66
Northern Piedmont	SpCond	183.95	40	71.33	56.67	85.99
Northern Piedmont	SpCond	188.00	41	72.53	57.84	87.21
Northern Piedmont	SpCond	191.50	42	73.20	58.54	87.87
Northern Piedmont	SpCond	216.00	43	74.85	60.03	89.67
Northern Piedmont	SpCond	224.00	44	81.80	70.03	93.58
Northern Piedmont	SpCond	231.45	45	83.00	71.22	94.77
Northern Piedmont	SpCond	257.00	46	84.19	72.42	95.97
Northern Piedmont	SpCond	263.50	47	85.84	74.24	97.43
Northern Piedmont	SpCond	282.00	48	87.48	75.63	99.33
Northern Piedmont	SpCond	292.00	49	89.13	77.42	100.00
Northern Piedmont	SpCond	318.00	50	90.32	78.74	100.00
Northern Piedmont	SpCond	357.85	51	91.97	80.51	100.00
Northern Piedmont	SpCond	438.50	52	98.92	97.64	100.00
Northern Piedmont	SpCond	634.95	53	99.32	98.09	100.00
Northern Piedmont	SpCond	753.50	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	SpCond	9.80	1	0.79	0.00	2.06
Central Appalachian Ridges and Valleys	SpCond	28.57	2	1.58	0.00	3.38
Central Appalachian Ridges and Valleys	SpCond	31.50	3	4.93	0.00	9.87
Central Appalachian Ridges and Valleys	SpCond	31.55	4	5.72	0.61	10.84
Central Appalachian Ridges and Valleys	SpCond	32.00	5	6.30	1.12	11.48
Central Appalachian Ridges and Valleys	SpCond	32.50	6	7.09	1.72	12.45
Central Appalachian Ridges and Valleys	SpCond	33.00	8	11.23	4.25	18.21
Central Appalachian Ridges and Valleys	SpCond	34.00	11	16.16	7.96	24.36
Central Appalachian Ridges and Valleys	SpCond	34.25	12	16.95	8.66	25.24
Central Appalachian Ridges and Valleys	SpCond	35.00	13	17.53	9.21	25.84
Central Appalachian Ridges and Valleys	SpCond	35.25	14	18.10	9.73	26.47
Central Appalachian Ridges and Valleys	SpCond	38.00	15	21.45	12.11	30.78
Central Appalachian Ridges and Valleys	SpCond	45.75	16	22.24	12.96	31.52
Central Appalachian Ridges and Valleys	SpCond	49.00	17	23.03	13.80	32.26
Central Appalachian Ridges and Valleys	SpCond	52.50	18	23.82	14.58	33.07
Central Appalachian Ridges and Valleys	SpCond	56.00	19	24.61	15.31	33.92
Central Appalachian Ridges and Valleys	SpCond	58.00	20	25.19	15.89	34.49
Central Appalachian Ridges and Valleys	SpCond	73.85	21	25.98	16.85	35.12
Central Appalachian Ridges and Valleys	SpCond	75.00	22	26.56	17.40	35.71
Central Appalachian Ridges and Valleys	SpCond	79.50	23	26.88	17.72	36.05
Central Appalachian Ridges and Valleys	SpCond	88.50	25	27.78	18.59	36.97
Central Appalachian Ridges and Valleys	SpCond	90.59	26	27.98	18.76	37.19
Central Appalachian Ridges and Valleys	SpCond	100.55	27	28.55	19.31	37.79
Central Appalachian Ridges and Valleys	SpCond	100.75	28	28.88	19.63	38.12
Central Appalachian Ridges and Valleys	SpCond	104.00	29	29.21	19.94	38.47
Central Appalachian Ridges and Valleys	SpCond	109.00	30	30.00	20.72	39.28
Central Appalachian Ridges and Valleys	SpCond	109.17	31	33.34	23.79	42.90
Central Appalachian Ridges and Valleys	SpCond	111.00	32	36.69	26.60	46.78

Central Appalachian Ridges and Valleys	SpCond	116.00	33	37.48	27.51	47.46
Central Appalachian Ridges and Valleys	SpCond	117.00	34	38.06	28.12	47.99
Central Appalachian Ridges and Valleys	SpCond	117.50	35	38.85	28.99	48.71
Central Appalachian Ridges and Valleys	SpCond	126.50	36	39.18	29.34	49.01
Central Appalachian Ridges and Valleys	SpCond	130.00	37	39.75	29.96	49.54
Central Appalachian Ridges and Valleys	SpCond	131.00	38	40.08	30.28	49.87
Central Appalachian Ridges and Valleys	SpCond	135.50	39	40.65	30.90	50.41
Central Appalachian Ridges and Valleys	SpCond	137.00	41	41.55	31.76	51.35
Central Appalachian Ridges and Valleys	SpCond	141.00	42	42.35	32.58	52.11
Central Appalachian Ridges and Valleys	SpCond	142.30	43	42.67	32.93	52.42
Central Appalachian Ridges and Valleys	SpCond	145.50	44	46.02	36.33	55.71
Central Appalachian Ridges and Valleys	SpCond	147.50	45	46.34	36.65	56.04
Central Appalachian Ridges and Valleys	SpCond	148.00	46	46.92	37.28	56.56
Central Appalachian Ridges and Valleys	SpCond	173.00	47	47.25	37.59	56.90
Central Appalachian Ridges and Valleys	SpCond	173.50	48	48.04	38.39	57.68
Central Appalachian Ridges and Valleys	SpCond	176.50	49	48.36	38.75	57.98
Central Appalachian Ridges and Valleys	SpCond	177.15	50	48.56	38.98	58.13
Central Appalachian Ridges and Valleys	SpCond	177.50	51	49.13	39.71	58.55
Central Appalachian Ridges and Valleys	SpCond	178.70	52	49.46	40.01	58.91
Central Appalachian Ridges and Valleys	SpCond	183.50	53	50.25	40.79	59.72
Central Appalachian Ridges and Valleys	SpCond	184.05	54	50.44	40.99	59.90
Central Appalachian Ridges and Valleys	SpCond	188.50	55	51.24	41.71	60.76
Central Appalachian Ridges and Valleys	SpCond	192.50	56	51.56	42.04	61.08
Central Appalachian Ridges and Valleys	SpCond	196.50	57	51.89	42.37	61.40
Central Appalachian Ridges and Valleys	SpCond	200.60	58	52.21	42.73	61.70
Central Appalachian Ridges and Valleys	SpCond	204.50	59	52.54	43.05	62.04
Central Appalachian Ridges and Valleys	SpCond	205.00	60	53.12	43.68	62.55
Central Appalachian Ridges and Valleys	SpCond	205.25	61	53.31	43.89	62.73
Central Appalachian Ridges and Valleys	SpCond	206.50	62	56.66	47.27	66.04
Central Appalachian Ridges and Valleys	SpCond	213.80	63	56.98	47.62	66.35
Central Appalachian Ridges and Valleys	SpCond	226.50	64	57.18	47.82	66.53
Central Appalachian Ridges and Valleys	SpCond	228.00	65	57.37	48.03	66.70
Central Appalachian Ridges and Valleys	SpCond	232.00	67	58.49	49.29	67.69
Central Appalachian Ridges and Valleys	SpCond	235.00	68	59.28	50.11	68.44
Central Appalachian Ridges and Valleys	SpCond	238.05	69	59.47	50.32	68.63
Central Appalachian Ridges and Valleys	SpCond	240.90	70	59.67	50.51	68.83
Central Appalachian Ridges and Valleys	SpCond	249.50	71	60.24	51.05	69.43
Central Appalachian Ridges and Valleys	SpCond	252.25	72	60.82	51.64	69.99
Central Appalachian Ridges and Valleys	SpCond	255.50	73	61.39	52.23	70.56
Central Appalachian Ridges and Valleys	SpCond	265.10	74	61.58	52.42	70.75
Central Appalachian Ridges and Valleys	SpCond	268.50	75	61.91	52.72	71.10
Central Appalachian Ridges and Valleys	SpCond	276.00	76	62.49	53.28	71.69
Central Appalachian Ridges and Valleys	SpCond	277.40	77	62.81	53.61	72.02
Central Appalachian Ridges and Valleys	SpCond	289.00	78	63.14	53.98	72.30
Central Appalachian Ridges and Valleys	SpCond	297.21	79	63.33	54.16	72.50
Central Appalachian Ridges and Valleys	SpCond	299.50	80	63.53	54.35	72.70
Central Appalachian Ridges and Valleys	SpCond	300.00	81	64.10	55.01	73.19
Central Appalachian Ridges and Valleys	SpCond	304.00	82	64.89	55.60	74.18
Central Appalachian Ridges and Valleys	SpCond	304.50	83	68.24	59.31	77.17
Central Appalachian Ridges and Valleys	SpCond	306.05	84	69.03	60.24	77.82
Central Appalachian Ridges and Valleys	SpCond	316.50	85	69.36	60.52	78.19
Central Appalachian Ridges and Valleys	SpCond	323.15	86	69.93	61.09	78.77
Central Appalachian Ridges and Valleys	SpCond	323.90	87	70.26	61.41	79.10
Central Appalachian Ridges and Valleys	SpCond	328.50	88	71.05	62.28	79.82
Central Appalachian Ridges and Valleys	SpCond	331.20	90	71.95	63.19	80.71
Central Appalachian Ridges and Valleys	SpCond	334.00	91	72.53	63.79	81.27
Central Appalachian Ridges and Valleys	SpCond	336.50	92	73.10	64.37	81.83
Central Appalachian Ridges and Valleys	SpCond	347.50	93	73.43	64.66	82.20
Central Appalachian Ridges and Valleys	SpCond	351.00	94	74.00	65.22	82.78
Central Appalachian Ridges and Valleys	SpCond	362.50	95	74.58	65.82	83.34
Central Appalachian Ridges and Valleys	SpCond	366.00	96	74.77	66.01	83.53

Central Appalachian Ridges and Valleys	SpCond	367.50	97	75.35	66.58	84.11
Central Appalachian Ridges and Valleys	SpCond	372.50	98	76.14	67.44	84.84
Central Appalachian Ridges and Valleys	SpCond	373.10	99	76.46	67.75	85.18
Central Appalachian Ridges and Valleys	SpCond	381.50	100	76.79	68.03	85.55
Central Appalachian Ridges and Valleys	SpCond	388.55	101	77.12	68.33	85.90
Central Appalachian Ridges and Valleys	SpCond	391.00	102	77.69	68.93	86.46
Central Appalachian Ridges and Valleys	SpCond	400.50	103	78.48	69.71	87.25
Central Appalachian Ridges and Valleys	SpCond	408.70	104	79.06	70.21	87.91
Central Appalachian Ridges and Valleys	SpCond	409.50	105	79.85	71.07	88.63
Central Appalachian Ridges and Valleys	SpCond	410.00	106	80.04	71.25	88.84
Central Appalachian Ridges and Valleys	SpCond	423.00	107	80.62	71.86	89.38
Central Appalachian Ridges and Valleys	SpCond	427.50	108	81.19	72.40	89.99
Central Appalachian Ridges and Valleys	SpCond	432.50	109	81.77	72.99	90.55
Central Appalachian Ridges and Valleys	SpCond	433.00	110	81.96	73.18	90.75
Central Appalachian Ridges and Valleys	SpCond	433.50	111	82.29	73.51	91.06
Central Appalachian Ridges and Valleys	SpCond	434.50	112	85.64	77.66	93.61
Central Appalachian Ridges and Valleys	SpCond	437.50	113	85.96	77.99	93.94
Central Appalachian Ridges and Valleys	SpCond	441.00	114	86.75	78.78	94.72
Central Appalachian Ridges and Valleys	SpCond	452.95	115	87.55	79.63	95.46
Central Appalachian Ridges and Valleys	SpCond	457.00	116	87.87	79.96	95.78
Central Appalachian Ridges and Valleys	SpCond	466.00	117	88.66	80.80	96.53
Central Appalachian Ridges and Valleys	SpCond	485.00	118	88.99	81.12	96.86
Central Appalachian Ridges and Valleys	SpCond	487.00	119	89.32	81.45	97.19
Central Appalachian Ridges and Valleys	SpCond	492.00	121	93.46	87.57	99.34
Central Appalachian Ridges and Valleys	SpCond	497.50	122	94.03	88.23	99.83
Central Appalachian Ridges and Valleys	SpCond	512.00	123	94.22	88.42	100.00
Central Appalachian Ridges and Valleys	SpCond	528.00	124	95.02	89.37	100.00
Central Appalachian Ridges and Valleys	SpCond	531.00	125	95.81	90.29	100.00
Central Appalachian Ridges and Valleys	SpCond	580.00	126	96.13	90.64	100.00
Central Appalachian Ridges and Valleys	SpCond	746.50	127	96.33	90.84	100.00
Central Appalachian Ridges and Valleys	SpCond	747.00	128	96.65	91.19	100.00
Central Appalachian Ridges and Valleys	SpCond	772.50	129	100.00	100.00	100.00
Southeastern Plains	SpCond	32.00	1	1.88	0.00	5.13
Southeastern Plains	SpCond	35.60	2	3.24	0.00	7.35
Southeastern Plains	SpCond	43.50	3	5.11	0.00	10.27
Southeastern Plains	SpCond	46.00	4	13.04	0.48	25.61
Southeastern Plains	SpCond	46.45	5	20.97	3.60	38.35
Southeastern Plains	SpCond	48.20	6	22.85	5.52	40.18
Southeastern Plains	SpCond	48.50	7	23.62	6.29	40.95
Southeastern Plains	SpCond	51.65	8	31.55	13.93	49.18
Southeastern Plains	SpCond	54.25	9	32.01	14.45	49.57
Southeastern Plains	SpCond	56.15	10	33.89	16.27	51.50
Southeastern Plains	SpCond	60.65	11	35.76	18.54	52.98
Southeastern Plains	SpCond	62.30	12	36.53	19.33	53.73
Southeastern Plains	SpCond	63.00	13	38.41	21.74	55.08
Southeastern Plains	SpCond	64.00	14	40.29	23.50	57.07
Southeastern Plains	SpCond	64.50	15	42.16	25.31	59.01
Southeastern Plains	SpCond	68.00	16	42.62	25.74	59.50
Southeastern Plains	SpCond	73.00	17	42.84	25.96	59.72
Southeastern Plains	SpCond	75.00	19	44.66	27.80	61.52
Southeastern Plains	SpCond	75.50	20	44.88	27.97	61.79
Southeastern Plains	SpCond	78.50	21	45.10	28.19	62.01
Southeastern Plains	SpCond	86.05	22	45.87	29.10	62.64
Southeastern Plains	SpCond	92.00	23	46.33	29.57	63.09
Southeastern Plains	SpCond	98.50	24	47.69	30.75	64.64
Southeastern Plains	SpCond	103.00	25	48.15	31.23	65.07
Southeastern Plains	SpCond	107.50	26	50.03	33.07	66.98
Southeastern Plains	SpCond	110.00	27	50.48	33.50	67.47
Southeastern Plains	SpCond	112.50	28	50.70	33.71	67.69
Southeastern Plains	SpCond	115.50	29	52.58	35.58	69.58
Southeastern Plains	SpCond	117.00	30	53.04	36.05	70.03

Southeastern Plains	SpCond	121.00	31	54.91	37.89	71.94
Southeastern Plains	SpCond	122.00	32	55.69	38.72	72.66
Southeastern Plains	SpCond	125.00	33	57.56	40.95	74.18
Southeastern Plains	SpCond	132.50	34	65.49	52.62	78.36
Southeastern Plains	SpCond	135.00	35	65.95	53.02	78.88
Southeastern Plains	SpCond	136.00	36	67.31	54.48	80.14
Southeastern Plains	SpCond	154.00	37	69.19	54.71	83.67
Southeastern Plains	SpCond	159.50	38	69.65	55.15	84.14
Southeastern Plains	SpCond	160.00	39	71.52	56.96	86.08
Southeastern Plains	SpCond	182.50	40	71.98	57.36	86.60
Southeastern Plains	SpCond	190.30	41	73.86	59.00	88.72
Southeastern Plains	SpCond	209.25	42	75.22	60.24	90.20
Southeastern Plains	SpCond	213.50	43	75.99	60.99	91.00
Southeastern Plains	SpCond	231.50	44	83.92	72.17	95.67
Southeastern Plains	SpCond	267.00	45	91.85	79.26	100.00
Southeastern Plains	SpCond	302.00	46	99.78	99.39	100.00
Southeastern Plains	SpCond	304.00	47	100.00	100.00	100.00
Blue Ridge Mountains	SpCond	9.55	1	5.31	0.00	14.02
Blue Ridge Mountains	SpCond	13.00	3	11.88	0.00	24.35
Blue Ridge Mountains	SpCond	13.75	4	13.14	0.84	25.44
Blue Ridge Mountains	SpCond	15.50	5	14.40	1.99	26.80
Blue Ridge Mountains	SpCond	17.00	6	15.31	2.97	27.65
Blue Ridge Mountains	SpCond	22.50	7	20.62	5.94	35.30
Blue Ridge Mountains	SpCond	24.00	8	25.94	9.61	42.26
Blue Ridge Mountains	SpCond	26.00	9	31.25	14.29	48.20
Blue Ridge Mountains	SpCond	28.50	10	36.56	18.86	54.26
Blue Ridge Mountains	SpCond	29.00	11	37.82	20.31	55.33
Blue Ridge Mountains	SpCond	34.75	12	38.73	21.19	56.28
Blue Ridge Mountains	SpCond	37.50	13	39.65	22.10	57.19
Blue Ridge Mountains	SpCond	39.85	14	44.96	27.46	62.46
Blue Ridge Mountains	SpCond	41.60	15	50.27	32.46	68.08
Blue Ridge Mountains	SpCond	44.70	16	51.18	33.23	69.14
Blue Ridge Mountains	SpCond	48.00	17	52.10	34.29	69.90
Blue Ridge Mountains	SpCond	50.50	18	53.35	35.76	70.95
Blue Ridge Mountains	SpCond	52.00	19	58.67	41.75	75.58
Blue Ridge Mountains	SpCond	54.00	20	59.92	42.92	76.93
Blue Ridge Mountains	SpCond	54.50	21	61.18	44.28	78.09
Blue Ridge Mountains	SpCond	59.50	22	62.44	45.32	79.55
Blue Ridge Mountains	SpCond	62.15	23	63.70	46.62	80.77
Blue Ridge Mountains	SpCond	68.50	24	64.61	47.41	81.81
Blue Ridge Mountains	SpCond	70.50	25	69.92	53.11	86.73
Blue Ridge Mountains	SpCond	74.55	26	71.18	54.53	87.83
Blue Ridge Mountains	SpCond	77.48	27	71.49	54.87	88.10
Blue Ridge Mountains	SpCond	88.20	28	76.80	61.45	92.15
Blue Ridge Mountains	SpCond	92.40	29	77.32	61.88	92.75
Blue Ridge Mountains	SpCond	103.20	30	82.63	68.71	96.55
Blue Ridge Mountains	SpCond	129.50	31	87.94	76.73	99.15
Blue Ridge Mountains	SpCond	156.50	32	88.86	77.52	100.00
Blue Ridge Mountains	SpCond	170.40	33	94.17	85.37	100.00
Blue Ridge Mountains	SpCond	198.50	34	99.48	98.59	100.00
Blue Ridge Mountains	SpCond	237.85	35	100.00	100.00	100.00
Central Appalachians	SpCond	26.50	1	2.53	0.00	6.57
Central Appalachians	SpCond	35.00	2	13.20	0.00	29.35
Central Appalachians	SpCond	69.00	3	15.73	0.00	32.12
Central Appalachians	SpCond	118.00	4	17.56	0.91	34.21
Central Appalachians	SpCond	141.00	5	20.09	3.40	36.77
Central Appalachians	SpCond	164.50	6	30.76	9.81	51.71
Central Appalachians	SpCond	189.20	7	41.44	19.63	63.24
Central Appalachians	SpCond	202.00	8	43.27	21.76	64.78
Central Appalachians	SpCond	207.00	9	45.11	23.98	66.23
Central Appalachians	SpCond	227.00	10	47.63	27.36	67.90

Central Appalachians	SpCond	265.20	11	50.16	30.95	69.36
Central Appalachians	SpCond	285.00	12	60.83	42.69	78.98
Central Appalachians	SpCond	329.00	13	63.36	45.63	81.09
Central Appalachians	SpCond	332.50	14	74.03	59.33	88.73
Central Appalachians	SpCond	381.50	15	75.87	61.76	89.97
Central Appalachians	SpCond	507.00	16	78.39	65.61	91.17
Central Appalachians	SpCond	512.50	17	79.43	67.04	91.83
Central Appalachians	SpCond	574.50	18	81.27	69.58	92.95
Central Appalachians	SpCond	577.00	19	83.10	72.27	93.93
Central Appalachians	SpCond	590.00	20	84.14	73.62	94.66
Central Appalachians	SpCond	646.00	21	85.18	75.17	95.20
Central Appalachians	SpCond	772.50	22	87.02	77.94	96.09
Central Appalachians	SpCond	778.50	23	88.85	80.97	96.73
Central Appalachians	SpCond	839.00	24	90.68	84.18	97.19
Central Appalachians	SpCond	910.00	25	91.73	85.67	97.78
Central Appalachians	SpCond	1003.50	26	92.77	86.44	99.09
Central Appalachians	SpCond	1006.00	27	95.29	91.61	98.97
Central Appalachians	SpCond	1156.00	28	97.13	93.94	100.00
Central Appalachians	SpCond	1167.00	29	98.17	95.17	100.00
Central Appalachians	SpCond	1892.00	30	100.00	100.00	100.00

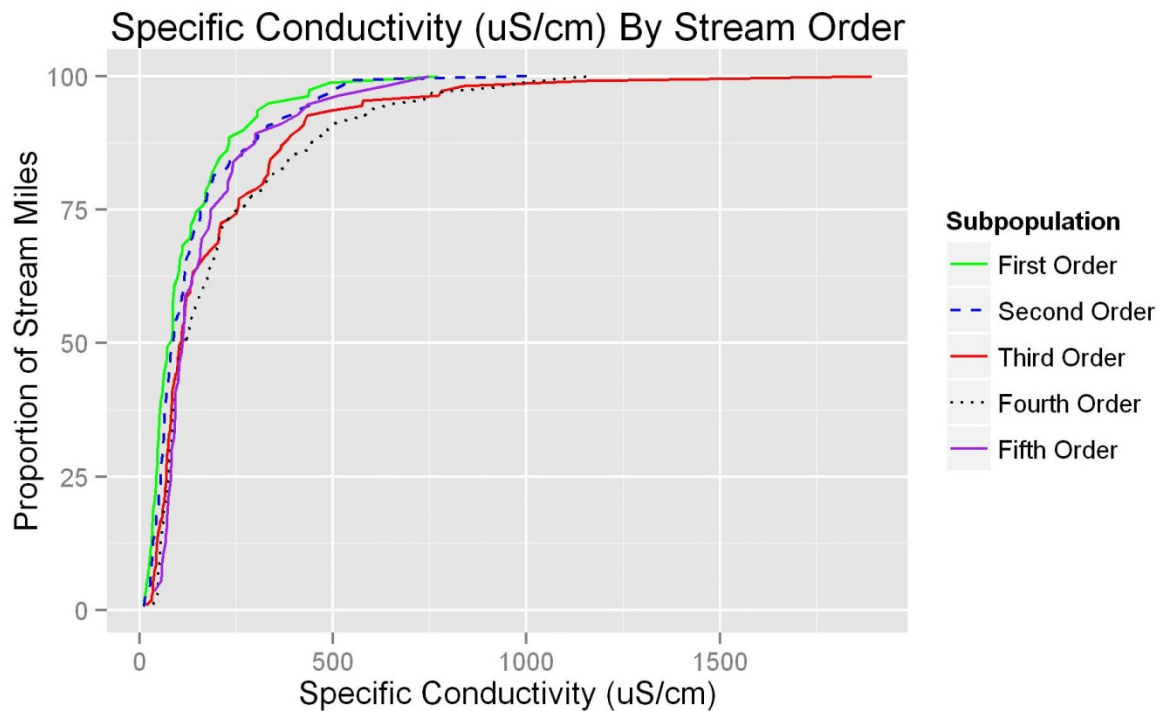


Figure 44. Specific Conductivity by Stream Order CDF graph.

The CDF curves for specific conductivity by stream order are relatively close together until the 60<sup>th</sup> percentile (Figure 44, Table 28). Seventy-five percent of first order streams have specific conductivity concentrations less than 164 uS/cm. Seventy-five percent of second order streams are less than 157 uS/cm. Fifth order streams show 184.05 uS/cm at the 75<sup>th</sup> percentile; whereas third order and fourth order streams are 252.25 uS/cm and 268.5, respectively.



Table 28. Specific Conductivity Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	SpCond	9.55	1	1.27	0.00	3.35
First Order	SpCond	13.00	2	2.53	0.00	5.60
First Order	SpCond	18.00	4	5.06	0.86	9.27
First Order	SpCond	22.50	6	7.59	2.49	12.70
First Order	SpCond	24.00	7	8.86	3.42	14.30
First Order	SpCond	26.00	8	10.13	4.31	15.94
First Order	SpCond	28.50	9	11.39	5.30	17.48
First Order	SpCond	31.50	10	12.66	6.27	19.04
First Order	SpCond	31.65	11	13.92	7.21	20.63
First Order	SpCond	32.25	12	15.19	8.33	22.05
First Order	SpCond	33.00	13	16.46	9.44	23.47
First Order	SpCond	34.00	14	17.72	10.40	25.04
First Order	SpCond	35.00	15	18.99	11.41	26.56
First Order	SpCond	38.00	16	20.25	12.42	28.09
First Order	SpCond	39.85	17	21.52	13.54	29.49
First Order	SpCond	41.60	18	22.78	14.78	30.79
First Order	SpCond	42.50	19	24.05	15.75	32.35
First Order	SpCond	43.40	20	25.32	17.00	33.64
First Order	SpCond	44.00	21	26.58	18.29	34.88
First Order	SpCond	45.75	22	27.85	19.33	36.36
First Order	SpCond	46.00	23	29.11	20.35	37.88
First Order	SpCond	46.45	24	30.38	21.39	39.37
First Order	SpCond	48.00	25	31.65	22.73	40.56
First Order	SpCond	50.00	26	32.91	23.74	42.09
First Order	SpCond	50.15	27	34.18	24.92	43.43
First Order	SpCond	50.50	28	35.44	26.30	44.58
First Order	SpCond	51.65	29	36.71	27.52	45.90
First Order	SpCond	52.00	30	37.97	28.84	47.11
First Order	SpCond	54.90	31	39.24	30.16	48.32
First Order	SpCond	58.20	32	40.51	31.51	49.50
First Order	SpCond	59.50	33	41.77	32.80	50.74
First Order	SpCond	60.50	34	43.04	34.18	51.90
First Order	SpCond	62.00	35	44.30	35.52	53.09
First Order	SpCond	65.50	36	45.57	36.82	54.31
First Order	SpCond	70.00	37	46.84	37.97	55.70
First Order	SpCond	70.50	38	48.10	39.30	56.90
First Order	SpCond	70.85	39	49.37	40.69	58.04
First Order	SpCond	83.00	40	50.63	41.86	59.41
First Order	SpCond	83.50	41	51.90	43.26	60.53
First Order	SpCond	85.85	42	53.16	44.55	61.78
First Order	SpCond	86.00	44	55.70	47.33	64.06
First Order	SpCond	86.50	45	56.96	48.44	65.49
First Order	SpCond	86.60	46	58.23	49.48	66.98
First Order	SpCond	88.20	47	59.49	50.96	68.02
First Order	SpCond	88.50	48	60.76	52.14	69.38
First Order	SpCond	95.25	49	62.03	53.35	70.70
First Order	SpCond	100.00	50	63.29	54.86	71.73
First Order	SpCond	102.50	51	64.56	56.23	72.89
First Order	SpCond	103.20	52	65.82	57.50	74.15
First Order	SpCond	109.17	53	67.09	58.72	75.45
First Order	SpCond	111.00	54	68.35	60.13	76.58
First Order	SpCond	129.50	55	69.62	61.69	77.55
First Order	SpCond	131.50	56	70.89	63.26	78.52
First Order	SpCond	132.50	57	72.15	64.69	79.62
First Order	SpCond	140.00	58	73.42	66.09	80.75
First Order	SpCond	145.50	59	74.68	67.66	81.70
First Order	SpCond	164.50	60	75.95	68.70	83.20
First Order	SpCond	170.40	61	77.22	70.26	84.17

First Order	SpCond	171.00	62	78.48	71.28	85.69
First Order	SpCond	178.50	63	79.75	72.87	86.62
First Order	SpCond	183.95	64	81.01	74.16	87.87
First Order	SpCond	189.20	65	82.28	75.40	89.16
First Order	SpCond	198.50	66	83.54	76.94	90.15
First Order	SpCond	206.50	67	84.81	78.33	91.29
First Order	SpCond	224.00	68	86.08	79.94	92.21
First Order	SpCond	230.00	69	87.34	81.23	93.45
First Order	SpCond	231.50	70	88.61	82.85	94.37
First Order	SpCond	267.00	71	89.87	84.31	95.44
First Order	SpCond	285.00	72	91.14	85.76	96.51
First Order	SpCond	302.00	73	92.41	87.48	97.33
First Order	SpCond	304.50	74	93.67	89.19	98.16
First Order	SpCond	332.50	75	94.94	90.83	99.04
First Order	SpCond	434.50	76	96.20	92.64	99.76
First Order	SpCond	438.50	77	97.47	94.53	100.00
First Order	SpCond	492.00	78	98.73	96.67	100.00
First Order	SpCond	772.50	79	100.00	100.00	100.00
Second Order	SpCond	9.80	1	0.78	0.00	2.12
Second Order	SpCond	13.00	2	1.55	0.00	3.44
Second Order	SpCond	13.75	3	2.33	0.05	4.60
Second Order	SpCond	15.50	4	3.10	0.71	5.49
Second Order	SpCond	26.00	5	3.88	1.17	6.58
Second Order	SpCond	26.50	6	4.65	1.62	7.68
Second Order	SpCond	28.57	7	5.43	2.16	8.70
Second Order	SpCond	28.63	8	6.20	2.67	9.73
Second Order	SpCond	29.00	9	6.98	3.21	10.75
Second Order	SpCond	30.40	10	7.75	3.80	11.70
Second Order	SpCond	31.55	11	8.53	4.36	12.70
Second Order	SpCond	32.00	12	9.30	4.92	13.68
Second Order	SpCond	32.50	13	10.08	5.52	14.64
Second Order	SpCond	33.00	14	10.85	6.16	15.54
Second Order	SpCond	34.00	16	12.40	7.56	17.24
Second Order	SpCond	34.25	17	13.18	8.27	18.09
Second Order	SpCond	37.28	18	13.95	8.87	19.03
Second Order	SpCond	37.90	19	14.73	9.56	19.90
Second Order	SpCond	42.00	20	15.50	10.29	20.72
Second Order	SpCond	43.00	21	16.28	10.96	21.60
Second Order	SpCond	43.30	22	17.05	11.60	22.50
Second Order	SpCond	43.50	23	17.83	12.23	23.43
Second Order	SpCond	45.75	24	18.60	13.01	24.20
Second Order	SpCond	48.20	25	19.38	13.63	25.13
Second Order	SpCond	49.00	26	20.16	14.44	25.87
Second Order	SpCond	49.25	27	20.93	15.19	26.67
Second Order	SpCond	50.50	29	22.48	16.63	28.34
Second Order	SpCond	52.50	30	23.26	17.41	29.10
Second Order	SpCond	53.80	31	24.03	18.04	30.02
Second Order	SpCond	54.00	32	24.81	18.77	30.84
Second Order	SpCond	54.50	33	25.58	19.61	31.56
Second Order	SpCond	55.70	34	26.36	20.40	32.32
Second Order	SpCond	56.00	35	27.13	21.10	33.17
Second Order	SpCond	56.15	36	27.91	21.79	34.02
Second Order	SpCond	57.50	37	28.68	22.44	34.93
Second Order	SpCond	59.50	38	29.46	23.31	35.60
Second Order	SpCond	59.90	39	30.23	24.13	36.34
Second Order	SpCond	60.65	40	31.01	24.79	37.23
Second Order	SpCond	61.14	41	31.78	25.50	38.06
Second Order	SpCond	62.00	42	32.56	26.18	38.94
Second Order	SpCond	62.15	43	33.33	27.01	39.66
Second Order	SpCond	63.00	44	34.11	27.80	40.42
Second Order	SpCond	64.00	45	34.88	28.49	41.27



Second Order	SpCond	64.50	46	35.66	29.25	42.07
Second Order	SpCond	64.90	47	36.43	30.02	42.85
Second Order	SpCond	65.00	48	37.21	30.73	43.69
Second Order	SpCond	66.00	49	37.98	31.54	44.43
Second Order	SpCond	67.00	50	38.76	32.19	45.33
Second Order	SpCond	68.10	51	39.53	32.95	46.12
Second Order	SpCond	69.00	53	41.09	34.43	47.74
Second Order	SpCond	73.06	54	41.86	35.09	48.63
Second Order	SpCond	73.85	55	42.64	35.85	49.42
Second Order	SpCond	74.55	56	43.41	36.59	50.23
Second Order	SpCond	75.50	57	44.19	37.31	51.06
Second Order	SpCond	76.50	58	44.96	38.13	51.80
Second Order	SpCond	77.00	59	45.74	38.89	52.59
Second Order	SpCond	77.65	60	46.51	39.71	53.31
Second Order	SpCond	79.50	61	47.29	40.43	54.15
Second Order	SpCond	80.00	62	48.06	41.16	54.97
Second Order	SpCond	82.14	63	48.84	41.99	55.69
Second Order	SpCond	83.00	64	49.61	42.73	56.50
Second Order	SpCond	86.05	65	50.39	43.53	57.25
Second Order	SpCond	88.00	66	51.16	44.34	57.99
Second Order	SpCond	88.50	67	51.94	45.19	58.69
Second Order	SpCond	90.00	68	52.71	45.92	59.50
Second Order	SpCond	90.50	69	53.49	46.82	60.16
Second Order	SpCond	92.50	70	54.26	47.59	60.93
Second Order	SpCond	97.45	71	55.04	48.40	61.67
Second Order	SpCond	102.95	72	55.81	49.26	62.37
Second Order	SpCond	103.50	73	56.59	50.16	63.02
Second Order	SpCond	106.70	74	57.36	51.01	63.72
Second Order	SpCond	107.50	75	58.14	51.83	64.45
Second Order	SpCond	109.00	76	58.91	52.57	65.26
Second Order	SpCond	112.00	77	59.69	53.36	66.02
Second Order	SpCond	114.90	78	60.47	53.99	66.94
Second Order	SpCond	115.00	79	61.24	54.83	67.65
Second Order	SpCond	115.50	80	62.02	55.73	68.30
Second Order	SpCond	116.00	81	62.79	56.60	68.98
Second Order	SpCond	117.50	82	63.57	57.46	69.67
Second Order	SpCond	118.00	83	64.34	58.28	70.40
Second Order	SpCond	120.50	84	65.12	59.19	71.04
Second Order	SpCond	121.00	85	65.89	59.97	71.82
Second Order	SpCond	125.00	86	66.67	60.89	72.44
Second Order	SpCond	129.50	87	67.44	61.82	73.06
Second Order	SpCond	130.50	88	68.22	62.71	73.72
Second Order	SpCond	131.00	89	68.99	63.50	74.48
Second Order	SpCond	135.00	90	69.77	64.44	75.10
Second Order	SpCond	141.00	92	71.32	66.12	76.51
Second Order	SpCond	150.50	93	72.09	66.78	77.40
Second Order	SpCond	154.00	94	72.87	67.62	78.12
Second Order	SpCond	156.50	95	73.64	68.29	79.00
Second Order	SpCond	157.00	96	74.42	69.10	79.74
Second Order	SpCond	157.90	97	75.19	69.93	80.46
Second Order	SpCond	160.00	98	75.97	70.85	81.09
Second Order	SpCond	172.00	99	76.74	71.78	81.71
Second Order	SpCond	173.50	100	77.52	72.50	82.54
Second Order	SpCond	175.00	101	78.29	73.44	83.15
Second Order	SpCond	182.60	102	79.07	74.21	83.93
Second Order	SpCond	183.50	103	79.84	75.04	84.65
Second Order	SpCond	188.50	104	80.62	75.72	85.52
Second Order	SpCond	190.30	105	81.40	76.68	86.11
Second Order	SpCond	216.00	106	82.17	77.54	86.80
Second Order	SpCond	227.00	107	82.95	78.14	87.75
Second Order	SpCond	232.00	108	83.72	78.93	88.52

Second Order	SpCond	235.00	109	84.50	79.85	89.14
Second Order	SpCond	263.50	110	85.27	80.69	89.85
Second Order	SpCond	265.20	111	86.05	81.39	90.70
Second Order	SpCond	282.00	112	86.82	82.30	91.34
Second Order	SpCond	292.00	113	87.60	83.28	91.92
Second Order	SpCond	304.00	114	88.37	84.08	92.66
Second Order	SpCond	306.05	115	89.15	85.06	93.23
Second Order	SpCond	328.50	116	89.92	86.01	93.83
Second Order	SpCond	329.00	117	90.70	86.77	94.62
Second Order	SpCond	357.85	118	91.47	87.78	95.16
Second Order	SpCond	372.50	119	92.25	88.76	95.74
Second Order	SpCond	400.50	120	93.02	89.57	96.48
Second Order	SpCond	409.50	121	93.80	90.58	97.02
Second Order	SpCond	441.00	122	94.57	91.35	97.80
Second Order	SpCond	452.95	123	95.35	92.41	98.29
Second Order	SpCond	466.00	124	96.12	93.48	98.77
Second Order	SpCond	492.00	125	96.90	94.38	99.41
Second Order	SpCond	507.00	126	97.67	95.41	99.94
Second Order	SpCond	528.00	127	98.45	96.63	100.00
Second Order	SpCond	531.00	128	99.22	97.91	100.00
Second Order	SpCond	1006.00	129	100.00	100.00	100.00
Third Order	SpCond	17.00	1	0.92	0.00	2.57
Third Order	SpCond	30.25	2	1.83	0.00	4.08
Third Order	SpCond	32.00	3	2.75	0.01	5.50
Third Order	SpCond	34.75	4	3.67	0.50	6.84
Third Order	SpCond	35.00	5	4.59	1.05	8.12
Third Order	SpCond	35.25	6	5.50	1.72	9.29
Third Order	SpCond	35.60	7	6.42	2.36	10.49
Third Order	SpCond	37.50	8	7.34	3.08	11.60
Third Order	SpCond	40.80	9	8.26	3.84	12.67
Third Order	SpCond	42.00	10	9.17	4.52	13.83
Third Order	SpCond	42.50	11	10.09	5.41	14.77
Third Order	SpCond	43.50	12	11.01	6.08	15.94
Third Order	SpCond	44.70	13	11.93	7.15	16.70
Third Order	SpCond	44.90	14	12.84	7.86	17.83
Third Order	SpCond	46.00	15	13.76	8.63	18.89
Third Order	SpCond	48.00	16	14.68	9.57	19.79
Third Order	SpCond	50.85	17	15.60	10.26	20.93
Third Order	SpCond	52.50	18	16.51	10.97	22.06
Third Order	SpCond	58.00	19	17.43	11.70	23.16
Third Order	SpCond	59.00	20	18.35	12.57	24.13
Third Order	SpCond	59.10	21	19.27	13.28	25.26
Third Order	SpCond	62.00	22	20.18	13.99	26.38
Third Order	SpCond	63.50	23	21.10	14.72	27.48
Third Order	SpCond	66.00	25	22.94	16.37	29.50
Third Order	SpCond	67.71	26	23.85	17.17	30.54
Third Order	SpCond	68.50	27	24.77	18.24	31.31
Third Order	SpCond	68.70	28	25.69	19.15	32.23
Third Order	SpCond	69.00	29	26.61	20.05	33.16
Third Order	SpCond	70.00	30	27.52	20.96	34.09
Third Order	SpCond	70.50	31	28.44	21.84	35.04
Third Order	SpCond	71.50	32	29.36	22.74	35.98
Third Order	SpCond	73.00	33	30.28	23.61	36.94
Third Order	SpCond	75.00	35	32.11	25.30	38.92
Third Order	SpCond	75.20	36	33.03	26.13	39.92
Third Order	SpCond	79.90	37	33.94	27.05	40.84
Third Order	SpCond	80.00	38	34.86	28.03	41.69
Third Order	SpCond	80.50	39	35.78	28.86	42.70
Third Order	SpCond	80.60	40	36.70	29.79	43.60
Third Order	SpCond	82.00	41	37.61	30.82	44.41
Third Order	SpCond	82.40	42	38.53	31.91	45.15

Third Order	SpCond	83.50	44	40.37	33.79	46.95
Third Order	SpCond	84.50	45	41.28	34.75	47.82
Third Order	SpCond	87.00	46	42.20	35.73	48.68
Third Order	SpCond	88.50	47	43.12	36.47	49.76
Third Order	SpCond	93.00	48	44.04	37.46	50.62
Third Order	SpCond	97.30	49	44.95	38.19	51.72
Third Order	SpCond	97.60	50	45.87	39.10	52.65
Third Order	SpCond	98.50	51	46.79	39.99	53.58
Third Order	SpCond	99.05	52	47.71	41.03	54.38
Third Order	SpCond	100.55	53	48.62	41.97	55.28
Third Order	SpCond	103.00	54	49.54	42.84	56.25
Third Order	SpCond	107.35	55	50.46	43.89	57.03
Third Order	SpCond	109.50	56	51.38	45.00	57.75
Third Order	SpCond	109.70	57	52.29	45.77	58.82
Third Order	SpCond	110.20	58	53.21	46.79	59.63
Third Order	SpCond	115.30	59	54.13	47.86	60.39
Third Order	SpCond	115.50	60	55.05	48.76	61.33
Third Order	SpCond	117.00	61	55.96	49.63	62.30
Third Order	SpCond	118.00	62	56.88	50.38	63.38
Third Order	SpCond	119.50	63	57.80	51.47	64.13
Third Order	SpCond	121.00	64	58.72	52.41	65.02
Third Order	SpCond	130.00	65	59.63	53.27	66.00
Third Order	SpCond	130.50	66	60.55	54.37	66.73
Third Order	SpCond	135.50	67	61.47	55.26	67.67
Third Order	SpCond	136.00	68	62.39	56.29	68.48
Third Order	SpCond	137.00	69	63.30	57.08	69.52
Third Order	SpCond	148.00	70	64.22	58.07	70.37
Third Order	SpCond	156.50	71	65.14	59.02	71.25
Third Order	SpCond	165.50	72	66.06	60.14	71.97
Third Order	SpCond	177.50	73	66.97	61.13	72.82
Third Order	SpCond	188.00	74	67.89	62.11	73.67
Third Order	SpCond	202.00	75	68.81	62.82	74.80
Third Order	SpCond	205.00	76	69.72	63.91	75.54
Third Order	SpCond	205.50	77	70.64	65.03	76.25
Third Order	SpCond	207.00	78	71.56	65.78	77.34
Third Order	SpCond	209.25	79	72.48	66.88	78.07
Third Order	SpCond	231.45	80	73.39	67.94	78.85
Third Order	SpCond	249.50	81	74.31	68.82	79.81
Third Order	SpCond	252.25	82	75.23	69.87	80.59
Third Order	SpCond	255.50	83	76.15	71.00	81.29
Third Order	SpCond	257.00	84	77.06	72.12	82.00
Third Order	SpCond	276.00	85	77.98	73.00	82.97
Third Order	SpCond	300.00	86	78.90	73.99	83.81
Third Order	SpCond	318.00	87	79.82	75.20	84.44
Third Order	SpCond	323.15	88	80.73	76.16	85.31
Third Order	SpCond	331.20	89	81.65	76.99	86.32
Third Order	SpCond	332.00	90	82.57	78.14	87.00
Third Order	SpCond	334.00	91	83.49	79.32	87.65
Third Order	SpCond	336.50	92	84.40	80.41	88.39
Third Order	SpCond	351.00	93	85.32	81.61	89.03
Third Order	SpCond	362.50	94	86.24	82.57	89.90
Third Order	SpCond	367.50	95	87.16	83.44	90.87
Third Order	SpCond	381.50	96	88.07	84.26	91.89
Third Order	SpCond	391.00	97	88.99	85.23	92.75
Third Order	SpCond	408.70	98	89.91	86.19	93.62
Third Order	SpCond	423.00	99	90.83	87.41	94.24
Third Order	SpCond	427.50	100	91.74	88.67	94.81
Third Order	SpCond	432.50	101	92.66	89.94	95.38
Third Order	SpCond	497.50	102	93.58	91.31	95.85
Third Order	SpCond	574.50	103	94.50	92.13	96.86
Third Order	SpCond	577.00	104	95.41	93.20	97.62

Third Order	SpCond	772.50	105	96.33	94.15	98.51
Third Order	SpCond	778.50	106	97.25	95.28	99.22
Third Order	SpCond	839.00	107	98.17	96.59	99.74
Third Order	SpCond	1156.00	108	99.08	97.59	100.00
Third Order	SpCond	1892.00	109	100.00	100.00	100.00
Fourth Order	SpCond	34.00	1	1.06	0.00	2.90
Fourth Order	SpCond	40.03	2	2.13	0.00	4.65
Fourth Order	SpCond	46.20	3	3.19	0.15	6.23
Fourth Order	SpCond	46.60	4	4.26	0.72	7.79
Fourth Order	SpCond	47.05	5	5.32	1.37	9.27
Fourth Order	SpCond	48.00	6	6.38	2.06	10.71
Fourth Order	SpCond	48.50	7	7.45	2.83	12.06
Fourth Order	SpCond	49.00	8	8.51	3.52	13.50
Fourth Order	SpCond	53.01	9	9.57	4.39	14.76
Fourth Order	SpCond	53.10	10	10.64	5.35	15.92
Fourth Order	SpCond	53.50	11	11.70	6.21	17.20
Fourth Order	SpCond	54.70	12	12.77	7.21	18.32
Fourth Order	SpCond	57.50	13	13.83	8.06	19.60
Fourth Order	SpCond	59.50	15	15.96	10.19	21.73
Fourth Order	SpCond	62.30	16	17.02	11.13	22.92
Fourth Order	SpCond	62.50	17	18.09	12.16	24.01
Fourth Order	SpCond	63.00	18	19.15	12.97	25.33
Fourth Order	SpCond	67.30	19	20.21	13.94	26.49
Fourth Order	SpCond	71.00	20	21.28	14.97	27.58
Fourth Order	SpCond	71.50	21	22.34	16.01	28.67
Fourth Order	SpCond	72.00	22	23.40	17.21	29.60
Fourth Order	SpCond	73.50	23	24.47	18.21	30.73
Fourth Order	SpCond	74.40	24	25.53	19.16	31.91
Fourth Order	SpCond	75.50	25	26.60	20.34	32.85
Fourth Order	SpCond	76.60	26	27.66	21.52	33.80
Fourth Order	SpCond	77.50	27	28.72	22.50	34.94
Fourth Order	SpCond	79.50	29	30.85	24.27	37.43
Fourth Order	SpCond	82.00	30	31.91	25.22	38.61
Fourth Order	SpCond	84.55	31	32.98	26.41	39.55
Fourth Order	SpCond	85.00	32	34.04	27.49	40.60
Fourth Order	SpCond	86.05	33	35.11	28.56	41.65
Fourth Order	SpCond	86.89	34	36.17	29.66	42.68
Fourth Order	SpCond	87.00	35	37.23	30.89	43.57
Fourth Order	SpCond	88.50	36	38.30	31.73	44.87
Fourth Order	SpCond	90.00	37	39.36	32.84	45.89
Fourth Order	SpCond	92.40	38	40.43	33.68	47.17
Fourth Order	SpCond	93.50	39	41.49	34.84	48.14
Fourth Order	SpCond	96.30	40	42.55	36.09	49.01
Fourth Order	SpCond	99.00	41	43.62	37.40	49.84
Fourth Order	SpCond	100.75	42	44.68	38.32	51.05
Fourth Order	SpCond	101.50	43	45.74	39.27	52.22
Fourth Order	SpCond	102.50	44	46.81	40.53	53.09
Fourth Order	SpCond	104.00	45	47.87	41.38	54.36
Fourth Order	SpCond	105.00	46	48.94	42.64	55.24
Fourth Order	SpCond	114.00	47	50.00	43.94	56.06
Fourth Order	SpCond	122.00	48	51.06	45.16	56.97
Fourth Order	SpCond	126.50	49	52.13	45.98	58.27
Fourth Order	SpCond	129.50	50	53.19	47.30	59.09
Fourth Order	SpCond	131.00	51	54.26	48.15	60.36
Fourth Order	SpCond	137.00	52	55.32	49.12	61.52
Fourth Order	SpCond	142.30	53	56.38	50.27	62.49
Fourth Order	SpCond	147.50	54	57.45	51.42	63.47
Fourth Order	SpCond	151.50	55	58.51	52.31	64.71
Fourth Order	SpCond	155.50	56	59.57	53.60	65.55
Fourth Order	SpCond	165.50	57	60.64	54.65	66.63
Fourth Order	SpCond	173.00	58	61.70	55.49	67.91

Fourth Order	SpCond	176.50	59	62.77	56.50	69.03
Fourth Order	SpCond	178.70	60	63.83	57.52	70.14
Fourth Order	SpCond	191.50	61	64.89	58.63	71.16
Fourth Order	SpCond	192.50	62	65.96	59.80	72.11
Fourth Order	SpCond	196.50	63	67.02	60.91	73.13
Fourth Order	SpCond	200.60	64	68.09	61.75	74.42
Fourth Order	SpCond	202.50	65	69.15	63.04	75.26
Fourth Order	SpCond	204.50	66	70.21	64.21	76.22
Fourth Order	SpCond	213.50	67	71.28	65.52	77.03
Fourth Order	SpCond	213.80	68	72.34	66.58	78.10
Fourth Order	SpCond	232.00	69	73.40	67.76	79.05
Fourth Order	SpCond	237.85	70	74.47	68.97	79.97
Fourth Order	SpCond	268.50	71	75.53	70.30	80.76
Fourth Order	SpCond	277.40	72	76.60	71.34	81.86
Fourth Order	SpCond	289.00	73	77.66	72.74	82.58
Fourth Order	SpCond	316.50	74	78.72	73.89	83.56
Fourth Order	SpCond	323.90	75	79.79	74.66	84.92
Fourth Order	SpCond	331.20	76	80.85	75.87	85.83
Fourth Order	SpCond	347.50	77	81.91	77.17	86.66
Fourth Order	SpCond	373.10	78	82.98	78.39	87.56
Fourth Order	SpCond	381.50	79	84.04	79.86	88.22
Fourth Order	SpCond	388.55	80	85.11	80.87	89.34
Fourth Order	SpCond	433.50	81	86.17	82.12	90.22
Fourth Order	SpCond	437.50	82	87.23	83.07	91.40
Fourth Order	SpCond	457.00	83	88.30	84.34	92.25
Fourth Order	SpCond	485.00	84	89.36	85.58	93.14
Fourth Order	SpCond	487.00	85	90.43	87.12	93.74
Fourth Order	SpCond	512.50	86	91.49	88.17	94.81
Fourth Order	SpCond	580.00	87	92.55	89.08	96.02
Fourth Order	SpCond	590.00	88	93.62	90.06	97.17
Fourth Order	SpCond	646.00	89	94.68	91.19	98.17
Fourth Order	SpCond	747.00	90	95.74	92.74	98.75
Fourth Order	SpCond	753.50	91	96.81	94.36	99.26
Fourth Order	SpCond	910.00	92	97.87	95.75	99.99
Fourth Order	SpCond	1003.50	93	98.94	97.12	100.00
Fourth Order	SpCond	1167.00	94	100.00	100.00	100.00
Fifth Order	SpCond	38.00	2	3.57	0.57	6.57
Fifth Order	SpCond	54.25	3	5.36	1.20	9.51
Fifth Order	SpCond	57.75	4	7.14	2.22	12.06
Fifth Order	SpCond	57.90	5	8.93	3.20	14.66
Fifth Order	SpCond	60.55	6	10.71	4.42	17.01
Fifth Order	SpCond	65.40	7	12.50	5.93	19.07
Fifth Order	SpCond	68.00	8	14.29	7.67	20.91
Fifth Order	SpCond	70.60	9	16.07	8.83	23.31
Fifth Order	SpCond	71.00	10	17.86	10.50	25.22
Fifth Order	SpCond	75.00	12	21.43	12.96	29.90
Fifth Order	SpCond	77.48	13	23.21	14.28	32.15
Fifth Order	SpCond	80.55	14	25.00	15.92	34.08
Fifth Order	SpCond	81.00	15	26.79	17.74	35.83
Fifth Order	SpCond	82.00	16	28.57	19.88	37.26
Fifth Order	SpCond	83.00	17	30.36	21.17	39.54
Fifth Order	SpCond	86.90	18	32.14	23.29	40.99
Fifth Order	SpCond	90.00	19	33.93	25.25	42.61
Fifth Order	SpCond	90.59	20	35.71	26.83	44.60
Fifth Order	SpCond	91.78	21	37.50	28.46	46.54
Fifth Order	SpCond	92.00	23	41.07	31.92	50.22
Fifth Order	SpCond	98.50	24	42.86	33.30	52.42
Fifth Order	SpCond	101.00	25	44.64	35.01	54.28
Fifth Order	SpCond	103.00	26	46.43	36.80	56.06
Fifth Order	SpCond	107.50	27	48.21	38.85	57.58
Fifth Order	SpCond	110.00	28	50.00	40.48	59.52

Fifth Order	SpCond	111.50	29	51.79	42.76	60.81
Fifth Order	SpCond	113.50	30	53.57	44.34	62.81
Fifth Order	SpCond	115.00	31	55.36	46.59	64.13
Fifth Order	SpCond	115.50	32	57.14	48.55	65.74
Fifth Order	SpCond	117.00	33	58.93	50.68	67.18
Fifth Order	SpCond	132.50	34	60.71	52.63	68.80
Fifth Order	SpCond	135.00	35	62.50	54.67	70.33
Fifth Order	SpCond	149.00	36	64.29	56.22	72.35
Fifth Order	SpCond	155.00	37	66.07	58.59	73.56
Fifth Order	SpCond	157.00	38	67.86	60.57	75.14
Fifth Order	SpCond	159.50	39	69.64	63.08	76.21
Fifth Order	SpCond	177.15	40	71.43	64.38	78.47
Fifth Order	SpCond	182.50	41	73.21	66.89	79.54
Fifth Order	SpCond	184.05	42	75.00	68.26	81.74
Fifth Order	SpCond	205.25	43	76.79	69.88	83.70
Fifth Order	SpCond	226.50	44	78.57	71.50	85.64
Fifth Order	SpCond	228.00	45	80.36	73.57	87.14
Fifth Order	SpCond	238.05	46	82.14	75.98	88.31
Fifth Order	SpCond	240.90	47	83.93	77.40	90.46
Fifth Order	SpCond	265.10	48	85.71	78.91	92.52
Fifth Order	SpCond	297.21	49	87.50	80.70	94.30
Fifth Order	SpCond	299.50	50	89.29	82.92	95.65
Fifth Order	SpCond	366.00	51	91.07	85.39	96.76
Fifth Order	SpCond	410.00	52	92.86	87.80	97.91
Fifth Order	SpCond	433.00	53	94.64	89.66	99.63
Fifth Order	SpCond	512.00	54	96.43	92.34	100.00
Fifth Order	SpCond	634.95	55	98.21	95.35	100.00
Fifth Order	SpCond	746.50	56	100.00	100.00	100.00

## Appendix F. Total Dissolved Solids Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by total dissolved solids) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Total dissolved solids (TDS) over 350 mg/L increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). Figure 45 shows VSCI scores declining as TDS increases. The case for this increased risk to the aquatic community is presented in this appendix.

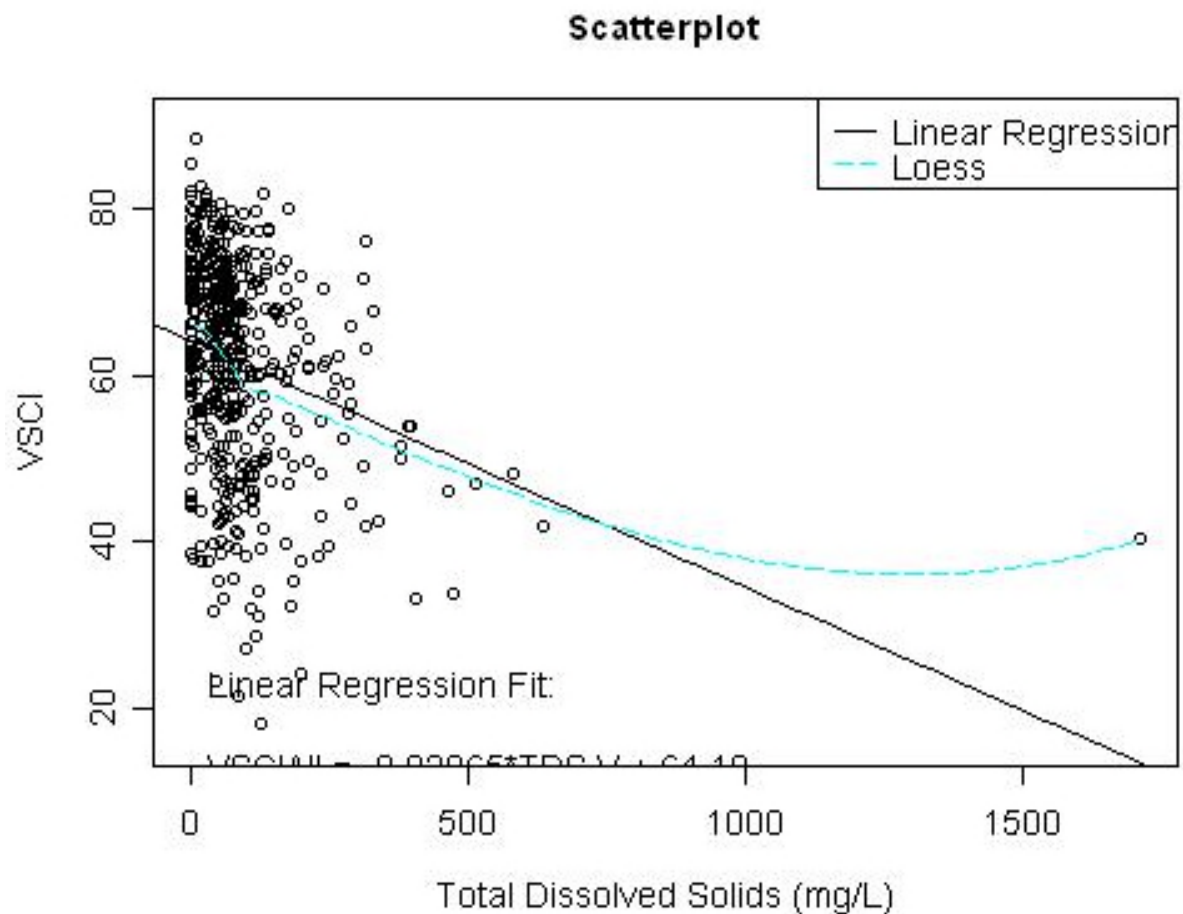


Figure 45. Total Dissolved Solids (mg/L) Stressor Gradient Scatterplot.

### *Total Dissolved Solids Relative Risk Results*

An optimal level of less than 100 mg/L TDS was selected based on the associated low risk to aquatic life. VDEQ estimates 75% of Virginia streams have a TDS less than 100 mg/L (Figure 50, Table 29). TDS above 350 mg/L is considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 46) and scatter plot graphs. Only 1.5% of Virginia streams have a TDS above 350 mg/L (Figure 47). VDEQ relative risk calculations found that a VSCI score is 5 times more likely to be below 50 when the TDS is above 350 mg/L than when the Specific Conductivity is below 100 mg/L (Figure 47).

Table 29. Total Dissolved Solids Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Specific Conductivity (uS/cm)	<100	>350

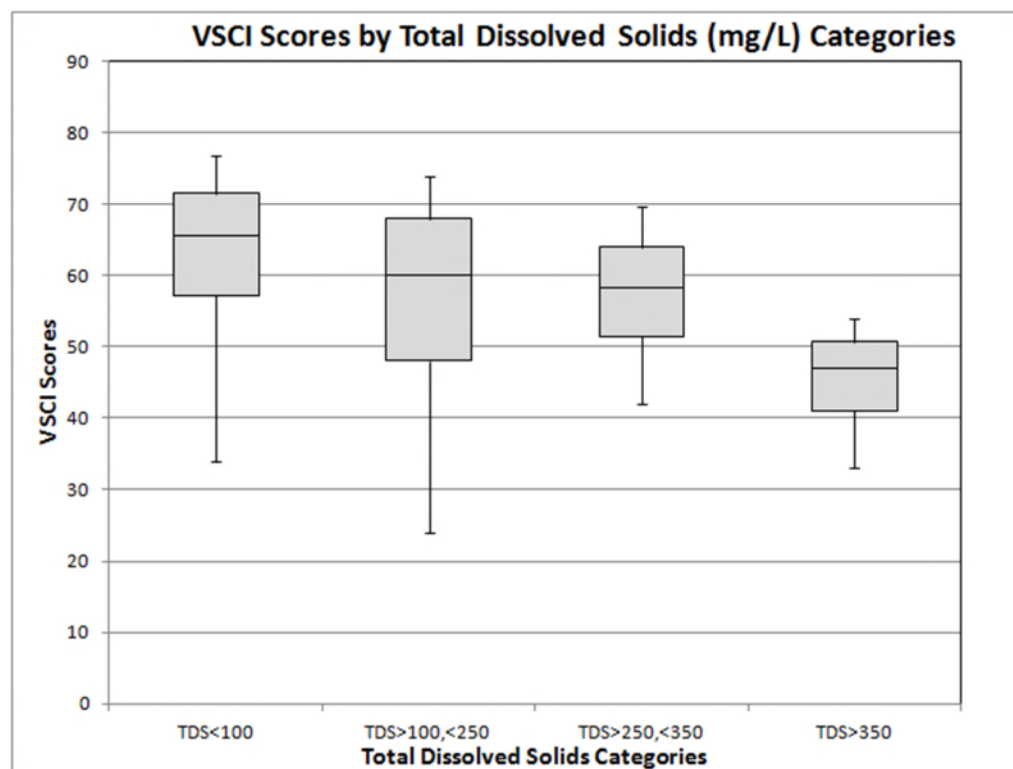


Figure 46. VSCI Scores by Total Dissolved Solids Categories.



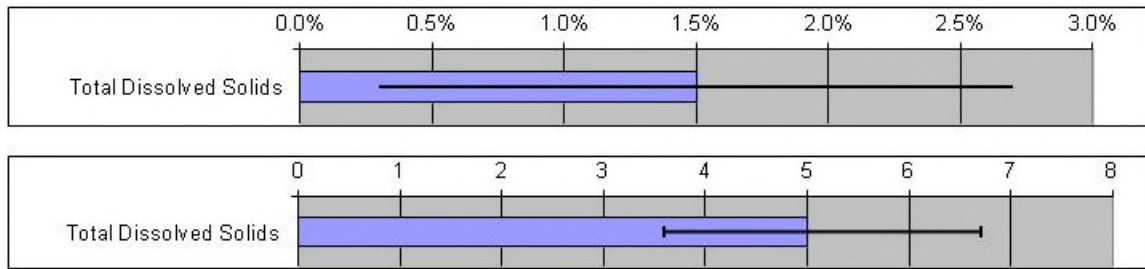


Figure 47. Total Dissolved Solids Relative Extent (TDS > 350 mg/L) and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 11 sites with TDS over 350 mg/L. None of the sites with TDS above 350 mg/L have a VSCI over 60. The probability of having VSCI score less than 60 when TDS is above 350 mg/L is 100% (Figure 48).

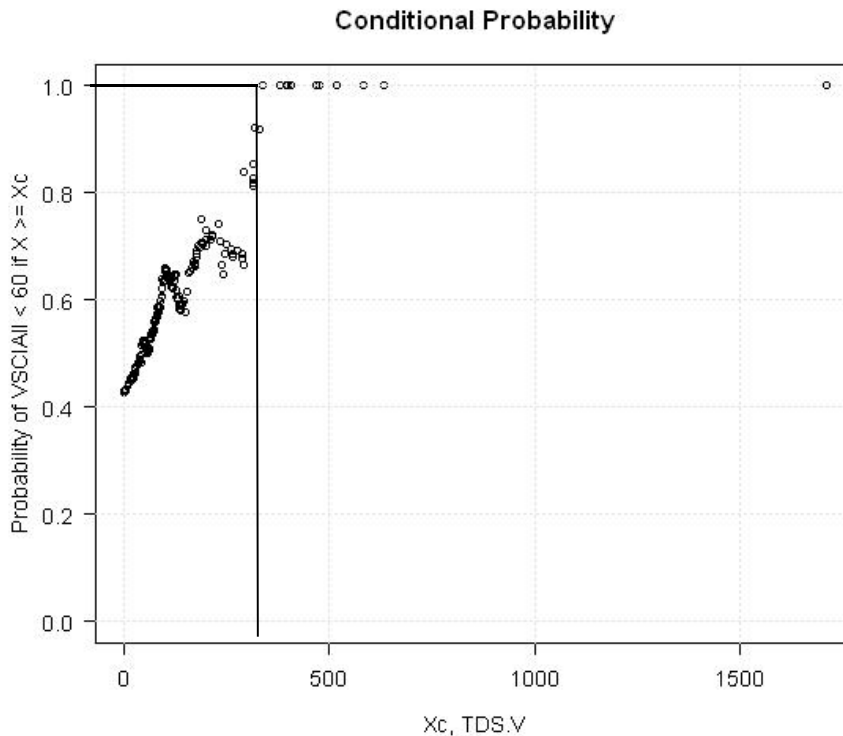


Figure 48. Probability of VSCI less than 60 if TDS > 350 mg/L.

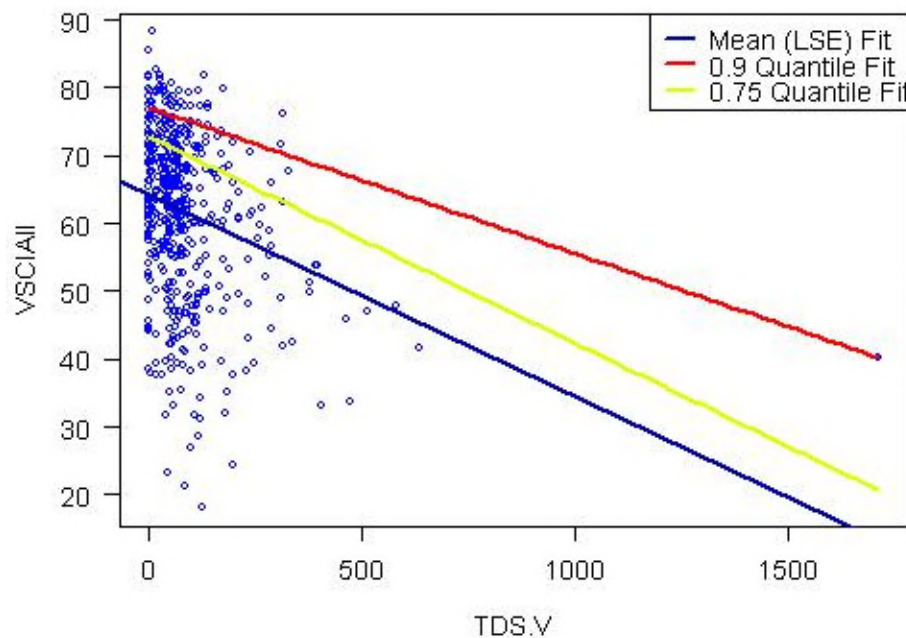


Figure 49. Quantile Regression VSCI versus TDS (mg/L).

Quantile regression in Figure 49 shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores compared to TDS mg/L values. The 50<sup>th</sup> percentile of reference crosses at 240 mg/L, 25th percentile intersects at 518 mg/L, and the 10<sup>th</sup> percentile is equal to 796 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed.

### *Total Dissolved Solids and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from TDS concentrations below 250 mg/L (Table 30). Streams with TDS above 350 mg/L do not support health benthic communities and are associated with VSCI scores less than 60.

Table 30. **Total Dissolved Solids (mg/L) concentrations and probability of stress to aquatic life (based on VSCI scores).**

Total Dissolved Solids	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 350
Medium	> 250 , < 350
Low	> 100, < 250
None	< 100

### *Total Dissolved Solids Cumulative Distribution Function curves*

TDS CDFs are shown statewide, by super basin, major ecoregion (level III), and by stream order in Figures 50-53. Tables 31-34 correspond to the aforementioned figures.

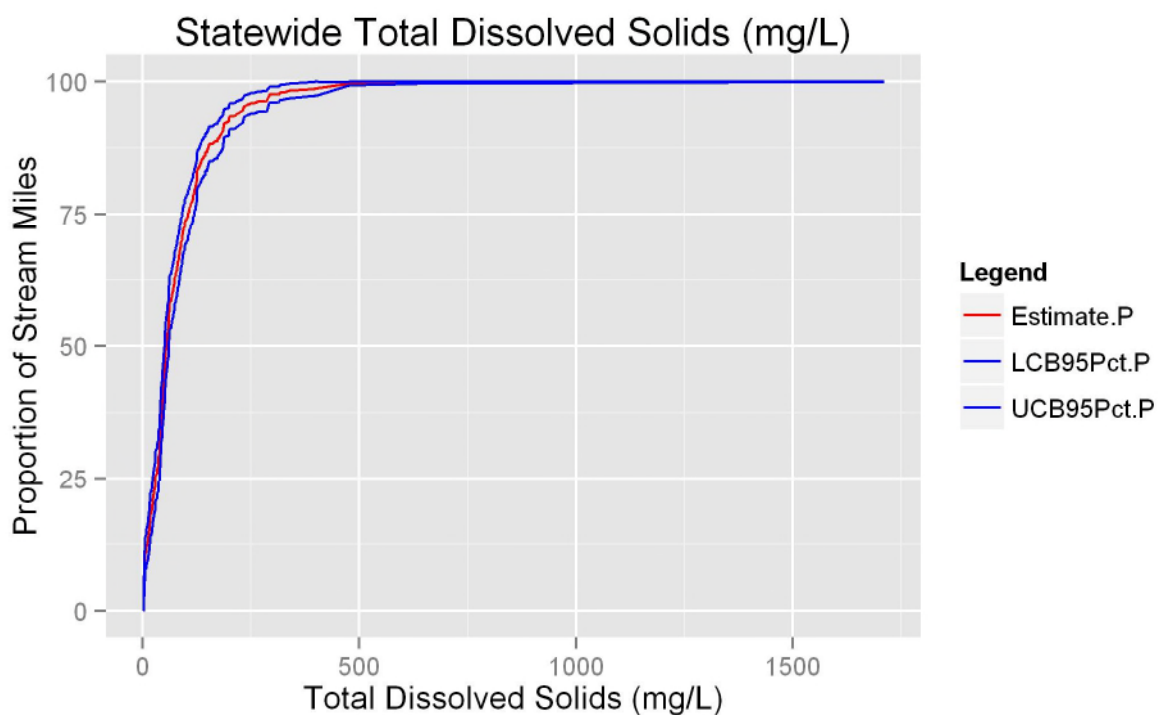


Figure 50. **Total Dissolved Solids Statewide CDF graph.**

Figure 50 and Table 31 display TDS CDF and data for Virginia. Ninety percent of stream miles have TDS concentrations below 185 mg/L.

Table 31.Total Dissolved Solids Statewide Population Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	TDS	1	2	0.29	0.00	0.63
Virginia	TDS	2	9	1.10	0.44	1.75
Virginia	TDS	3	28	4.65	2.65	6.64
Virginia	TDS	4	45	8.49	5.63	11.35
Virginia	TDS	5	49	9.58	6.48	12.67
Virginia	TDS	6	59	10.85	7.67	14.03
Virginia	TDS	7	61	11.15	7.94	14.35
Virginia	TDS	8	62	11.22	8.01	14.42
Virginia	TDS	9	65	12.15	8.78	15.52
Virginia	TDS	10	68	12.56	9.17	15.96
Virginia	TDS	11	71	12.83	9.42	16.23
Virginia	TDS	12	73	13.08	9.67	16.48
Virginia	TDS	13	76	14.09	10.50	17.68
Virginia	TDS	15	78	14.94	11.23	18.65
Virginia	TDS	16	82	16.62	12.65	20.59
Virginia	TDS	17	83	16.79	12.81	20.77
Virginia	TDS	18	88	18.20	14.07	22.32
Virginia	TDS	19	89	18.37	14.24	22.49
Virginia	TDS	20	91	18.66	14.54	22.79
Virginia	TDS	21	93	18.80	14.67	22.93
Virginia	TDS	22	97	20.04	15.81	24.27
Virginia	TDS	23	100	21.10	16.73	25.47
Virginia	TDS	24	101	21.22	16.85	25.60
Virginia	TDS	26	103	22.67	18.17	27.16
Virginia	TDS	27	105	22.83	18.34	27.32
Virginia	TDS	28	108	23.34	18.82	27.86
Virginia	TDS	29	109	24.07	19.44	28.69
Virginia	TDS	30	111	25.51	20.76	30.26
Virginia	TDS	31	112	25.68	20.92	30.44
Virginia	TDS	32	115	25.92	21.16	30.68
Virginia	TDS	33	117	26.76	21.93	31.60
Virginia	TDS	34	119	27.00	22.17	31.84
Virginia	TDS	35	121	27.30	22.46	32.14
Virginia	TDS	36	125	28.44	23.57	33.30
Virginia	TDS	37	128	29.35	24.43	34.27
Virginia	TDS	38	130	29.55	24.63	34.47
Virginia	TDS	39	133	31.12	26.08	36.15
Virginia	TDS	40	137	32.15	27.07	37.23
Virginia	TDS	41	143	34.73	29.56	39.89
Virginia	TDS	42	149	36.70	31.47	41.94
Virginia	TDS	43	153	37.34	32.12	42.57
Virginia	TDS	44	154	38.06	32.77	43.35
Virginia	TDS	45	158	39.05	33.74	44.36
Virginia	TDS	46	162	40.19	34.87	45.51
Virginia	TDS	47	169	41.56	36.21	46.91
Virginia	TDS	48	172	42.45	37.08	47.82
Virginia	TDS	49	175	43.33	37.96	48.71
Virginia	TDS	50	180	44.59	39.25	49.93
Virginia	TDS	51	186	45.25	39.90	50.59
Virginia	TDS	52	195	47.53	42.15	52.92
Virginia	TDS	53	200	49.23	43.82	54.64
Virginia	TDS	54	202	49.47	44.08	54.86
Virginia	TDS	55	206	50.37	45.01	55.74
Virginia	TDS	56	212	51.22	45.89	56.56
Virginia	TDS	57	214	51.56	46.24	56.89
Virginia	TDS	58	220	52.71	47.40	58.02
Virginia	TDS	59	224	53.10	47.81	58.38

Virginia	TDS	60	230	54.82	49.58	60.05
Virginia	TDS	61	232	56.26	51.09	61.42
Virginia	TDS	62	238	58.11	53.04	63.18
Virginia	TDS	63	241	58.35	53.28	63.41
Virginia	TDS	64	243	58.44	53.37	63.50
Virginia	TDS	65	244	58.51	53.45	63.56
Virginia	TDS	66	251	59.14	54.10	64.19
Virginia	TDS	67	253	59.36	54.33	64.38
Virginia	TDS	68	259	59.94	54.93	64.95
Virginia	TDS	69	263	60.35	55.34	65.35
Virginia	TDS	70	268	60.95	55.97	65.93
Virginia	TDS	71	270	61.20	56.23	66.17
Virginia	TDS	72	275	61.60	56.63	66.57
Virginia	TDS	73	278	61.98	57.02	66.94
Virginia	TDS	74	281	63.00	58.09	67.91
Virginia	TDS	75	284	63.15	58.24	68.06
Virginia	TDS	76	286	63.35	58.43	68.27
Virginia	TDS	77	291	63.88	58.98	68.77
Virginia	TDS	78	294	64.21	59.32	69.11
Virginia	TDS	79	300	64.86	60.00	69.73
Virginia	TDS	80	303	65.18	60.31	70.05
Virginia	TDS	81	306	66.01	61.19	70.83
Virginia	TDS	82	307	66.14	61.32	70.95
Virginia	TDS	83	310	66.37	61.57	71.18
Virginia	TDS	84	312	67.17	62.41	71.92
Virginia	TDS	85	314	68.06	63.34	72.77
Virginia	TDS	86	315	68.18	63.48	72.89
Virginia	TDS	87	319	68.67	63.97	73.37
Virginia	TDS	89	321	69.56	64.95	74.17
Virginia	TDS	90	324	69.88	65.28	74.49
Virginia	TDS	91	325	70.05	65.46	74.65
Virginia	TDS	92	328	71.01	66.47	75.56
Virginia	TDS	93	331	71.82	67.34	76.30
Virginia	TDS	94	335	72.27	67.81	76.74
Virginia	TDS	95	336	72.31	67.85	76.78
Virginia	TDS	96	338	72.56	68.09	77.02
Virginia	TDS	97	339	72.68	68.22	77.14
Virginia	TDS	98	343	73.56	69.12	77.99
Virginia	TDS	99	345	73.70	69.27	78.12
Virginia	TDS	100	348	74.06	69.64	78.48
Virginia	TDS	101	349	74.13	69.71	78.55
Virginia	TDS	102	350	74.30	69.88	78.72
Virginia	TDS	103	351	74.34	69.92	78.77
Virginia	TDS	104	353	74.56	70.14	78.98
Virginia	TDS	105	354	75.28	70.98	79.57
Virginia	TDS	107	355	75.45	71.16	79.74
Virginia	TDS	108	356	76.17	72.02	80.32
Virginia	TDS	110	359	76.58	72.45	80.71
Virginia	TDS	111	361	76.92	72.81	81.03
Virginia	TDS	112	362	77.09	72.94	81.25
Virginia	TDS	113	364	77.39	73.22	81.55
Virginia	TDS	115	367	77.73	73.55	81.90
Virginia	TDS	116	369	78.52	74.41	82.62
Virginia	TDS	117	370	78.69	74.59	82.79
Virginia	TDS	119	372	78.98	74.88	83.09
Virginia	TDS	120	374	79.75	75.72	83.77
Virginia	TDS	121	375	79.82	75.79	83.84
Virginia	TDS	122	376	80.54	76.61	84.46
Virginia	TDS	124	380	81.13	77.23	85.02
Virginia	TDS	125	382	82.57	78.95	86.19
Virginia	TDS	126	383	83.29	79.79	86.80

Virginia	TDS	127	385	83.63	80.14	87.13
Virginia	TDS	129	386	83.70	80.21	87.20
Virginia	TDS	133	388	84.47	80.84	88.09
Virginia	TDS	134	391	84.83	81.21	88.45
Virginia	TDS	135	393	85.17	81.56	88.79
Virginia	TDS	136	394	85.24	81.63	88.86
Virginia	TDS	137	395	85.31	81.70	88.93
Virginia	TDS	138	397	85.51	81.89	89.12
Virginia	TDS	140	399	85.80	82.20	89.40
Virginia	TDS	142	400	85.93	82.33	89.52
Virginia	TDS	143	401	85.97	82.37	89.57
Virginia	TDS	144	402	86.69	83.18	90.20
Virginia	TDS	148	403	86.73	83.22	90.25
Virginia	TDS	150	405	87.52	84.10	90.95
Virginia	TDS	154	406	88.25	85.00	91.49
Virginia	TDS	157	407	88.29	85.04	91.54
Virginia	TDS	163	409	88.40	85.15	91.65
Virginia	TDS	166	410	88.57	85.32	91.82
Virginia	TDS	167	411	88.69	85.45	91.94
Virginia	TDS	171	412	88.77	85.52	92.01
Virginia	TDS	172	413	88.89	85.64	92.14
Virginia	TDS	173	415	89.18	85.95	92.41
Virginia	TDS	176	417	89.38	86.13	92.62
Virginia	TDS	177	419	89.67	86.43	92.91
Virginia	TDS	178	420	89.80	86.56	93.03
Virginia	TDS	180	421	89.92	86.69	93.15
Virginia	TDS	185	422	90.64	87.57	93.72
Virginia	TDS	187	424	92.09	89.45	94.72
Virginia	TDS	189	425	92.16	89.53	94.79
Virginia	TDS	191	426	92.20	89.57	94.83
Virginia	TDS	192	427	92.27	89.64	94.89
Virginia	TDS	198	428	92.44	89.83	95.05
Virginia	TDS	200	429	93.16	90.75	95.57
Virginia	TDS	201	431	93.46	91.04	95.87
Virginia	TDS	212	432	93.53	91.10	95.95
Virginia	TDS	214	433	93.57	91.14	95.99
Virginia	TDS	215	435	93.76	91.34	96.19
Virginia	TDS	231	436	94.48	92.25	96.71
Virginia	TDS	234	437	95.20	93.21	97.20
Virginia	TDS	236	439	95.42	93.45	97.39
Virginia	TDS	240	441	95.66	93.71	97.61
Virginia	TDS	247	442	95.78	93.84	97.72
Virginia	TDS	248	443	95.91	93.98	97.83
Virginia	TDS	259	444	96.03	94.11	97.95
Virginia	TDS	263	445	96.10	94.18	98.02
Virginia	TDS	266	446	96.17	94.26	98.09
Virginia	TDS	275	447	96.24	94.33	98.15
Virginia	TDS	286	448	96.37	94.47	98.27
Virginia	TDS	287	449	96.49	94.60	98.38
Virginia	TDS	291	450	97.21	95.71	98.71
Virginia	TDS	292	452	97.51	96.03	98.98
Virginia	TDS	313	453	97.58	96.10	99.05
Virginia	TDS	314	454	97.62	96.15	99.09
Virginia	TDS	315	455	97.69	96.22	99.16
Virginia	TDS	316	456	97.86	96.42	99.30
Virginia	TDS	319	457	97.90	96.46	99.34
Virginia	TDS	330	458	98.07	96.66	99.48
Virginia	TDS	338	459	98.24	96.86	99.62
Virginia	TDS	381	461	98.54	97.20	99.87
Virginia	TDS	394	462	98.58	97.25	99.91
Virginia	TDS	397	463	98.65	97.32	99.98

Virginia	TDS	405	464	98.72	97.39	100.00
Virginia	TDS	466	465	99.44	99.00	99.89
Virginia	TDS	476	466	99.61	99.30	99.93
Virginia	TDS	516	467	99.68	99.39	99.97
Virginia	TDS	584	468	99.75	99.46	100.00
Virginia	TDS	634	469	99.88	99.68	100.00
Virginia	TDS	1711	470	100.00	100.00	100.00

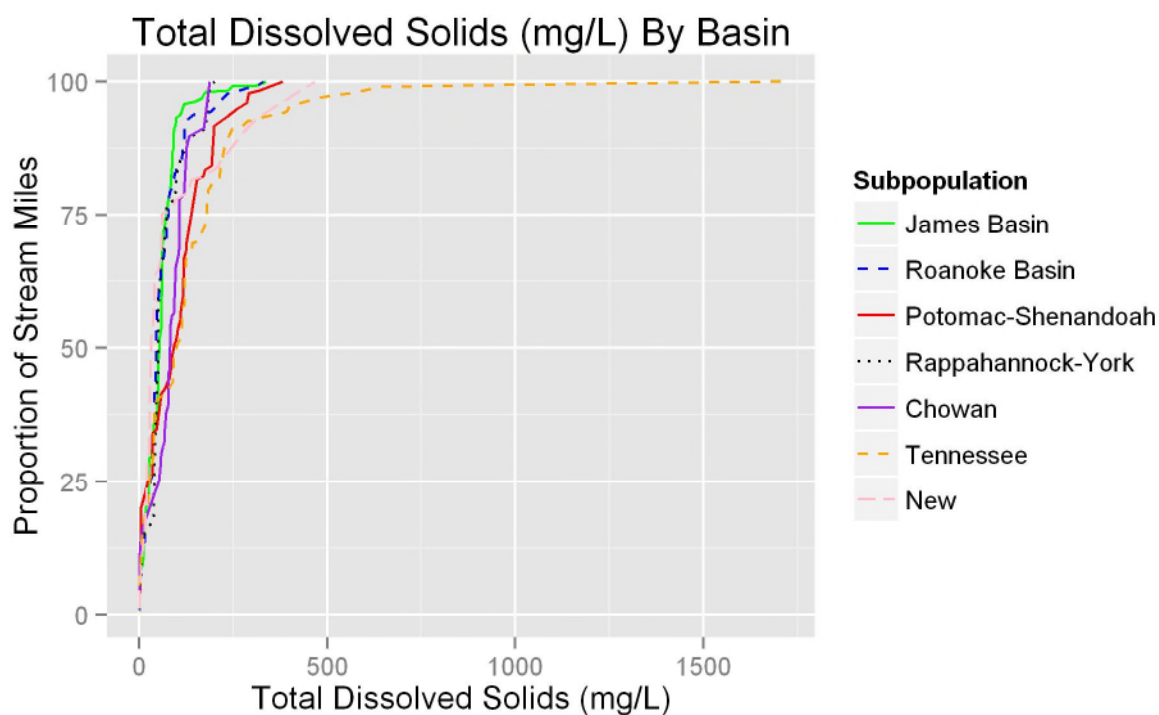


Figure 51. Total Dissolved Solids by Major Basin CDF graph.

Figure 51 and Table 32 present CDF data for TDS by major river basin. The Tennessee basin has the highest TDS concentrations and at the 90<sup>th</sup> percentile, concentrations are 240 mg/L. Ninety percent of New River Basin stream miles have TDS concentrations less than 291 mg/L.

Table 32. Total Dissolved Solids Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	TDS	1	1	0.73	0.00	1.89
James Basin	TDS	2	2	1.47	0.00	3.20
James Basin	TDS	3	3	4.57	0.00	9.52
James Basin	TDS	4	8	6.98	1.65	12.31
James Basin	TDS	5	9	7.28	1.94	12.63
James Basin	TDS	6	11	8.55	2.97	14.14
James Basin	TDS	9	12	9.29	3.57	15.01
James Basin	TDS	10	13	10.02	4.15	15.90
James Basin	TDS	11	14	10.33	4.41	16.24
James Basin	TDS	12	15	10.86	4.87	16.85
James Basin	TDS	13	18	15.23	7.49	22.98
James Basin	TDS	16	19	18.34	9.61	27.07
James Basin	TDS	18	20	19.07	10.26	27.89

James Basin	TDS	19	21	19.81	10.98	28.63
James Basin	TDS	20	22	20.34	11.46	29.22
James Basin	TDS	23	23	21.08	12.09	30.06
James Basin	TDS	24	24	21.61	12.58	30.64
James Basin	TDS	26	26	27.82	17.75	37.89
James Basin	TDS	27	27	28.00	17.99	38.01
James Basin	TDS	28	29	29.47	19.31	39.63
James Basin	TDS	32	30	29.65	19.54	39.75
James Basin	TDS	34	31	29.95	19.83	40.07
James Basin	TDS	35	33	31.22	21.01	41.43
James Basin	TDS	36	34	31.75	21.53	41.98
James Basin	TDS	37	35	32.06	21.80	42.32
James Basin	TDS	38	36	32.36	22.11	42.61
James Basin	TDS	39	37	32.89	22.62	43.16
James Basin	TDS	40	38	36.00	25.13	46.86
James Basin	TDS	41	39	36.30	25.45	47.15
James Basin	TDS	43	40	37.04	26.15	47.92
James Basin	TDS	48	41	37.57	26.71	48.43
James Basin	TDS	49	42	38.10	27.17	49.04
James Basin	TDS	50	44	41.94	30.83	53.05
James Basin	TDS	51	46	42.86	31.68	54.04
James Basin	TDS	52	50	47.97	36.39	59.54
James Basin	TDS	54	52	49.00	37.54	60.47
James Basin	TDS	55	53	52.11	40.87	63.35
James Basin	TDS	56	54	52.64	41.38	63.91
James Basin	TDS	58	55	52.95	41.70	64.19
James Basin	TDS	59	56	53.48	42.30	64.65
James Basin	TDS	60	58	59.69	48.99	70.39
James Basin	TDS	61	60	65.90	56.13	75.67
James Basin	TDS	62	62	69.31	60.09	78.53
James Basin	TDS	63	63	69.84	60.66	79.02
James Basin	TDS	64	64	70.15	60.98	79.31
James Basin	TDS	66	68	71.90	62.81	80.98
James Basin	TDS	68	69	72.43	63.39	81.46
James Basin	TDS	69	70	73.16	64.18	82.15
James Basin	TDS	70	71	73.90	64.99	82.81
James Basin	TDS	71	72	74.43	65.60	83.26
James Basin	TDS	72	74	74.70	65.88	83.52
James Basin	TDS	73	75	75.43	66.70	84.17
James Basin	TDS	74	76	75.97	67.27	84.67
James Basin	TDS	75	79	76.63	67.94	85.32
James Basin	TDS	77	81	77.67	69.14	86.19
James Basin	TDS	79	82	78.20	69.73	86.67
James Basin	TDS	80	83	78.73	70.28	87.18
James Basin	TDS	83	84	78.91	70.47	87.35
James Basin	TDS	85	85	82.02	74.41	89.62
James Basin	TDS	86	86	82.55	75.06	90.04
James Basin	TDS	87	88	83.82	76.48	91.16
James Basin	TDS	89	89	86.93	81.29	92.56
James Basin	TDS	90	90	87.23	81.62	92.84
James Basin	TDS	92	92	90.64	86.54	94.73
James Basin	TDS	94	93	91.37	87.54	95.21
James Basin	TDS	95	94	91.55	87.75	95.35
James Basin	TDS	97	95	92.08	88.44	95.72
James Basin	TDS	98	96	92.26	88.66	95.86
James Basin	TDS	100	98	93.30	90.02	96.58
James Basin	TDS	104	99	93.48	90.24	96.72
James Basin	TDS	110	100	93.78	90.58	96.99
James Basin	TDS	113	101	94.32	91.29	97.34
James Basin	TDS	117	102	95.05	92.35	97.76
James Basin	TDS	119	103	95.79	93.40	98.17



James Basin	TDS	133	104	95.97	93.59	98.34
James Basin	TDS	150	105	96.27	93.94	98.59
James Basin	TDS	167	106	96.80	94.70	98.90
James Basin	TDS	173	107	97.54	95.89	99.18
James Basin	TDS	177	108	98.07	96.60	99.54
James Basin	TDS	236	109	98.25	96.83	99.67
James Basin	TDS	240	110	98.55	97.06	100.00
James Basin	TDS	247	111	99.09	97.92	100.00
James Basin	TDS	314	112	99.27	98.05	100.00
James Basin	TDS	338	113	100.00	100.00	100.00
Roanoke Basin	TDS	3	3	1.78	0.00	3.67
Roanoke Basin	TDS	4	6	9.06	1.60	16.53
Roanoke Basin	TDS	5	7	9.85	2.26	17.45
Roanoke Basin	TDS	6	9	10.76	3.08	18.43
Roanoke Basin	TDS	7	11	12.13	4.24	20.02
Roanoke Basin	TDS	10	12	12.45	4.54	20.37
Roanoke Basin	TDS	11	13	12.78	4.84	20.72
Roanoke Basin	TDS	12	14	13.36	5.50	21.21
Roanoke Basin	TDS	15	15	13.93	6.00	21.86
Roanoke Basin	TDS	16	18	18.40	9.09	27.71
Roanoke Basin	TDS	18	19	19.20	9.86	28.53
Roanoke Basin	TDS	21	20	19.52	10.18	28.87
Roanoke Basin	TDS	23	21	22.88	12.83	32.93
Roanoke Basin	TDS	28	22	23.67	13.47	33.87
Roanoke Basin	TDS	31	23	24.46	14.16	34.76
Roanoke Basin	TDS	32	25	25.37	15.03	35.70
Roanoke Basin	TDS	34	26	26.16	15.81	36.50
Roanoke Basin	TDS	36	28	30.09	19.42	40.75
Roanoke Basin	TDS	39	29	33.44	22.26	44.61
Roanoke Basin	TDS	40	30	33.77	22.60	44.93
Roanoke Basin	TDS	41	32	37.91	26.41	49.42
Roanoke Basin	TDS	42	34	41.59	29.79	53.39
Roanoke Basin	TDS	43	36	42.96	31.21	54.71
Roanoke Basin	TDS	46	40	48.26	36.52	60.00
Roanoke Basin	TDS	47	44	53.31	41.50	65.11
Roanoke Basin	TDS	49	45	56.66	45.19	68.12
Roanoke Basin	TDS	50	47	58.03	46.86	69.19
Roanoke Basin	TDS	51	49	58.93	47.77	70.09
Roanoke Basin	TDS	52	51	59.70	48.56	70.84
Roanoke Basin	TDS	53	52	60.49	49.41	71.58
Roanoke Basin	TDS	55	54	61.01	49.93	72.09
Roanoke Basin	TDS	56	55	61.81	50.80	72.81
Roanoke Basin	TDS	58	57	65.35	54.72	75.98
Roanoke Basin	TDS	62	58	65.93	55.32	76.53
Roanoke Basin	TDS	63	59	66.12	55.53	76.71
Roanoke Basin	TDS	66	61	67.11	56.58	77.64
Roanoke Basin	TDS	67	62	67.90	57.49	78.32
Roanoke Basin	TDS	69	64	68.67	58.25	79.09
Roanoke Basin	TDS	72	65	69.47	59.04	79.89
Roanoke Basin	TDS	73	66	69.66	59.25	80.07
Roanoke Basin	TDS	74	67	73.01	63.11	82.92
Roanoke Basin	TDS	76	68	73.59	63.69	83.49
Roanoke Basin	TDS	77	70	74.74	64.90	84.58
Roanoke Basin	TDS	79	71	75.53	65.81	85.25
Roanoke Basin	TDS	81	72	78.89	70.04	87.73
Roanoke Basin	TDS	83	73	79.46	70.68	88.25
Roanoke Basin	TDS	89	74	80.25	71.46	89.04
Roanoke Basin	TDS	91	75	81.05	72.38	89.72
Roanoke Basin	TDS	92	76	81.84	73.30	90.38
Roanoke Basin	TDS	96	78	82.96	74.50	91.42
Roanoke Basin	TDS	99	79	83.29	74.87	91.71

Roanoke Basin	TDS	100	80	83.86	75.48	92.25
Roanoke Basin	TDS	110	81	84.66	76.36	92.95
Roanoke Basin	TDS	113	82	85.45	76.94	93.95
Roanoke Basin	TDS	115	83	86.03	77.43	94.62
Roanoke Basin	TDS	125	85	92.73	88.35	97.11
Roanoke Basin	TDS	140	86	93.52	89.38	97.67
Roanoke Basin	TDS	143	87	93.72	89.54	97.89
Roanoke Basin	TDS	148	88	93.91	89.72	98.10
Roanoke Basin	TDS	157	89	94.10	89.92	98.29
Roanoke Basin	TDS	191	90	94.30	90.12	98.48
Roanoke Basin	TDS	234	91	97.65	96.16	99.14
Roanoke Basin	TDS	263	92	97.98	96.52	99.44
Roanoke Basin	TDS	266	93	98.30	96.97	99.64
Roanoke Basin	TDS	292	94	98.88	97.56	100.00
Roanoke Basin	TDS	315	95	99.21	97.94	100.00
Roanoke Basin	TDS	330	96	100.00	100.00	100.00
Potomac-Shenandoah	TDS	2	2	2.48	0.00	5.84
Potomac-Shenandoah	TDS	3	4	3.93	0.00	7.88
Potomac-Shenandoah	TDS	4	6	12.65	0.33	24.97
Potomac-Shenandoah	TDS	5	7	20.08	4.18	35.99
Potomac-Shenandoah	TDS	11	8	21.36	5.45	37.27
Potomac-Shenandoah	TDS	17	9	23.12	7.25	38.99
Potomac-Shenandoah	TDS	22	10	24.88	9.17	40.59
Potomac-Shenandoah	TDS	36	11	26.64	10.64	42.64
Potomac-Shenandoah	TDS	37	12	34.07	17.02	51.12
Potomac-Shenandoah	TDS	47	13	34.80	17.76	51.83
Potomac-Shenandoah	TDS	56	16	40.07	23.91	56.24
Potomac-Shenandoah	TDS	59	17	41.35	25.48	57.22
Potomac-Shenandoah	TDS	71	18	42.63	26.91	58.35
Potomac-Shenandoah	TDS	80	19	44.39	28.41	60.36
Potomac-Shenandoah	TDS	83	20	45.11	29.23	61.00
Potomac-Shenandoah	TDS	84	21	45.84	29.95	61.72
Potomac-Shenandoah	TDS	85	22	47.60	31.55	63.64
Potomac-Shenandoah	TDS	87	23	48.32	32.11	64.53
Potomac-Shenandoah	TDS	94	25	50.81	34.64	66.97
Potomac-Shenandoah	TDS	98	26	51.23	35.14	67.32
Potomac-Shenandoah	TDS	102	27	52.99	36.72	69.27
Potomac-Shenandoah	TDS	103	28	53.42	37.03	69.81
Potomac-Shenandoah	TDS	110	29	55.18	39.14	71.22
Potomac-Shenandoah	TDS	111	30	56.94	41.09	72.79
Potomac-Shenandoah	TDS	115	31	58.70	42.76	74.64
Potomac-Shenandoah	TDS	116	32	59.43	43.23	75.62
Potomac-Shenandoah	TDS	120	33	66.86	51.47	82.25
Potomac-Shenandoah	TDS	124	34	68.14	52.84	83.44
Potomac-Shenandoah	TDS	127	35	69.90	54.70	85.10
Potomac-Shenandoah	TDS	135	37	73.42	58.15	88.68
Potomac-Shenandoah	TDS	136	38	74.14	58.82	89.46
Potomac-Shenandoah	TDS	154	39	81.58	69.52	93.63
Potomac-Shenandoah	TDS	171	40	82.30	70.25	94.35
Potomac-Shenandoah	TDS	176	41	83.58	71.25	95.91
Potomac-Shenandoah	TDS	192	42	84.30	72.08	96.53
Potomac-Shenandoah	TDS	200	43	91.74	85.65	97.83
Potomac-Shenandoah	TDS	236	44	93.50	88.21	98.79
Potomac-Shenandoah	TDS	259	45	94.77	89.97	99.58
Potomac-Shenandoah	TDS	286	46	96.05	91.95	100.00
Potomac-Shenandoah	TDS	292	47	97.81	94.73	100.00
Potomac-Shenandoah	TDS	319	48	98.24	95.28	100.00
Potomac-Shenandoah	TDS	381	49	100.00	100.00	100.00
Rappahannock-York	TDS	3	4	5.35	0.54	10.17
Rappahannock-York	TDS	6	5	6.48	1.20	11.76
Rappahannock-York	TDS	8	6	7.12	1.68	12.56

Rappahannock-York	TDS	9	8	14.05	3.79	24.31
Rappahannock-York	TDS	18	9	15.60	5.33	25.87
Rappahannock-York	TDS	21	10	16.24	5.90	26.58
Rappahannock-York	TDS	38	11	17.36	6.89	27.84
Rappahannock-York	TDS	40	13	19.55	9.77	29.33
Rappahannock-York	TDS	41	15	27.66	15.25	40.06
Rappahannock-York	TDS	43	16	29.21	16.97	41.44
Rappahannock-York	TDS	44	17	35.76	21.17	50.35
Rappahannock-York	TDS	45	18	36.40	21.86	50.94
Rappahannock-York	TDS	47	19	36.78	22.24	51.31
Rappahannock-York	TDS	48	21	43.71	28.69	58.72
Rappahannock-York	TDS	50	22	44.35	29.42	59.28
Rappahannock-York	TDS	51	24	46.60	31.75	61.45
Rappahannock-York	TDS	52	26	54.70	39.22	70.18
Rappahannock-York	TDS	53	29	62.01	47.46	76.57
Rappahannock-York	TDS	55	30	62.65	48.18	77.12
Rappahannock-York	TDS	56	31	63.03	48.56	77.49
Rappahannock-York	TDS	57	32	64.58	50.26	78.89
Rappahannock-York	TDS	60	34	66.51	52.38	80.63
Rappahannock-York	TDS	62	35	66.89	52.80	80.97
Rappahannock-York	TDS	65	36	67.53	53.59	81.46
Rappahannock-York	TDS	68	39	70.42	57.09	83.74
Rappahannock-York	TDS	70	42	73.24	60.21	86.28
Rappahannock-York	TDS	72	43	73.62	60.56	86.68
Rappahannock-York	TDS	73	44	75.17	62.23	88.11
Rappahannock-York	TDS	74	45	76.72	63.97	89.48
Rappahannock-York	TDS	81	46	77.36	64.66	90.06
Rappahannock-York	TDS	94	47	77.74	65.07	90.41
Rappahannock-York	TDS	105	48	84.29	76.20	92.38
Rappahannock-York	TDS	112	49	85.84	76.86	94.83
Rappahannock-York	TDS	119	50	86.97	78.00	95.94
Rappahannock-York	TDS	127	51	88.52	79.71	97.32
Rappahannock-York	TDS	134	52	89.65	80.70	98.59
Rappahannock-York	TDS	177	53	91.20	82.28	100.00
Rappahannock-York	TDS	180	54	92.32	83.54	100.00
Rappahannock-York	TDS	187	55	98.87	96.94	100.00
Rappahannock-York	TDS	201	56	100.00	100.00	100.00
Chowan	TDS	2	1	0.85	0.00	2.33
Chowan	TDS	3	4	11.55	0.00	25.57
Chowan	TDS	4	5	13.61	0.00	27.85
Chowan	TDS	6	6	14.45	0.13	28.78
Chowan	TDS	10	7	16.51	1.83	31.20
Chowan	TDS	53	8	25.22	5.82	44.61
Chowan	TDS	58	11	28.97	9.46	48.48
Chowan	TDS	59	12	29.82	10.27	49.37
Chowan	TDS	60	14	30.56	10.95	50.18
Chowan	TDS	63	15	31.41	11.93	50.89
Chowan	TDS	64	16	31.65	12.17	51.13
Chowan	TDS	66	17	31.89	12.40	51.39
Chowan	TDS	67	18	32.39	12.95	51.84
Chowan	TDS	68	20	34.09	14.52	53.66
Chowan	TDS	69	21	34.94	15.35	54.53
Chowan	TDS	70	22	36.43	17.05	55.82
Chowan	TDS	72	23	37.93	18.32	57.54
Chowan	TDS	76	24	38.78	19.03	58.52
Chowan	TDS	77	25	39.28	19.53	59.03
Chowan	TDS	78	27	41.28	21.34	61.21
Chowan	TDS	79	31	45.58	25.80	65.35
Chowan	TDS	80	32	45.82	25.96	65.67
Chowan	TDS	84	33	54.52	34.17	74.87
Chowan	TDS	87	34	56.01	35.71	76.32

Chowan	TDS	93	35	56.52	36.17	76.87
Chowan	TDS	98	36	65.22	45.50	84.93
Chowan	TDS	104	37	67.28	47.53	87.02
Chowan	TDS	107	38	69.34	49.66	89.01
Chowan	TDS	108	39	78.04	59.93	96.14
Chowan	TDS	115	40	78.54	60.41	96.67
Chowan	TDS	120	41	79.04	60.90	97.19
Chowan	TDS	126	42	87.74	74.44	100.00
Chowan	TDS	134	43	89.80	76.54	100.00
Chowan	TDS	172	44	91.30	77.91	100.00
Chowan	TDS	187	45	100.00	100.00	100.00
Tennessee	TDS	2	2	1.54	0.00	3.46
Tennessee	TDS	3	6	5.42	1.13	9.70
Tennessee	TDS	4	11	9.62	3.82	15.43
Tennessee	TDS	5	12	10.61	4.38	16.84
Tennessee	TDS	6	14	12.94	5.73	20.15
Tennessee	TDS	15	15	18.66	8.21	29.12
Tennessee	TDS	23	16	20.02	9.21	30.82
Tennessee	TDS	29	17	25.74	12.27	39.21
Tennessee	TDS	39	18	31.46	16.76	46.16
Tennessee	TDS	42	20	38.53	22.97	54.09
Tennessee	TDS	45	21	39.09	23.65	54.53
Tennessee	TDS	47	22	40.44	24.98	55.91
Tennessee	TDS	78	23	41.80	26.29	57.30
Tennessee	TDS	82	24	42.78	27.44	58.11
Tennessee	TDS	90	25	43.76	28.44	59.08
Tennessee	TDS	93	26	49.48	33.99	64.97
Tennessee	TDS	99	27	50.04	34.65	65.43
Tennessee	TDS	101	28	50.60	35.29	65.90
Tennessee	TDS	111	29	51.95	36.80	67.10
Tennessee	TDS	116	30	57.67	43.04	72.30
Tennessee	TDS	121	31	58.23	43.69	72.76
Tennessee	TDS	122	32	63.95	50.34	77.56
Tennessee	TDS	124	34	66.66	53.62	79.69
Tennessee	TDS	138	35	67.64	54.64	80.64
Tennessee	TDS	140	36	68.62	55.79	81.45
Tennessee	TDS	142	37	69.60	56.87	82.33
Tennessee	TDS	163	38	70.16	57.44	82.88
Tennessee	TDS	166	39	71.51	58.76	84.27
Tennessee	TDS	173	40	72.50	59.85	85.15
Tennessee	TDS	176	41	73.06	60.47	85.64
Tennessee	TDS	178	42	74.04	61.52	86.55
Tennessee	TDS	185	43	79.76	69.56	89.96
Tennessee	TDS	189	44	80.32	70.22	90.41
Tennessee	TDS	198	45	81.67	72.01	91.33
Tennessee	TDS	214	46	82.00	72.36	91.64
Tennessee	TDS	215	47	82.98	73.51	92.45
Tennessee	TDS	231	48	88.70	82.63	94.78
Tennessee	TDS	240	49	90.06	84.55	95.57
Tennessee	TDS	248	50	91.04	86.01	96.07
Tennessee	TDS	275	51	91.60	86.69	96.50
Tennessee	TDS	287	52	92.58	88.03	97.13
Tennessee	TDS	313	53	93.14	88.74	97.54
Tennessee	TDS	381	54	94.12	90.20	98.04
Tennessee	TDS	394	55	94.45	90.59	98.31
Tennessee	TDS	397	56	95.01	91.31	98.70
Tennessee	TDS	405	57	95.57	91.82	99.31
Tennessee	TDS	476	58	96.92	94.26	99.57
Tennessee	TDS	516	59	97.48	95.05	99.91
Tennessee	TDS	584	60	98.03	95.67	100.00
Tennessee	TDS	634	61	99.02	97.43	100.00

Tennessee	TDS	1711	62	100.00	100.00	100.00
New	TDS	1	1	1.16	0.00	3.04
New	TDS	2	2	2.31	0.00	5.13
New	TDS	3	4	5.50	0.42	10.57
New	TDS	4	5	7.09	1.48	12.69
New	TDS	6	7	9.83	3.38	16.29
New	TDS	18	9	18.16	6.72	29.59
New	TDS	20	10	19.75	8.40	31.09
New	TDS	22	13	29.66	15.30	44.02
New	TDS	27	14	30.81	16.14	45.49
New	TDS	30	16	44.27	27.52	61.02
New	TDS	33	18	52.16	34.21	70.10
New	TDS	37	19	53.31	35.38	71.25
New	TDS	41	20	60.04	43.16	76.92
New	TDS	42	22	62.79	45.98	79.60
New	TDS	45	23	63.94	47.13	80.76
New	TDS	49	24	64.33	47.49	81.18
New	TDS	52	25	64.72	47.82	81.62
New	TDS	57	26	66.31	49.47	83.16
New	TDS	59	27	66.97	50.29	83.65
New	TDS	62	29	75.29	60.59	89.99
New	TDS	81	30	75.68	60.98	90.38
New	TDS	90	31	76.83	62.13	91.54
New	TDS	93	32	77.22	62.53	91.92
New	TDS	98	33	77.88	63.09	92.67
New	TDS	124	34	79.04	64.43	93.64
New	TDS	129	35	79.69	65.02	94.36
New	TDS	134	36	80.35	65.60	95.09
New	TDS	137	37	81.00	66.23	95.77
New	TDS	138	38	81.66	66.91	96.41
New	TDS	163	39	82.05	67.30	96.80
New	TDS	201	40	83.64	68.83	98.44
New	TDS	212	41	84.30	69.30	99.29
New	TDS	215	42	84.95	69.87	100.00
New	TDS	291	43	91.68	80.21	100.00
New	TDS	316	44	93.27	82.01	100.00
New	TDS	466	45	100.00	100.00	100.00

## Total Dissolved Solids (mg/L) By Ecoregion

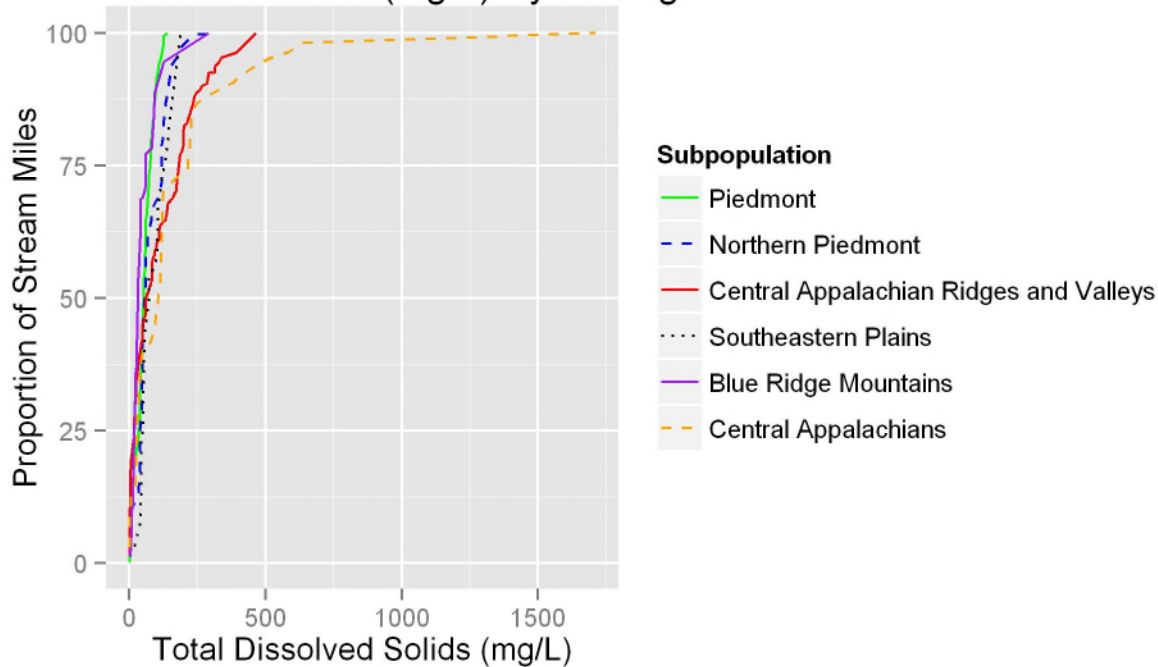


Figure 52. Total Dissolved Solids by Ecoregion (Level III) CDF graph.

Figure 52 and Table 33 contain CDF curve data for TDS by Level III ecoregion. The Central Appalachians and Central Appalachian Ridges and Valleys have the highest overall TDS concentrations. The ninetieth percentiles for the aforementioned ecoregions are 381 mg/L and 286 mg/L, respectively.

Table 33. Total Dissolved Solids Population Estimates by Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	TDS	2	1	0.19	0.00	0.52
Piedmont	TDS	3	7	3.97	0.42	7.51
Piedmont	TDS	4	15	9.83	4.27	15.40
Piedmont	TDS	5	16	10.29	4.67	15.92
Piedmont	TDS	6	19	11.01	5.33	16.69
Piedmont	TDS	7	20	11.34	5.63	17.06
Piedmont	TDS	9	21	11.80	6.06	17.55
Piedmont	TDS	10	23	12.45	6.65	18.26
Piedmont	TDS	11	24	12.64	6.82	18.46
Piedmont	TDS	12	25	12.98	7.20	18.76
Piedmont	TDS	13	26	14.93	8.48	21.37
Piedmont	TDS	15	27	15.26	8.79	21.74
Piedmont	TDS	16	30	17.86	10.81	24.91
Piedmont	TDS	18	32	18.78	11.70	25.86
Piedmont	TDS	20	33	19.12	11.99	26.24
Piedmont	TDS	21	34	19.31	12.18	26.43
Piedmont	TDS	26	35	21.25	13.86	28.65
Piedmont	TDS	27	36	21.37	13.99	28.74
Piedmont	TDS	28	37	21.83	14.38	29.27
Piedmont	TDS	31	38	22.29	14.80	29.77

Piedmont	TDS	32	41	22.92	15.45	30.40
Piedmont	TDS	34	43	23.57	16.09	31.06
Piedmont	TDS	36	44	25.52	17.83	33.22
Piedmont	TDS	37	45	25.71	18.00	33.43
Piedmont	TDS	38	46	26.05	18.32	33.78
Piedmont	TDS	39	47	27.99	19.97	36.01
Piedmont	TDS	40	49	30.13	21.78	38.48
Piedmont	TDS	41	51	32.54	23.98	41.10
Piedmont	TDS	42	53	34.68	25.94	43.42
Piedmont	TDS	43	56	35.93	27.17	44.70
Piedmont	TDS	46	60	39.01	30.16	47.86
Piedmont	TDS	47	64	41.94	32.98	50.91
Piedmont	TDS	48	65	42.06	33.09	51.02
Piedmont	TDS	49	66	44.01	35.05	52.96
Piedmont	TDS	50	69	44.99	36.19	53.79
Piedmont	TDS	51	73	45.96	37.16	54.77
Piedmont	TDS	52	78	49.15	40.35	57.96
Piedmont	TDS	53	80	51.56	42.61	60.51
Piedmont	TDS	54	81	51.75	42.79	60.71
Piedmont	TDS	55	84	54.00	45.09	62.91
Piedmont	TDS	56	86	54.80	45.92	63.67
Piedmont	TDS	58	91	57.70	48.97	66.42
Piedmont	TDS	59	94	58.56	49.87	67.24
Piedmont	TDS	60	95	60.50	52.03	68.97
Piedmont	TDS	61	97	64.40	56.38	72.42
Piedmont	TDS	62	99	64.92	56.94	72.91
Piedmont	TDS	63	101	65.23	57.26	73.19
Piedmont	TDS	64	102	65.42	57.46	73.37
Piedmont	TDS	66	107	66.63	58.70	74.55
Piedmont	TDS	67	109	67.20	59.35	75.05
Piedmont	TDS	68	112	67.91	60.07	75.75
Piedmont	TDS	69	116	69.01	61.19	76.84
Piedmont	TDS	70	120	70.46	62.74	78.17
Piedmont	TDS	71	121	70.79	63.11	78.48
Piedmont	TDS	72	124	71.42	63.74	79.10
Piedmont	TDS	73	125	71.53	63.86	79.21
Piedmont	TDS	74	126	73.48	66.05	80.91
Piedmont	TDS	75	128	73.70	66.28	81.13
Piedmont	TDS	76	130	74.23	66.75	81.71
Piedmont	TDS	77	135	75.66	68.27	83.05
Piedmont	TDS	78	136	76.00	68.61	83.38
Piedmont	TDS	79	140	77.37	70.10	84.63
Piedmont	TDS	80	141	77.70	70.45	84.95
Piedmont	TDS	81	143	79.84	72.99	86.68
Piedmont	TDS	83	144	80.17	73.35	86.99
Piedmont	TDS	84	145	82.12	75.81	88.43
Piedmont	TDS	86	146	82.45	76.18	88.73
Piedmont	TDS	87	149	83.58	77.37	89.80
Piedmont	TDS	89	150	84.05	77.83	90.26
Piedmont	TDS	91	151	84.51	78.34	90.67
Piedmont	TDS	92	153	86.91	81.19	92.64
Piedmont	TDS	94	154	87.38	81.71	93.04
Piedmont	TDS	96	156	88.03	82.35	93.70
Piedmont	TDS	97	157	88.36	82.71	94.01
Piedmont	TDS	98	159	90.42	85.00	95.84
Piedmont	TDS	99	160	90.61	85.21	96.01
Piedmont	TDS	100	162	91.41	85.99	96.82
Piedmont	TDS	102	163	91.87	86.50	97.24
Piedmont	TDS	104	164	91.98	86.62	97.34
Piedmont	TDS	108	165	93.93	89.65	98.20
Piedmont	TDS	110	166	94.39	90.17	98.60

Piedmont	TDS	113	167	94.85	90.49	99.20
Piedmont	TDS	115	168	95.18	90.76	99.60
Piedmont	TDS	117	169	95.64	91.28	100.00
Piedmont	TDS	125	170	97.59	94.67	100.00
Piedmont	TDS	126	171	99.54	98.77	100.00
Piedmont	TDS	140	172	100.00	100.00	100.00
Northern Piedmont	TDS	3	2	1.87	0.00	4.32
Northern Piedmont	TDS	5	3	8.83	0.00	20.17
Northern Piedmont	TDS	6	4	10.02	0.00	21.53
Northern Piedmont	TDS	11	5	10.70	0.00	22.26
Northern Piedmont	TDS	35	7	13.54	1.65	25.43
Northern Piedmont	TDS	36	8	14.73	2.81	26.66
Northern Piedmont	TDS	38	9	15.41	3.56	27.26
Northern Piedmont	TDS	40	11	17.73	5.62	29.85
Northern Piedmont	TDS	41	13	25.36	11.45	39.28
Northern Piedmont	TDS	43	14	27.01	13.05	40.97
Northern Piedmont	TDS	45	15	27.69	13.78	41.60
Northern Piedmont	TDS	47	16	28.09	14.22	41.96
Northern Piedmont	TDS	48	18	36.24	21.10	51.37
Northern Piedmont	TDS	49	19	37.43	22.13	52.73
Northern Piedmont	TDS	50	20	39.08	23.90	54.25
Northern Piedmont	TDS	52	21	46.03	30.46	61.61
Northern Piedmont	TDS	53	22	46.43	30.84	62.02
Northern Piedmont	TDS	55	23	47.11	31.61	62.61
Northern Piedmont	TDS	56	25	50.40	35.66	65.14
Northern Piedmont	TDS	60	26	50.80	36.13	65.48
Northern Piedmont	TDS	62	28	58.16	44.56	71.75
Northern Piedmont	TDS	65	29	58.83	45.47	72.20
Northern Piedmont	TDS	68	31	61.22	48.40	74.05
Northern Piedmont	TDS	73	32	62.87	50.31	75.43
Northern Piedmont	TDS	80	33	64.51	51.70	77.33
Northern Piedmont	TDS	83	34	64.92	52.18	77.66
Northern Piedmont	TDS	85	35	66.56	53.67	79.45
Northern Piedmont	TDS	87	36	67.24	54.09	80.38
Northern Piedmont	TDS	94	37	67.92	54.59	81.24
Northern Piedmont	TDS	98	38	68.32	55.05	81.59
Northern Piedmont	TDS	103	39	68.72	55.29	82.15
Northern Piedmont	TDS	115	40	70.37	56.81	83.92
Northern Piedmont	TDS	116	41	71.04	57.21	84.87
Northern Piedmont	TDS	119	42	72.24	58.35	86.13
Northern Piedmont	TDS	120	43	79.19	67.18	91.20
Northern Piedmont	TDS	124	44	80.39	68.43	92.35
Northern Piedmont	TDS	127	46	83.68	71.87	95.49
Northern Piedmont	TDS	135	48	86.97	75.11	98.82
Northern Piedmont	TDS	154	49	93.92	89.41	98.42
Northern Piedmont	TDS	177	50	95.56	91.55	99.58
Northern Piedmont	TDS	180	51	96.76	93.26	100.00
Northern Piedmont	TDS	201	52	97.95	95.15	100.00
Northern Piedmont	TDS	236	53	99.60	98.91	100.00
Northern Piedmont	TDS	319	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	TDS	1	2	1.37	0.00	2.95
Central Appalachian Ridges and Valleys	TDS	2	6	3.85	1.03	6.67
Central Appalachian Ridges and Valleys	TDS	3	13	10.42	4.27	16.57
Central Appalachian Ridges and Valleys	TDS	4	20	16.80	8.69	24.92
Central Appalachian Ridges and Valleys	TDS	5	22	17.70	9.51	25.90
Central Appalachian Ridges and Valleys	TDS	6	25	19.86	11.47	28.25
Central Appalachian Ridges and Valleys	TDS	10	26	20.66	12.16	29.15
Central Appalachian Ridges and Valleys	TDS	11	27	21.23	12.70	29.76
Central Appalachian Ridges and Valleys	TDS	12	28	21.81	13.22	30.39
Central Appalachian Ridges and Valleys	TDS	13	29	22.60	14.01	31.18
Central Appalachian Ridges and Valleys	TDS	17	30	23.39	14.72	32.06



Central Appalachian Ridges and Valleys	TDS	18	31	26.74	17.36	36.11
Central Appalachian Ridges and Valleys	TDS	20	32	27.53	18.20	36.85
Central Appalachian Ridges and Valleys	TDS	22	35	29.90	20.50	39.30
Central Appalachian Ridges and Valleys	TDS	23	36	30.69	21.18	40.21
Central Appalachian Ridges and Valleys	TDS	24	37	31.27	21.70	40.84
Central Appalachian Ridges and Valleys	TDS	26	38	34.62	24.68	44.55
Central Appalachian Ridges and Valleys	TDS	28	39	35.41	25.39	45.43
Central Appalachian Ridges and Valleys	TDS	37	41	39.33	28.93	49.73
Central Appalachian Ridges and Valleys	TDS	39	42	39.91	29.50	50.32
Central Appalachian Ridges and Valleys	TDS	42	43	40.70	30.25	51.15
Central Appalachian Ridges and Valleys	TDS	45	45	41.60	31.13	52.07
Central Appalachian Ridges and Valleys	TDS	47	46	41.93	31.43	52.42
Central Appalachian Ridges and Valleys	TDS	50	47	45.27	34.70	55.84
Central Appalachian Ridges and Valleys	TDS	52	48	45.47	34.87	56.06
Central Appalachian Ridges and Valleys	TDS	54	49	46.26	35.85	56.67
Central Appalachian Ridges and Valleys	TDS	58	50	46.58	36.20	56.97
Central Appalachian Ridges and Valleys	TDS	60	51	49.93	39.64	60.22
Central Appalachian Ridges and Valleys	TDS	66	52	50.72	40.51	60.94
Central Appalachian Ridges and Valleys	TDS	71	53	51.30	41.12	61.48
Central Appalachian Ridges and Valleys	TDS	74	54	51.87	41.73	62.02
Central Appalachian Ridges and Valleys	TDS	75	55	52.20	42.07	62.33
Central Appalachian Ridges and Valleys	TDS	79	56	52.77	42.70	62.85
Central Appalachian Ridges and Valleys	TDS	81	57	52.97	42.90	63.03
Central Appalachian Ridges and Valleys	TDS	83	58	53.29	43.25	63.34
Central Appalachian Ridges and Valleys	TDS	84	59	53.62	43.58	63.66
Central Appalachian Ridges and Valleys	TDS	85	60	56.97	47.02	66.91
Central Appalachian Ridges and Valleys	TDS	90	62	57.87	47.95	67.78
Central Appalachian Ridges and Valleys	TDS	93	63	58.06	48.16	67.97
Central Appalachian Ridges and Valleys	TDS	94	64	58.85	49.00	68.70
Central Appalachian Ridges and Valleys	TDS	95	65	59.05	49.23	68.86
Central Appalachian Ridges and Valleys	TDS	98	66	59.37	49.54	69.21
Central Appalachian Ridges and Valleys	TDS	99	67	59.70	49.88	69.52
Central Appalachian Ridges and Valleys	TDS	100	68	60.03	50.23	69.82
Central Appalachian Ridges and Valleys	TDS	101	69	60.35	50.55	70.15
Central Appalachian Ridges and Valleys	TDS	110	71	61.47	51.82	71.12
Central Appalachian Ridges and Valleys	TDS	111	73	63.05	53.55	72.56
Central Appalachian Ridges and Valleys	TDS	113	74	63.63	54.21	73.05
Central Appalachian Ridges and Valleys	TDS	121	75	63.95	54.53	73.38
Central Appalachian Ridges and Valleys	TDS	124	76	64.53	55.22	73.84
Central Appalachian Ridges and Valleys	TDS	133	77	64.72	55.43	74.01
Central Appalachian Ridges and Valleys	TDS	134	78	65.05	55.78	74.32
Central Appalachian Ridges and Valleys	TDS	136	79	65.38	56.10	74.65
Central Appalachian Ridges and Valleys	TDS	137	80	65.70	56.42	74.98
Central Appalachian Ridges and Valleys	TDS	138	82	66.60	57.32	75.89
Central Appalachian Ridges and Valleys	TDS	140	83	67.18	57.91	76.45
Central Appalachian Ridges and Valleys	TDS	142	84	67.75	58.49	77.01
Central Appalachian Ridges and Valleys	TDS	143	85	67.95	58.68	77.21
Central Appalachian Ridges and Valleys	TDS	148	86	68.14	58.87	77.41
Central Appalachian Ridges and Valleys	TDS	150	87	68.47	59.23	77.70
Central Appalachian Ridges and Valleys	TDS	157	88	68.66	59.43	77.89
Central Appalachian Ridges and Valleys	TDS	163	90	69.18	59.94	78.42
Central Appalachian Ridges and Valleys	TDS	167	91	69.75	60.59	78.92
Central Appalachian Ridges and Valleys	TDS	171	92	70.08	60.91	79.25
Central Appalachian Ridges and Valleys	TDS	173	94	71.45	62.40	80.50
Central Appalachian Ridges and Valleys	TDS	176	96	72.35	63.20	81.50
Central Appalachian Ridges and Valleys	TDS	177	97	72.92	63.79	82.06
Central Appalachian Ridges and Valleys	TDS	178	98	73.50	64.33	82.66
Central Appalachian Ridges and Valleys	TDS	185	99	76.85	68.31	85.38
Central Appalachian Ridges and Valleys	TDS	189	100	77.17	68.67	85.67
Central Appalachian Ridges and Valleys	TDS	191	101	77.37	68.86	85.87
Central Appalachian Ridges and Valleys	TDS	192	102	77.69	69.22	86.16

Central Appalachian Ridges and Valleys	TDS	198	103	78.48	70.08	86.89
Central Appalachian Ridges and Valleys	TDS	200	104	81.83	74.31	89.35
Central Appalachian Ridges and Valleys	TDS	201	105	82.62	75.04	90.21
Central Appalachian Ridges and Valleys	TDS	212	106	82.95	75.31	90.59
Central Appalachian Ridges and Valleys	TDS	214	107	83.14	75.50	90.78
Central Appalachian Ridges and Valleys	TDS	215	108	83.47	75.81	91.13
Central Appalachian Ridges and Valleys	TDS	234	109	86.82	80.24	93.39
Central Appalachian Ridges and Valleys	TDS	236	110	87.01	80.46	93.56
Central Appalachian Ridges and Valleys	TDS	240	112	88.13	81.69	94.56
Central Appalachian Ridges and Valleys	TDS	247	113	88.70	82.34	95.07
Central Appalachian Ridges and Valleys	TDS	259	114	89.28	82.97	95.58
Central Appalachian Ridges and Valleys	TDS	263	115	89.60	83.30	95.90
Central Appalachian Ridges and Valleys	TDS	266	116	89.93	83.64	96.21
Central Appalachian Ridges and Valleys	TDS	286	117	90.50	84.31	96.70
Central Appalachian Ridges and Valleys	TDS	287	118	91.08	84.95	97.21
Central Appalachian Ridges and Valleys	TDS	292	120	92.45	86.44	98.46
Central Appalachian Ridges and Valleys	TDS	314	121	92.64	86.62	98.66
Central Appalachian Ridges and Valleys	TDS	315	122	92.97	86.96	98.97
Central Appalachian Ridges and Valleys	TDS	316	123	93.76	87.88	99.64
Central Appalachian Ridges and Valleys	TDS	330	124	94.55	88.82	100.00
Central Appalachian Ridges and Valleys	TDS	338	125	95.34	89.75	100.00
Central Appalachian Ridges and Valleys	TDS	381	126	96.13	90.66	100.00
Central Appalachian Ridges and Valleys	TDS	394	127	96.33	90.85	100.00
Central Appalachian Ridges and Valleys	TDS	397	128	96.65	91.19	100.00
Central Appalachian Ridges and Valleys	TDS	466	129	100.00	100.00	100.00
Southeastern Plains	TDS	3	1	1.36	0.00	3.75
Southeastern Plains	TDS	8	2	2.14	0.00	4.93
Southeastern Plains	TDS	9	3	2.59	0.00	5.51
Southeastern Plains	TDS	21	4	3.37	0.17	6.57
Southeastern Plains	TDS	28	5	5.24	1.01	9.47
Southeastern Plains	TDS	41	6	7.12	1.58	12.65
Southeastern Plains	TDS	44	7	15.05	1.23	28.86
Southeastern Plains	TDS	45	8	22.98	6.30	39.65
Southeastern Plains	TDS	51	10	26.22	9.57	42.86
Southeastern Plains	TDS	52	12	29.97	13.39	46.55
Southeastern Plains	TDS	53	14	38.35	21.15	55.56
Southeastern Plains	TDS	56	16	40.69	24.05	57.33
Southeastern Plains	TDS	57	17	42.56	25.91	59.22
Southeastern Plains	TDS	60	20	45.12	28.43	61.80
Southeastern Plains	TDS	63	21	46.48	29.94	63.02
Southeastern Plains	TDS	64	22	46.70	30.15	63.25
Southeastern Plains	TDS	66	23	46.92	30.36	63.48
Southeastern Plains	TDS	68	24	47.69	31.20	64.19
Southeastern Plains	TDS	70	25	48.47	32.14	64.79
Southeastern Plains	TDS	72	27	50.29	33.72	66.85
Southeastern Plains	TDS	73	28	52.16	35.58	68.74
Southeastern Plains	TDS	74	29	54.04	37.85	70.22
Southeastern Plains	TDS	78	30	54.50	38.28	70.71
Southeastern Plains	TDS	79	31	54.72	38.43	71.00
Southeastern Plains	TDS	80	32	54.93	38.58	71.29
Southeastern Plains	TDS	92	33	55.71	39.36	72.06
Southeastern Plains	TDS	93	34	56.17	39.78	72.55
Southeastern Plains	TDS	94	35	56.62	40.26	72.99
Southeastern Plains	TDS	104	36	58.50	42.02	74.98
Southeastern Plains	TDS	105	37	66.43	53.68	79.18
Southeastern Plains	TDS	107	38	68.31	55.44	81.17
Southeastern Plains	TDS	112	39	70.18	55.64	84.72
Southeastern Plains	TDS	115	40	70.64	56.04	85.24
Southeastern Plains	TDS	119	41	72.51	57.63	87.40
Southeastern Plains	TDS	120	42	72.97	58.07	87.87
Southeastern Plains	TDS	134	44	76.21	61.10	91.32

Southeastern Plains	TDS	150	45	84.14	67.49	100.00
Southeastern Plains	TDS	187	47	100.00	100.00	100.00
Blue Ridge Mountains	TDS	3	1	1.26	0.00	3.43
Blue Ridge Mountains	TDS	6	3	3.43	0.00	7.13
Blue Ridge Mountains	TDS	7	4	4.68	0.23	9.13
Blue Ridge Mountains	TDS	9	5	10.00	1.79	18.21
Blue Ridge Mountains	TDS	13	6	10.91	2.69	19.13
Blue Ridge Mountains	TDS	15	7	16.22	4.30	28.15
Blue Ridge Mountains	TDS	16	8	21.54	7.33	35.74
Blue Ridge Mountains	TDS	18	10	24.05	9.67	38.43
Blue Ridge Mountains	TDS	19	11	25.31	11.13	39.49
Blue Ridge Mountains	TDS	22	12	30.62	15.11	46.13
Blue Ridge Mountains	TDS	23	13	35.93	19.04	52.82
Blue Ridge Mountains	TDS	27	14	36.85	19.96	53.74
Blue Ridge Mountains	TDS	30	16	47.47	29.49	65.45
Blue Ridge Mountains	TDS	33	18	53.70	35.10	72.30
Blue Ridge Mountains	TDS	36	20	55.87	37.33	74.40
Blue Ridge Mountains	TDS	41	21	61.18	43.52	78.84
Blue Ridge Mountains	TDS	42	24	68.66	51.45	85.88
Blue Ridge Mountains	TDS	49	25	68.97	51.73	86.22
Blue Ridge Mountains	TDS	57	26	70.23	52.92	87.54
Blue Ridge Mountains	TDS	59	27	70.75	53.50	87.99
Blue Ridge Mountains	TDS	62	29	77.32	61.38	93.25
Blue Ridge Mountains	TDS	82	30	78.23	62.26	94.20
Blue Ridge Mountains	TDS	89	31	83.54	69.57	97.52
Blue Ridge Mountains	TDS	93	32	88.86	77.50	100.00
Blue Ridge Mountains	TDS	125	33	94.17	85.27	100.00
Blue Ridge Mountains	TDS	129	34	94.69	85.84	100.00
Blue Ridge Mountains	TDS	291	35	100.00	100.00	100.00
Central Appalachians	TDS	2	2	2.87	0.00	6.58
Central Appalachians	TDS	3	4	6.54	0.21	12.88
Central Appalachians	TDS	4	6	10.90	1.90	19.90
Central Appalachians	TDS	6	7	12.74	2.65	22.83
Central Appalachians	TDS	23	8	15.26	4.07	26.46
Central Appalachians	TDS	29	9	25.94	8.19	43.69
Central Appalachians	TDS	39	10	36.61	16.18	57.04
Central Appalachians	TDS	47	11	39.14	18.73	59.54
Central Appalachians	TDS	78	12	41.66	21.27	62.06
Central Appalachians	TDS	90	13	43.50	23.26	63.73
Central Appalachians	TDS	116	14	54.17	34.52	73.83
Central Appalachians	TDS	122	15	64.85	46.14	83.56
Central Appalachians	TDS	124	17	69.90	53.06	86.74
Central Appalachians	TDS	166	18	72.43	55.52	89.33
Central Appalachians	TDS	215	19	74.26	57.79	90.73
Central Appalachians	TDS	231	20	84.94	74.55	95.32
Central Appalachians	TDS	248	21	86.77	77.53	96.00
Central Appalachians	TDS	275	22	87.81	78.92	96.70
Central Appalachians	TDS	313	23	88.85	80.28	97.42
Central Appalachians	TDS	381	24	90.68	83.17	98.20
Central Appalachians	TDS	405	25	91.73	84.24	99.21
Central Appalachians	TDS	476	26	94.25	89.02	99.48
Central Appalachians	TDS	516	27	95.29	90.57	100.00
Central Appalachians	TDS	584	28	96.33	91.79	100.00
Central Appalachians	TDS	634	29	98.17	95.17	100.00
Central Appalachians	TDS	1711	30	100.00	100.00	100.00

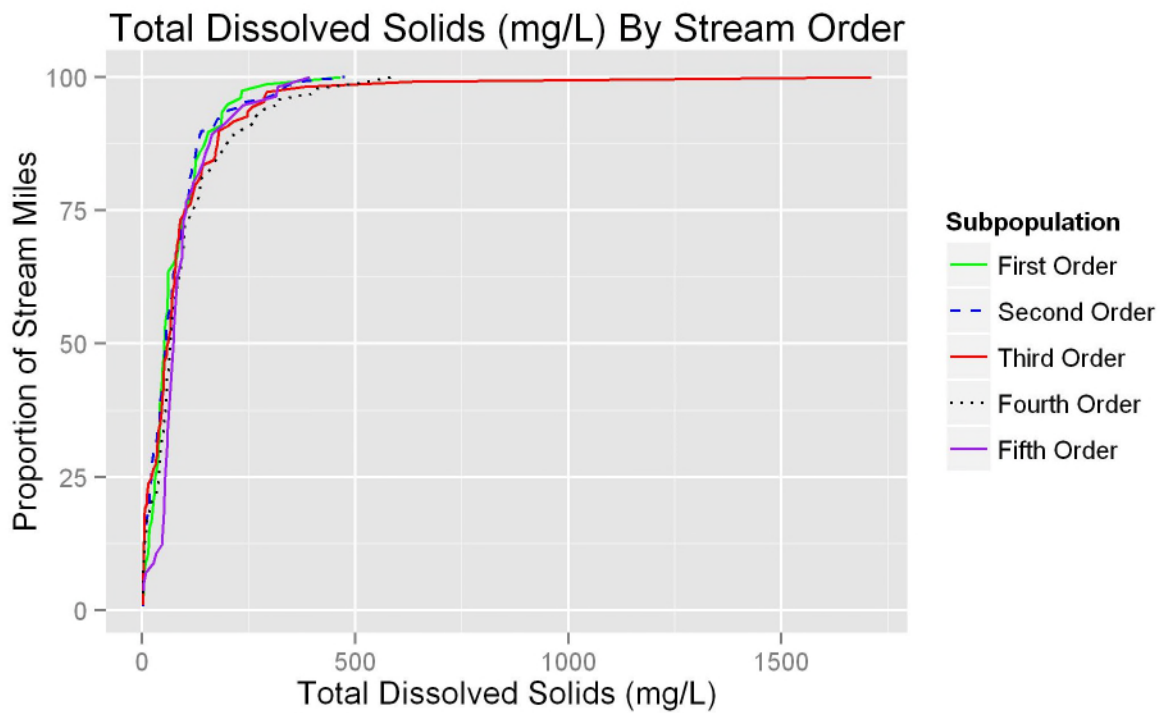


Figure 53. Total Dissolved Solids by Stream Order CDF graph.

TDS CDF curve by stream order is shown in Figure 53. Table 34 corresponds to Figure 53. All stream orders follow a similar distribution with fourth order having the highest concentration at the 90<sup>th</sup> percentile (240 mg/L).

Table 34. Total Dissolved Solids Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	TDS	3	2	2.60	0.00	5.67
First Order	TDS	4	5	6.49	1.88	11.10
First Order	TDS	5	6	7.79	2.66	12.92
First Order	TDS	9	7	9.09	3.65	14.53
First Order	TDS	13	8	10.39	4.55	16.23
First Order	TDS	15	9	11.69	5.47	17.91
First Order	TDS	16	11	14.29	7.35	21.22
First Order	TDS	18	12	15.58	8.35	22.82
First Order	TDS	22	13	16.88	9.45	24.32
First Order	TDS	23	14	18.18	10.45	25.91
First Order	TDS	26	16	20.78	12.89	28.67
First Order	TDS	29	17	22.08	13.94	30.22
First Order	TDS	30	19	24.68	16.28	33.07
First Order	TDS	33	20	25.97	17.40	34.55
First Order	TDS	36	21	27.27	18.45	36.09
First Order	TDS	37	22	28.57	19.63	37.51
First Order	TDS	39	24	31.17	21.83	40.50
First Order	TDS	40	25	32.47	23.16	41.78
First Order	TDS	41	28	36.36	26.79	45.93
First Order	TDS	42	30	38.96	29.55	48.37
First Order	TDS	44	31	40.26	30.71	49.81

First Order	TDS	45	32	41.56	31.80	51.32
First Order	TDS	46	33	42.86	33.03	52.68
First Order	TDS	47	34	44.16	34.33	53.98
First Order	TDS	48	35	45.45	35.61	55.30
First Order	TDS	49	36	46.75	37.07	56.43
First Order	TDS	50	37	48.05	38.33	57.77
First Order	TDS	52	39	50.65	40.75	60.54
First Order	TDS	53	41	53.25	43.28	63.21
First Order	TDS	55	42	54.55	44.54	64.55
First Order	TDS	58	43	55.84	45.99	65.70
First Order	TDS	60	45	58.44	48.78	68.11
First Order	TDS	61	47	61.04	51.53	70.54
First Order	TDS	62	49	63.64	54.54	72.73
First Order	TDS	74	50	64.94	56.09	73.78
First Order	TDS	81	51	66.23	57.50	74.96
First Order	TDS	84	52	67.53	58.77	76.29
First Order	TDS	85	53	68.83	60.33	77.33
First Order	TDS	89	54	70.13	61.92	78.34
First Order	TDS	92	55	71.43	63.53	79.33
First Order	TDS	93	56	72.73	65.08	80.37
First Order	TDS	98	57	74.03	66.37	81.68
First Order	TDS	105	58	75.32	67.95	82.70
First Order	TDS	108	59	76.62	69.40	83.84
First Order	TDS	116	60	77.92	70.68	85.17
First Order	TDS	120	61	79.22	72.05	86.39
First Order	TDS	122	62	80.52	73.57	87.47
First Order	TDS	125	64	83.12	76.79	89.45
First Order	TDS	126	65	84.42	78.49	90.34
First Order	TDS	133	66	85.71	79.48	91.94
First Order	TDS	144	67	87.01	80.81	93.21
First Order	TDS	150	68	88.31	82.31	94.32
First Order	TDS	154	69	89.61	84.01	95.21
First Order	TDS	185	70	90.91	85.47	96.34
First Order	TDS	187	72	93.51	88.93	98.09
First Order	TDS	200	73	94.81	90.80	98.81
First Order	TDS	231	74	96.10	92.77	99.44
First Order	TDS	234	75	97.40	94.32	100.00
First Order	TDS	291	76	98.70	96.58	100.00
First Order	TDS	466	77	100.00	100.00	100.00
Second Order	TDS	1	1	0.78	0.00	2.12
Second Order	TDS	2	3	2.34	0.03	4.66
Second Order	TDS	3	10	7.81	3.64	11.98
Second Order	TDS	4	14	10.94	6.12	15.76
Second Order	TDS	5	15	11.72	6.72	16.72
Second Order	TDS	6	18	14.06	8.82	19.31
Second Order	TDS	7	19	14.84	9.44	20.25
Second Order	TDS	9	20	15.63	10.11	21.14
Second Order	TDS	10	22	17.19	11.51	22.86
Second Order	TDS	13	23	17.97	12.27	23.67
Second Order	TDS	16	24	18.75	12.95	24.55
Second Order	TDS	17	25	19.53	13.69	25.37
Second Order	TDS	18	29	22.66	16.57	28.74
Second Order	TDS	19	30	23.44	17.40	29.48
Second Order	TDS	20	31	24.22	18.24	30.19
Second Order	TDS	22	34	26.56	20.65	32.48
Second Order	TDS	23	36	28.13	22.11	34.14
Second Order	TDS	28	39	30.47	24.20	36.73
Second Order	TDS	31	40	31.25	24.93	37.57
Second Order	TDS	34	41	32.03	25.67	38.39
Second Order	TDS	35	42	32.81	26.43	39.19
Second Order	TDS	36	43	33.59	27.10	40.08

Second Order	TDS	40	44	34.38	27.85	40.90
Second Order	TDS	41	46	35.94	29.20	42.68
Second Order	TDS	42	48	37.50	30.82	44.18
Second Order	TDS	43	51	39.84	32.96	46.73
Second Order	TDS	46	52	40.63	33.74	47.51
Second Order	TDS	47	54	42.19	35.38	49.00
Second Order	TDS	50	56	43.75	36.97	50.53
Second Order	TDS	51	57	44.53	37.69	51.37
Second Order	TDS	52	60	46.88	39.97	53.78
Second Order	TDS	53	61	47.66	40.76	54.56
Second Order	TDS	54	62	48.44	41.52	55.36
Second Order	TDS	56	66	51.56	44.55	58.57
Second Order	TDS	57	68	53.13	46.17	60.08
Second Order	TDS	58	69	53.91	47.02	60.80
Second Order	TDS	60	70	54.69	47.88	61.50
Second Order	TDS	62	71	55.47	48.78	62.16
Second Order	TDS	66	73	57.03	50.35	63.71
Second Order	TDS	67	74	57.81	51.19	64.44
Second Order	TDS	69	75	58.59	51.96	65.23
Second Order	TDS	70	77	60.16	53.66	66.65
Second Order	TDS	72	78	60.94	54.53	67.34
Second Order	TDS	73	80	62.50	56.29	68.71
Second Order	TDS	74	81	63.28	57.22	69.34
Second Order	TDS	77	82	64.06	58.15	69.98
Second Order	TDS	78	83	64.84	59.03	70.66
Second Order	TDS	79	85	66.41	60.68	72.13
Second Order	TDS	80	86	67.19	61.30	73.07
Second Order	TDS	85	87	67.97	61.98	73.96
Second Order	TDS	87	88	68.75	62.82	74.68
Second Order	TDS	89	89	69.53	63.56	75.51
Second Order	TDS	91	90	70.31	64.44	76.19
Second Order	TDS	92	91	71.09	65.38	76.81
Second Order	TDS	94	93	72.66	66.96	78.35
Second Order	TDS	96	94	73.44	67.86	79.02
Second Order	TDS	100	95	74.22	68.79	79.65
Second Order	TDS	102	96	75.00	69.47	80.53
Second Order	TDS	104	97	75.78	70.14	81.42
Second Order	TDS	107	98	76.56	70.94	82.18
Second Order	TDS	110	100	78.13	72.69	83.56
Second Order	TDS	111	102	79.69	74.34	85.04
Second Order	TDS	112	103	80.47	75.18	85.76
Second Order	TDS	113	104	81.25	76.02	86.48
Second Order	TDS	115	105	82.03	76.84	87.23
Second Order	TDS	117	106	82.81	77.78	87.85
Second Order	TDS	119	107	83.59	78.74	88.45
Second Order	TDS	124	109	85.16	80.21	90.10
Second Order	TDS	127	111	86.72	81.86	91.58
Second Order	TDS	134	112	87.50	82.81	92.19
Second Order	TDS	135	114	89.06	84.58	93.54
Second Order	TDS	140	115	89.84	85.55	94.14
Second Order	TDS	166	116	90.63	86.43	94.82
Second Order	TDS	173	117	91.41	87.42	95.39
Second Order	TDS	177	118	92.19	88.43	95.94
Second Order	TDS	198	119	92.97	89.41	96.53
Second Order	TDS	201	120	93.75	90.19	97.31
Second Order	TDS	236	121	94.53	91.24	97.83
Second Order	TDS	240	122	95.31	92.26	98.37
Second Order	TDS	292	123	96.09	93.34	98.84
Second Order	TDS	316	124	96.88	94.25	99.50
Second Order	TDS	330	125	97.66	95.41	99.90
Second Order	TDS	338	126	98.44	96.59	100.00

Second Order	TDS	381	127	99.22	97.90	100.00
Second Order	TDS	476	128	100.00	100.00	100.00
Third Order	TDS	1	1	0.92	0.00	2.50
Third Order	TDS	2	3	2.75	0.05	5.45
Third Order	TDS	3	8	7.34	2.98	11.70
Third Order	TDS	4	14	12.84	7.48	18.21
Third Order	TDS	5	15	13.76	8.23	19.29
Third Order	TDS	6	20	18.35	11.92	24.78
Third Order	TDS	7	21	19.27	12.64	25.89
Third Order	TDS	11	22	20.18	13.39	26.98
Third Order	TDS	12	24	22.02	14.88	29.16
Third Order	TDS	13	25	22.94	15.67	30.20
Third Order	TDS	15	26	23.85	16.48	31.23
Third Order	TDS	20	27	24.77	17.32	32.23
Third Order	TDS	24	28	25.69	18.23	33.15
Third Order	TDS	27	29	26.61	19.04	34.17
Third Order	TDS	32	30	27.52	19.91	35.14
Third Order	TDS	33	31	28.44	20.76	36.12
Third Order	TDS	35	32	29.36	21.57	37.15
Third Order	TDS	36	34	31.19	23.45	38.94
Third Order	TDS	37	35	32.11	24.41	39.81
Third Order	TDS	38	36	33.03	25.28	40.77
Third Order	TDS	39	37	33.94	26.15	41.74
Third Order	TDS	42	38	34.86	27.19	42.54
Third Order	TDS	43	39	35.78	28.27	43.29
Third Order	TDS	45	40	36.70	29.14	44.26
Third Order	TDS	46	42	38.53	30.96	46.10
Third Order	TDS	47	43	39.45	31.88	47.02
Third Order	TDS	48	44	40.37	32.91	47.82
Third Order	TDS	49	45	41.28	33.82	48.75
Third Order	TDS	50	46	42.20	34.63	49.77
Third Order	TDS	51	49	44.95	37.41	52.50
Third Order	TDS	52	51	46.79	39.22	54.36
Third Order	TDS	56	52	47.71	40.07	55.34
Third Order	TDS	59	54	49.54	41.87	57.21
Third Order	TDS	62	55	50.46	42.91	58.01
Third Order	TDS	63	56	51.38	43.83	58.92
Third Order	TDS	66	57	52.29	44.71	59.88
Third Order	TDS	68	60	55.05	47.39	62.70
Third Order	TDS	69	61	55.96	48.30	63.63
Third Order	TDS	70	62	56.88	49.05	64.71
Third Order	TDS	71	64	58.72	50.82	66.61
Third Order	TDS	72	65	59.63	51.68	67.59
Third Order	TDS	74	66	60.55	52.59	68.51
Third Order	TDS	76	67	61.47	53.49	69.44
Third Order	TDS	77	69	63.30	55.47	71.14
Third Order	TDS	78	70	64.22	56.38	72.07
Third Order	TDS	79	72	66.06	58.31	73.80
Third Order	TDS	80	73	66.97	59.36	74.59
Third Order	TDS	82	74	67.89	60.30	75.48
Third Order	TDS	83	75	68.81	61.38	76.24
Third Order	TDS	86	76	69.72	62.46	76.99
Third Order	TDS	87	78	71.56	64.61	78.51
Third Order	TDS	90	80	73.39	66.46	80.32
Third Order	TDS	97	81	74.31	67.56	81.06
Third Order	TDS	100	82	75.23	68.63	81.83
Third Order	TDS	113	83	76.15	69.73	82.57
Third Order	TDS	115	84	77.06	70.82	83.31
Third Order	TDS	119	85	77.98	71.80	84.16
Third Order	TDS	124	87	79.82	73.97	85.66
Third Order	TDS	134	88	80.73	75.07	86.40

Third Order	TDS	138	89	81.65	75.96	87.34
Third Order	TDS	140	90	82.57	77.02	88.12
Third Order	TDS	142	91	83.49	78.06	88.91
Third Order	TDS	167	92	84.40	79.05	89.76
Third Order	TDS	172	93	85.32	80.17	90.47
Third Order	TDS	173	94	86.24	81.16	91.32
Third Order	TDS	176	95	87.16	82.11	92.20
Third Order	TDS	177	96	88.07	83.25	92.89
Third Order	TDS	178	97	88.99	84.30	93.68
Third Order	TDS	180	98	89.91	85.42	94.39
Third Order	TDS	201	99	90.83	86.64	95.01
Third Order	TDS	215	100	91.74	87.66	95.83
Third Order	TDS	247	101	92.66	88.84	96.48
Third Order	TDS	248	102	93.58	89.77	97.39
Third Order	TDS	259	103	94.50	90.95	98.04
Third Order	TDS	286	104	95.41	92.21	98.62
Third Order	TDS	287	105	96.33	93.36	99.30
Third Order	TDS	292	106	97.25	94.68	99.82
Third Order	TDS	381	107	98.17	96.02	100.00
Third Order	TDS	634	108	99.08	97.59	100.00
Third Order	TDS	1711	109	100.00	100.00	100.00
Fourth Order	TDS	2	3	3.19	0.04	6.35
Fourth Order	TDS	3	6	6.38	1.97	10.79
Fourth Order	TDS	4	9	9.57	4.37	14.78
Fourth Order	TDS	5	10	10.64	5.16	16.12
Fourth Order	TDS	6	12	12.77	6.73	18.80
Fourth Order	TDS	8	13	13.83	7.52	20.14
Fourth Order	TDS	10	14	14.89	8.43	21.35
Fourth Order	TDS	11	16	17.02	10.26	23.79
Fourth Order	TDS	16	17	18.09	11.21	24.96
Fourth Order	TDS	21	19	20.21	13.25	27.17
Fourth Order	TDS	32	20	21.28	14.18	28.37
Fourth Order	TDS	34	21	22.34	15.04	29.64
Fourth Order	TDS	37	22	23.40	15.93	30.88
Fourth Order	TDS	38	23	24.47	16.96	31.98
Fourth Order	TDS	40	25	26.60	18.99	34.20
Fourth Order	TDS	41	26	27.66	20.10	35.22
Fourth Order	TDS	42	27	28.72	21.35	36.10
Fourth Order	TDS	45	29	30.85	23.31	38.39
Fourth Order	TDS	47	31	32.98	25.32	40.64
Fourth Order	TDS	50	32	34.04	26.21	41.88
Fourth Order	TDS	51	33	35.11	27.43	42.79
Fourth Order	TDS	54	34	36.17	28.34	44.00
Fourth Order	TDS	55	36	38.30	30.76	45.83
Fourth Order	TDS	58	39	41.49	33.62	49.36
Fourth Order	TDS	59	41	43.62	35.53	51.71
Fourth Order	TDS	62	42	44.68	36.66	52.70
Fourth Order	TDS	63	43	45.74	37.81	53.68
Fourth Order	TDS	64	44	46.81	38.91	54.71
Fourth Order	TDS	65	45	47.87	40.00	55.74
Fourth Order	TDS	66	46	48.94	41.18	56.69
Fourth Order	TDS	68	49	52.13	44.59	59.66
Fourth Order	TDS	69	50	53.19	45.89	60.49
Fourth Order	TDS	70	52	55.32	48.14	62.50
Fourth Order	TDS	75	53	56.38	49.11	63.65
Fourth Order	TDS	76	54	57.45	50.24	64.66
Fourth Order	TDS	77	55	58.51	51.52	65.50
Fourth Order	TDS	81	56	59.57	52.82	66.33
Fourth Order	TDS	83	57	60.64	53.79	67.48
Fourth Order	TDS	84	58	61.70	55.02	68.38
Fourth Order	TDS	87	59	62.77	56.12	69.41



Fourth Order	TDS	90	60	63.83	57.05	70.61
Fourth Order	TDS	92	61	64.89	58.33	71.46
Fourth Order	TDS	94	62	65.96	59.57	72.34
Fourth Order	TDS	96	63	67.02	60.88	73.16
Fourth Order	TDS	98	64	68.09	61.89	74.28
Fourth Order	TDS	99	66	70.21	64.25	76.18
Fourth Order	TDS	100	67	71.28	65.43	77.12
Fourth Order	TDS	101	68	72.34	66.54	78.14
Fourth Order	TDS	110	69	73.40	67.72	79.09
Fourth Order	TDS	116	70	74.47	69.03	79.90
Fourth Order	TDS	121	71	75.53	70.28	80.78
Fourth Order	TDS	129	72	76.60	71.48	81.71
Fourth Order	TDS	134	73	77.66	72.54	82.78
Fourth Order	TDS	136	74	78.72	73.93	83.52
Fourth Order	TDS	137	75	79.79	74.72	84.85
Fourth Order	TDS	138	76	80.85	75.76	85.95
Fourth Order	TDS	150	77	81.91	77.18	86.65
Fourth Order	TDS	163	78	82.98	78.44	87.52
Fourth Order	TDS	171	79	84.04	79.64	88.45
Fourth Order	TDS	176	80	85.11	81.15	89.06
Fourth Order	TDS	189	81	86.17	81.86	90.48
Fourth Order	TDS	192	82	87.23	83.32	91.15
Fourth Order	TDS	212	83	88.30	84.65	91.95
Fourth Order	TDS	215	84	89.36	86.16	92.57
Fourth Order	TDS	240	85	90.43	87.08	93.77
Fourth Order	TDS	263	86	91.49	88.29	94.69
Fourth Order	TDS	266	87	92.55	89.78	95.33
Fourth Order	TDS	275	88	93.62	90.86	96.37
Fourth Order	TDS	313	89	94.68	91.65	97.71
Fourth Order	TDS	315	90	95.74	93.23	98.26
Fourth Order	TDS	397	91	96.81	94.36	99.26
Fourth Order	TDS	405	92	97.87	95.44	100.00
Fourth Order	TDS	516	93	98.94	97.12	100.00
Fourth Order	TDS	584	94	100.00	100.00	100.00
Fifth Order	TDS	3	2	3.57	0.00	7.90
Fifth Order	TDS	4	3	5.36	0.01	10.71
Fifth Order	TDS	9	4	7.14	0.93	13.35
Fifth Order	TDS	27	5	8.93	2.09	15.77
Fifth Order	TDS	32	6	10.71	3.82	17.61
Fifth Order	TDS	47	7	12.50	5.00	20.00
Fifth Order	TDS	48	8	14.29	6.55	22.02
Fifth Order	TDS	49	9	16.07	7.82	24.32
Fifth Order	TDS	51	10	17.86	9.09	26.62
Fifth Order	TDS	52	12	21.43	12.04	30.82
Fifth Order	TDS	53	14	25.00	15.68	34.32
Fifth Order	TDS	55	15	26.79	17.39	36.19
Fifth Order	TDS	56	16	28.57	19.01	38.13
Fifth Order	TDS	58	17	30.36	20.39	40.32
Fifth Order	TDS	60	19	33.93	23.54	44.32
Fifth Order	TDS	62	20	35.71	25.47	45.96
Fifth Order	TDS	63	21	37.50	27.23	47.77
Fifth Order	TDS	66	23	41.07	30.46	51.69
Fifth Order	TDS	67	24	42.86	32.13	53.59
Fifth Order	TDS	69	25	44.64	34.23	55.06
Fifth Order	TDS	72	27	48.21	37.60	58.83
Fifth Order	TDS	73	28	50.00	39.78	60.22
Fifth Order	TDS	75	30	53.57	43.53	63.62
Fifth Order	TDS	77	31	55.36	45.50	65.21
Fifth Order	TDS	78	32	57.14	47.16	67.13
Fifth Order	TDS	79	33	58.93	49.42	68.44
Fifth Order	TDS	81	34	60.71	51.08	70.35

Fifth Order	TDS	83	35	62.50	52.99	72.01
Fifth Order	TDS	93	37	66.07	56.47	75.67
Fifth Order	TDS	94	38	67.86	58.79	76.93
Fifth Order	TDS	95	39	69.64	60.23	79.06
Fifth Order	TDS	98	41	73.21	64.12	82.31
Fifth Order	TDS	103	42	75.00	65.99	84.01
Fifth Order	TDS	104	43	76.79	68.33	85.25
Fifth Order	TDS	115	44	78.57	70.37	86.77
Fifth Order	TDS	120	45	80.36	72.75	87.96
Fifth Order	TDS	133	46	82.14	74.82	89.47
Fifth Order	TDS	143	47	83.93	76.51	91.35
Fifth Order	TDS	148	48	85.71	78.44	92.99
Fifth Order	TDS	157	49	87.50	80.60	94.40
Fifth Order	TDS	163	50	89.29	83.00	95.57
Fifth Order	TDS	191	51	91.07	85.39	96.76
Fifth Order	TDS	214	52	92.86	87.24	98.48
Fifth Order	TDS	236	53	94.64	89.46	99.83
Fifth Order	TDS	314	54	96.43	92.35	100.00
Fifth Order	TDS	319	55	98.21	95.36	100.00
Fifth Order	TDS	394	56	100.00	100.00	100.00

## Appendix G. Total Dissolved Chlorides Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by dissolved chlorides) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Dissolved chloride over 40 mg/L increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). Figure 54 shows VSCI scores declining with increasing concentrations of dissolved chlorides. The case for this increased risk to the aquatic community is presented in this appendix.

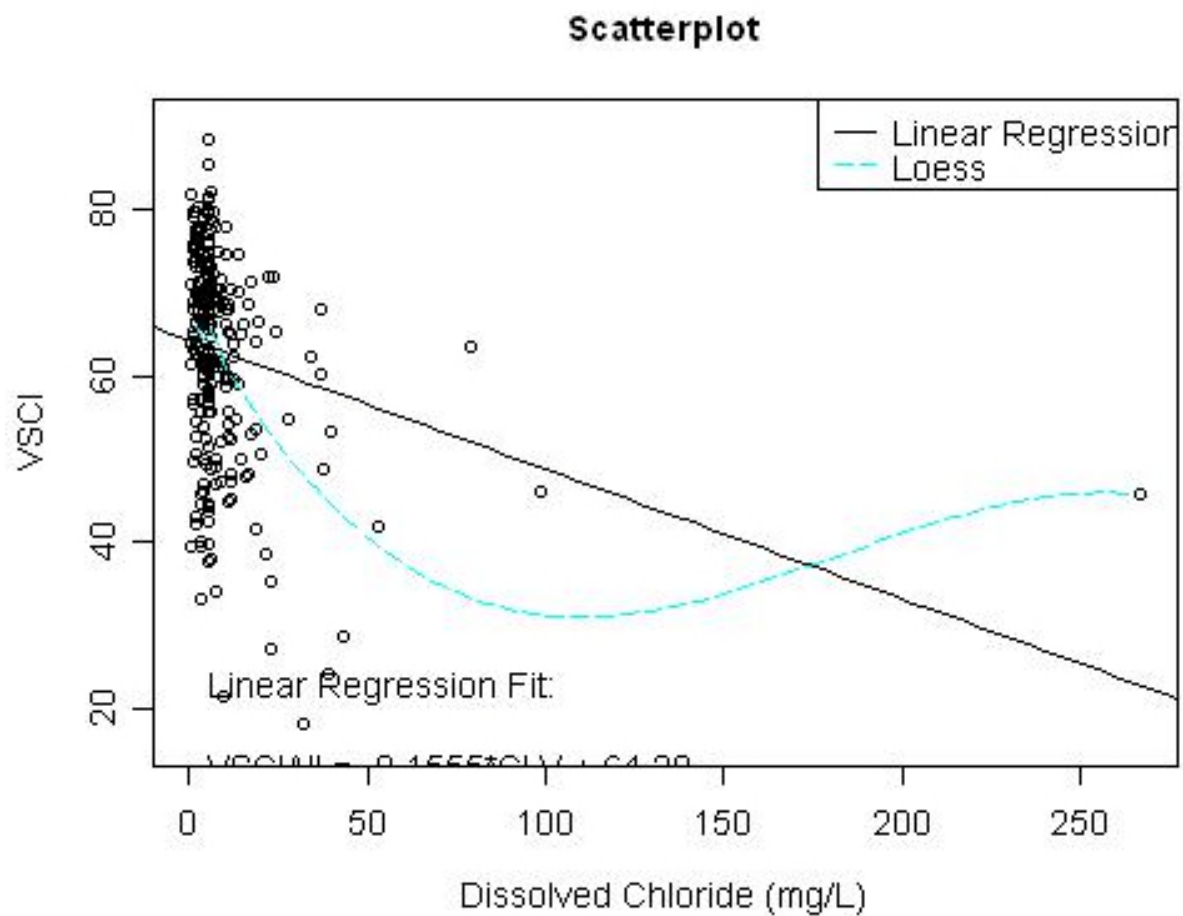


Figure 54. Dissolved Chlorides Stressor Gradient Scatterplot.

### *Total Dissolved Chloride Relative Risk Results*

An optimal level of less than 10 mg/L dissolved chlorides was selected based on the low risk to aquatic life. VDEQ estimates 78% of Virginia streams have dissolved chlorides less than 10 mg/L (Table 35, Figure). Dissolved chlorides above 40 mg/L is considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 55) and scatter plot graphs. Only 1.9% of Virginia streams have a dissolved chloride concentration above 40 mg/L (Figure 56). VDEQ relative risk calculations found that a VSCI score is 5 times more likely to be below 50 when dissolved chlorides are above 40 mg/L than when the chlorides are below 10 mg/L (Figure 56).

Table 35. Dissolved Chlorides Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Dissolved Chlorides (mg/L)	<10	>40

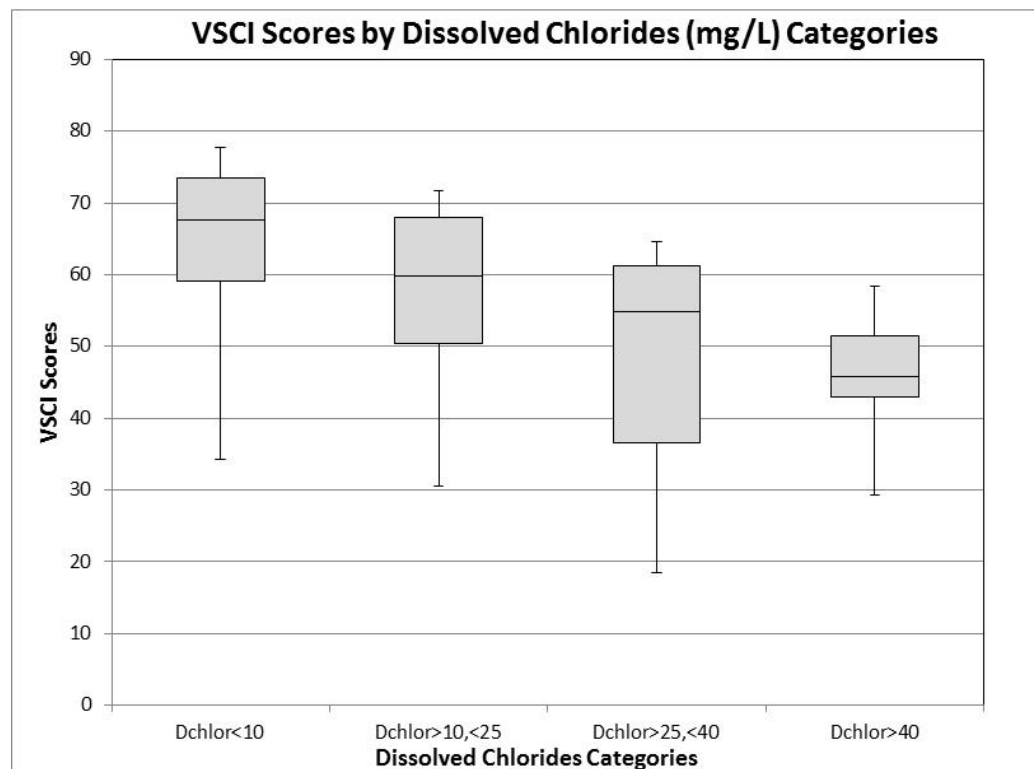


Figure 55. VSCI Scores by Dissolved Chloride Categories.



Figure 56. Dissolved Chlorides Relative Extent (Dissolved Chlorides > 40 mg/L) and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 6 sites with dissolved chlorides over 40 mg/L. One site out of six has a VSCI over 60. The probability of having VSCI score less than 60 when dissolved chlorides are over 40 mg/L is 90% and 100% when chlorides are over 100 mg/L (Figure 57).

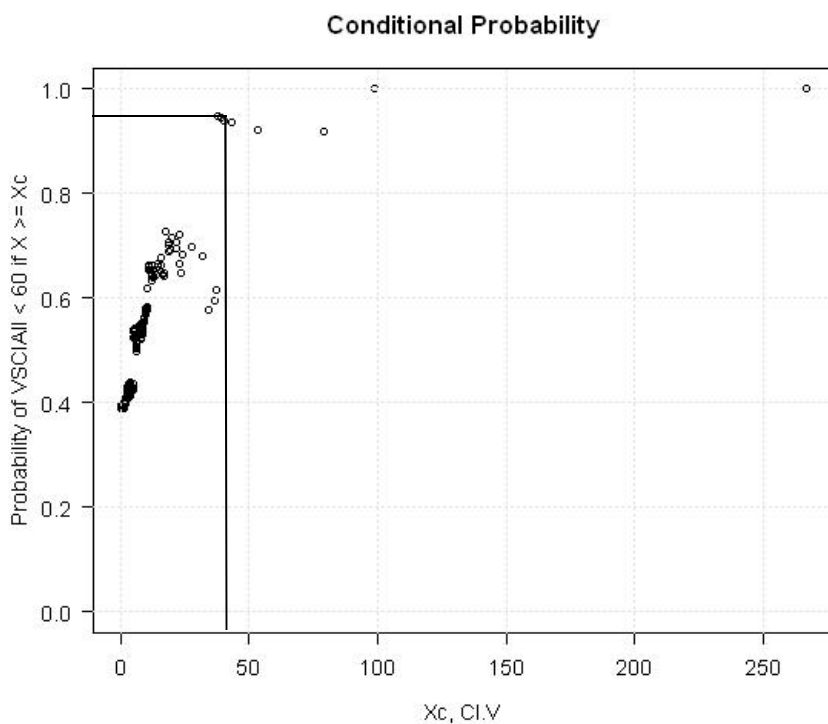


Figure 57. Probability of VSCI less than 60 if Dissolved Chloride > 40 mg/L.

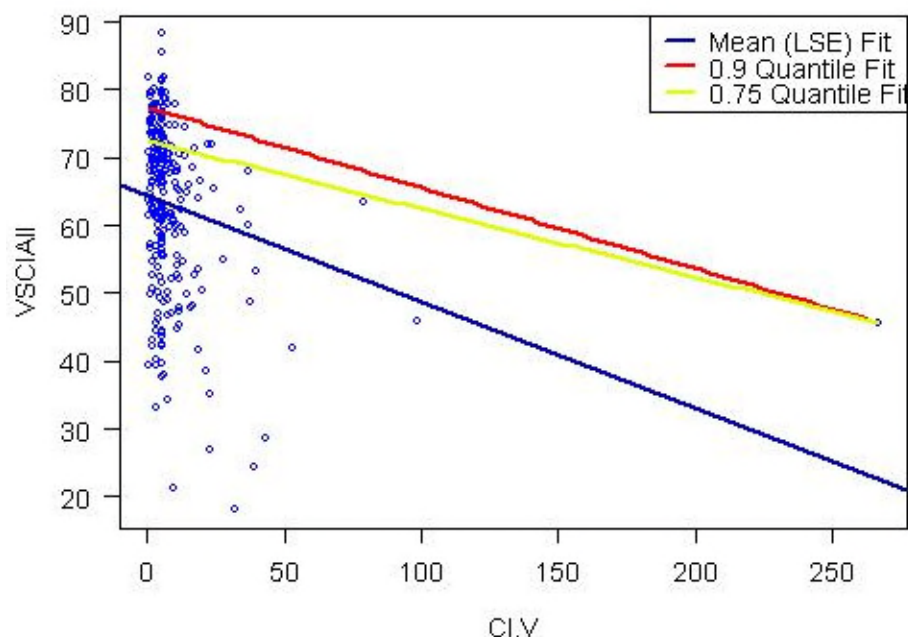


Figure 58. Quantile Regression VSCI versus Dissolved Chloride (mg/L).

Quantile regression techniques are applied to total chlorides and shown in Figure 58. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to Dissolved Chlorides mg/L values. The 50<sup>th</sup> percentile of percentile of reference crosses at 46 mg/L, 25th percentile intersects at 96 mg/L, and the 10<sup>th</sup> percentile is equal to 146 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed.

### *Dissolved Chlorides and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from dissolved sulfate concentrations below 10 mg/L (Table 36). Streams with dissolved chloride above 40 mg/L do not support healthy benthic communities and are associated with VSCI scores less than 60.

Table 36. Total Chloride (mg/L) concentrations and probability of stress to aquatic life.

Dissolved Chloride	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 50
Medium	> 25 , < 50
Low	> 10, < 25
None	< 10

### *Dissolved Chloride Cumulative Distribution Function curves*

Cumulative distribution function (CDF) curves depicting total chloride are shown in Figures 59-62 and supporting data is contained in Tables 37-40. Dissolved chloride CDF curves are shown statewide, by major basin, ecoregion (level III), and stream order.

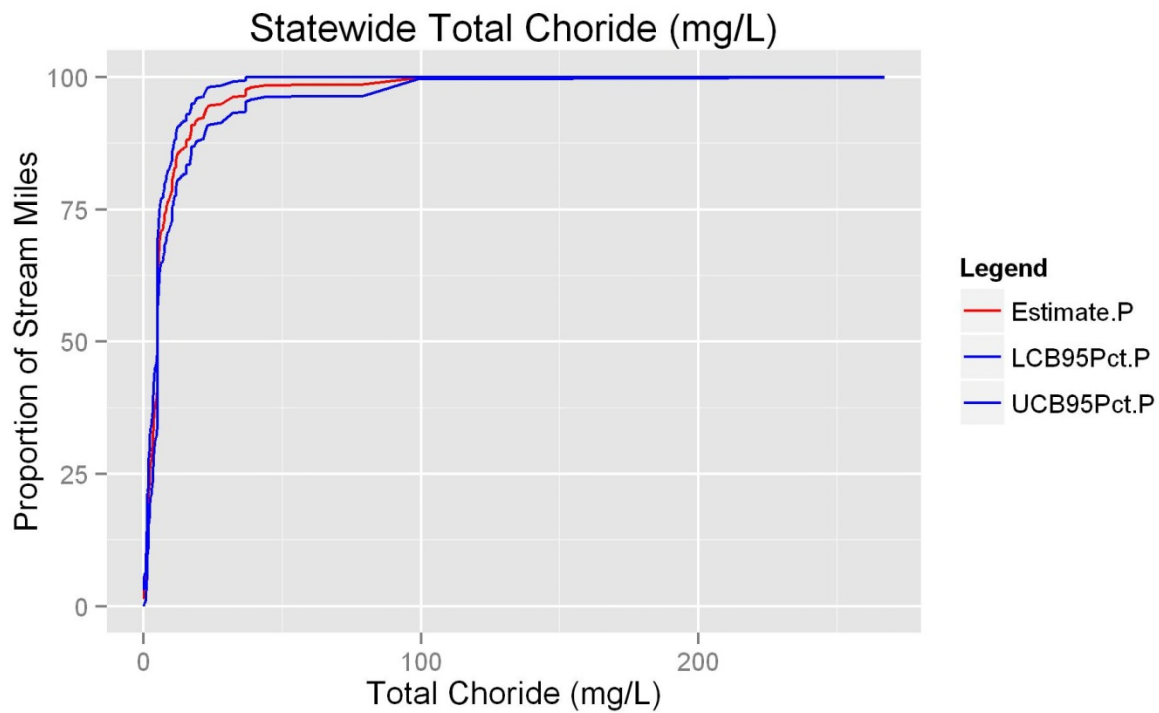


Figure 59. Dissolved Chloride Statewide CDF graph.

Figure 59 and Table 37 show the dissolved chloride statewide distribution along with the 95% confidence intervals. Sixty percent of stream miles in Virginia have dissolved chloride concentrations below 5.0 mg/L.

Table 37. Dissolved Chloride Statewide Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Dissolved chloride	0.22	1	1.25	0.00	3.02
Virginia	Dissolved chloride	0.30	3	1.84	0.00	3.74
Virginia	Dissolved chloride	0.31	4	3.10	0.44	5.75
Virginia	Dissolved chloride	0.50	5	3.39	0.69	6.09
Virginia	Dissolved chloride	0.82	6	3.69	1.01	6.36
Virginia	Dissolved chloride	0.84	7	4.94	1.70	8.18
Virginia	Dissolved chloride	1.00	9	6.49	2.83	10.14
Virginia	Dissolved chloride	1.06	10	6.78	3.10	10.47
Virginia	Dissolved chloride	1.13	11	8.03	3.87	12.20
Virginia	Dissolved chloride	1.16	12	8.16	3.99	12.32
Virginia	Dissolved chloride	1.23	14	9.53	4.99	14.07
Virginia	Dissolved chloride	1.36	15	10.78	5.93	15.63
Virginia	Dissolved chloride	1.38	16	11.08	6.21	15.94
Virginia	Dissolved chloride	1.39	17	12.33	7.16	17.50
Virginia	Dissolved chloride	1.40	18	13.58	8.10	19.06
Virginia	Dissolved chloride	1.42	19	14.83	9.09	20.57



Virginia	Dissolved chloride	1.44	20	15.13	9.40	20.86
Virginia	Dissolved chloride	1.45	21	15.42	9.68	21.17
Virginia	Dissolved chloride	1.46	22	15.64	9.91	21.37
Virginia	Dissolved chloride	1.62	23	15.71	9.99	21.43
Virginia	Dissolved chloride	1.63	24	15.93	10.21	21.65
Virginia	Dissolved chloride	1.64	25	16.14	10.42	21.87
Virginia	Dissolved chloride	1.73	26	16.36	10.63	22.09
Virginia	Dissolved chloride	1.75	27	16.48	10.77	22.19
Virginia	Dissolved chloride	1.77	29	18.03	12.06	24.00
Virginia	Dissolved chloride	1.82	30	19.28	13.21	25.35
Virginia	Dissolved chloride	1.84	31	19.57	13.49	25.66
Virginia	Dissolved chloride	1.85	32	19.87	13.78	25.96
Virginia	Dissolved chloride	1.87	34	21.42	15.12	27.72
Virginia	Dissolved chloride	1.88	35	21.63	15.33	27.94
Virginia	Dissolved chloride	1.92	36	21.85	15.53	28.16
Virginia	Dissolved chloride	2.04	37	22.14	15.81	28.48
Virginia	Dissolved chloride	2.06	38	22.36	16.02	28.70
Virginia	Dissolved chloride	2.08	39	22.57	16.23	28.92
Virginia	Dissolved chloride	2.09	40	22.70	16.35	29.05
Virginia	Dissolved chloride	2.13	41	22.99	16.64	29.35
Virginia	Dissolved chloride	2.33	43	23.33	16.99	29.67
Virginia	Dissolved chloride	2.40	44	23.63	17.28	29.97
Virginia	Dissolved chloride	2.41	45	24.88	18.39	31.36
Virginia	Dissolved chloride	2.43	46	26.13	19.56	32.70
Virginia	Dissolved chloride	2.51	47	26.34	19.78	32.91
Virginia	Dissolved chloride	2.55	48	26.47	19.91	33.02
Virginia	Dissolved chloride	2.56	49	26.68	20.13	33.24
Virginia	Dissolved chloride	2.59	50	26.90	20.33	33.46
Virginia	Dissolved chloride	2.66	51	27.19	20.63	33.76
Virginia	Dissolved chloride	2.75	52	27.41	20.84	33.98
Virginia	Dissolved chloride	2.81	53	27.62	21.06	34.19
Virginia	Dissolved chloride	2.90	54	27.74	21.17	34.31
Virginia	Dissolved chloride	2.99	55	28.04	21.46	34.62
Virginia	Dissolved chloride	3.03	56	28.34	21.77	34.90
Virginia	Dissolved chloride	3.04	57	28.63	22.06	35.20
Virginia	Dissolved chloride	3.08	58	28.75	22.18	35.33
Virginia	Dissolved chloride	3.12	59	28.97	22.40	35.54
Virginia	Dissolved chloride	3.20	60	29.09	22.52	35.66
Virginia	Dissolved chloride	3.22	61	29.21	22.64	35.79
Virginia	Dissolved chloride	3.23	62	29.51	22.93	36.09
Virginia	Dissolved chloride	3.34	63	29.72	23.14	36.31
Virginia	Dissolved chloride	3.36	64	29.94	23.34	36.54
Virginia	Dissolved chloride	3.40	65	31.19	24.51	37.87
Virginia	Dissolved chloride	3.41	66	31.41	24.72	38.09
Virginia	Dissolved chloride	3.43	67	31.53	24.86	38.20
Virginia	Dissolved chloride	3.48	68	31.82	25.17	38.48
Virginia	Dissolved chloride	3.54	69	31.90	25.24	38.55
Virginia	Dissolved chloride	3.58	70	33.15	26.39	39.90
Virginia	Dissolved chloride	3.61	71	34.40	27.53	41.27
Virginia	Dissolved chloride	3.64	72	34.43	27.57	41.30
Virginia	Dissolved chloride	3.65	73	34.51	27.65	41.36
Virginia	Dissolved chloride	3.72	74	34.72	27.87	41.57
Virginia	Dissolved chloride	3.79	75	34.84	28.00	41.69

Virginia	Dissolved chloride	3.80	77	35.26	28.42	42.10
Virginia	Dissolved chloride	3.81	78	35.56	28.71	42.41
Virginia	Dissolved chloride	3.84	80	36.93	29.99	43.87
Virginia	Dissolved chloride	3.91	81	37.00	30.06	43.95
Virginia	Dissolved chloride	3.94	82	37.22	30.29	44.15
Virginia	Dissolved chloride	3.95	83	37.29	30.36	44.22
Virginia	Dissolved chloride	4.07	84	37.41	30.48	44.35
Virginia	Dissolved chloride	4.10	85	37.63	30.71	44.55
Virginia	Dissolved chloride	4.11	86	37.84	30.92	44.77
Virginia	Dissolved chloride	4.20	87	37.97	31.04	44.89
Virginia	Dissolved chloride	4.25	88	38.18	31.26	45.11
Virginia	Dissolved chloride	4.26	89	38.30	31.36	45.25
Virginia	Dissolved chloride	4.30	90	38.42	31.47	45.38
Virginia	Dissolved chloride	4.31	91	38.50	31.55	45.44
Virginia	Dissolved chloride	4.39	92	38.79	31.86	45.73
Virginia	Dissolved chloride	4.66	93	38.92	31.97	45.86
Virginia	Dissolved chloride	4.74	94	39.13	32.19	46.08
Virginia	Dissolved chloride	4.87	95	40.38	33.38	47.38
Virginia	Dissolved chloride	5.00	141	61.66	55.22	68.10
Virginia	Dissolved chloride	5.11	142	61.87	55.44	68.30
Virginia	Dissolved chloride	5.13	143	63.12	56.74	69.50
Virginia	Dissolved chloride	5.18	144	63.34	56.95	69.73
Virginia	Dissolved chloride	5.21	146	63.68	57.30	70.05
Virginia	Dissolved chloride	5.25	147	63.89	57.53	70.25
Virginia	Dissolved chloride	5.32	148	64.01	57.66	70.37
Virginia	Dissolved chloride	5.37	149	64.31	57.97	70.65
Virginia	Dissolved chloride	5.39	150	64.38	58.05	70.71
Virginia	Dissolved chloride	5.42	152	64.97	58.67	71.27
Virginia	Dissolved chloride	5.49	153	65.19	58.90	71.48
Virginia	Dissolved chloride	5.51	154	65.31	59.03	71.59
Virginia	Dissolved chloride	5.52	155	65.43	59.16	71.70
Virginia	Dissolved chloride	5.55	156	65.73	59.46	72.00
Virginia	Dissolved chloride	5.56	158	65.87	59.59	72.15
Virginia	Dissolved chloride	5.57	159	65.99	59.72	72.27
Virginia	Dissolved chloride	5.67	160	67.25	61.03	73.46
Virginia	Dissolved chloride	5.77	161	67.37	61.16	73.58
Virginia	Dissolved chloride	5.80	162	68.62	62.52	74.72
Virginia	Dissolved chloride	5.82	163	68.83	62.74	74.93
Virginia	Dissolved chloride	5.85	164	69.13	63.05	75.21
Virginia	Dissolved chloride	5.93	165	69.43	63.37	75.49
Virginia	Dissolved chloride	5.95	167	69.85	63.82	75.87
Virginia	Dissolved chloride	5.98	169	70.13	64.11	76.15
Virginia	Dissolved chloride	6.28	170	70.35	64.34	76.36
Virginia	Dissolved chloride	6.35	172	70.72	64.69	76.74
Virginia	Dissolved chloride	6.36	173	70.84	64.82	76.86
Virginia	Dissolved chloride	6.76	174	71.05	65.04	77.06
Virginia	Dissolved chloride	6.86	175	71.18	65.16	77.19
Virginia	Dissolved chloride	6.99	176	71.25	65.23	77.26
Virginia	Dissolved chloride	7.04	177	71.28	65.27	77.30
Virginia	Dissolved chloride	7.11	178	71.58	65.56	77.60
Virginia	Dissolved chloride	7.13	179	71.65	65.63	77.67
Virginia	Dissolved chloride	7.19	180	71.95	65.94	77.95
Virginia	Dissolved chloride	7.28	181	72.24	66.24	78.24

Virginia	Dissolved chloride	7.33	182	72.46	66.46	78.46
Virginia	Dissolved chloride	7.38	183	72.53	66.52	78.54
Virginia	Dissolved chloride	7.40	184	72.83	66.85	78.80
Virginia	Dissolved chloride	7.54	185	72.95	66.97	78.93
Virginia	Dissolved chloride	7.69	186	74.20	68.39	80.01
Virginia	Dissolved chloride	8.00	187	74.41	68.61	80.22
Virginia	Dissolved chloride	8.01	188	74.71	68.92	80.51
Virginia	Dissolved chloride	8.03	189	74.78	68.99	80.58
Virginia	Dissolved chloride	8.23	191	75.20	69.39	81.01
Virginia	Dissolved chloride	8.25	192	75.50	69.69	81.30
Virginia	Dissolved chloride	8.30	193	75.79	70.01	81.58
Virginia	Dissolved chloride	8.49	194	75.92	70.12	81.71
Virginia	Dissolved chloride	8.50	195	76.13	70.34	81.92
Virginia	Dissolved chloride	8.56	196	76.20	70.42	81.99
Virginia	Dissolved chloride	8.77	197	76.50	70.73	82.27
Virginia	Dissolved chloride	9.23	198	76.79	71.04	82.55
Virginia	Dissolved chloride	9.33	199	77.09	71.37	82.81
Virginia	Dissolved chloride	9.38	200	77.21	71.50	82.93
Virginia	Dissolved chloride	9.47	201	77.43	71.72	83.14
Virginia	Dissolved chloride	9.77	202	77.64	71.95	83.34
Virginia	Dissolved chloride	9.88	203	77.86	72.13	83.59
Virginia	Dissolved chloride	9.97	204	77.98	72.25	83.71
Virginia	Dissolved chloride	9.99	205	78.05	72.32	83.78
Virginia	Dissolved chloride	10.00	206	78.17	72.45	83.90
Virginia	Dissolved chloride	10.10	207	78.39	72.68	84.10
Virginia	Dissolved chloride	10.30	208	79.64	74.13	85.16
Virginia	Dissolved chloride	10.40	209	80.89	75.57	86.22
Virginia	Dissolved chloride	10.60	210	81.19	75.84	86.54
Virginia	Dissolved chloride	10.80	212	81.70	76.39	87.01
Virginia	Dissolved chloride	10.90	214	82.12	76.82	87.42
Virginia	Dissolved chloride	11.00	215	82.24	76.93	87.55
Virginia	Dissolved chloride	11.10	217	82.67	77.36	87.98
Virginia	Dissolved chloride	11.70	219	83.09	77.81	88.37
Virginia	Dissolved chloride	11.80	221	84.64	79.57	89.71
Virginia	Dissolved chloride	11.90	223	84.97	79.92	90.02
Virginia	Dissolved chloride	12.10	224	85.27	80.24	90.30
Virginia	Dissolved chloride	12.30	225	85.39	80.37	90.41
Virginia	Dissolved chloride	12.50	226	85.69	80.68	90.70
Virginia	Dissolved chloride	12.90	227	85.81	80.80	90.82
Virginia	Dissolved chloride	13.40	228	86.02	81.00	91.05
Virginia	Dissolved chloride	13.60	230	86.36	81.33	91.39
Virginia	Dissolved chloride	14.30	231	86.48	81.45	91.52
Virginia	Dissolved chloride	14.40	232	86.61	81.57	91.64
Virginia	Dissolved chloride	15.40	233	86.90	81.89	91.91
Virginia	Dissolved chloride	15.50	234	88.15	83.36	92.95
Virginia	Dissolved chloride	16.30	235	88.23	83.43	93.02
Virginia	Dissolved chloride	16.70	236	88.35	83.53	93.16
Virginia	Dissolved chloride	17.00	237	89.60	85.13	94.07
Virginia	Dissolved chloride	17.30	238	90.85	86.77	94.93
Virginia	Dissolved chloride	18.40	239	91.07	87.01	95.12
Virginia	Dissolved chloride	18.50	240	91.19	87.14	95.24
Virginia	Dissolved chloride	18.70	241	91.48	87.42	95.55
Virginia	Dissolved chloride	19.00	242	91.78	87.74	95.82

Virginia	Dissolved chloride	19.80	243	92.08	88.04	96.11
Virginia	Dissolved chloride	21.60	244	92.37	88.37	96.38
Virginia	Dissolved chloride	21.80	245	92.67	88.70	96.64
Virginia	Dissolved chloride	22.70	246	93.92	90.33	97.51
Virginia	Dissolved chloride	22.80	247	94.22	90.63	97.80
Virginia	Dissolved chloride	23.20	248	94.51	90.95	98.07
Virginia	Dissolved chloride	23.90	249	94.63	91.08	98.18
Virginia	Dissolved chloride	27.90	250	94.93	91.40	98.46
Virginia	Dissolved chloride	32.00	251	96.18	93.24	99.13
Virginia	Dissolved chloride	34.20	252	96.30	93.36	99.24
Virginia	Dissolved chloride	36.80	253	96.43	93.49	99.36
Virginia	Dissolved chloride	37.00	254	97.68	95.42	99.94
Virginia	Dissolved chloride	37.70	255	97.80	95.55	100.00
Virginia	Dissolved chloride	38.70	256	98.01	95.80	100.00
Virginia	Dissolved chloride	40.00	257	98.14	95.93	100.00
Virginia	Dissolved chloride	43.40	258	98.43	96.27	100.00
Virginia	Dissolved chloride	53.20	259	98.50	96.34	100.00
Virginia	Dissolved chloride	79.30	260	98.63	96.47	100.00
Virginia	Dissolved chloride	98.70	261	99.88	99.67	100.00
Virginia	Dissolved chloride	267.00	262	100.00	100.00	100.00

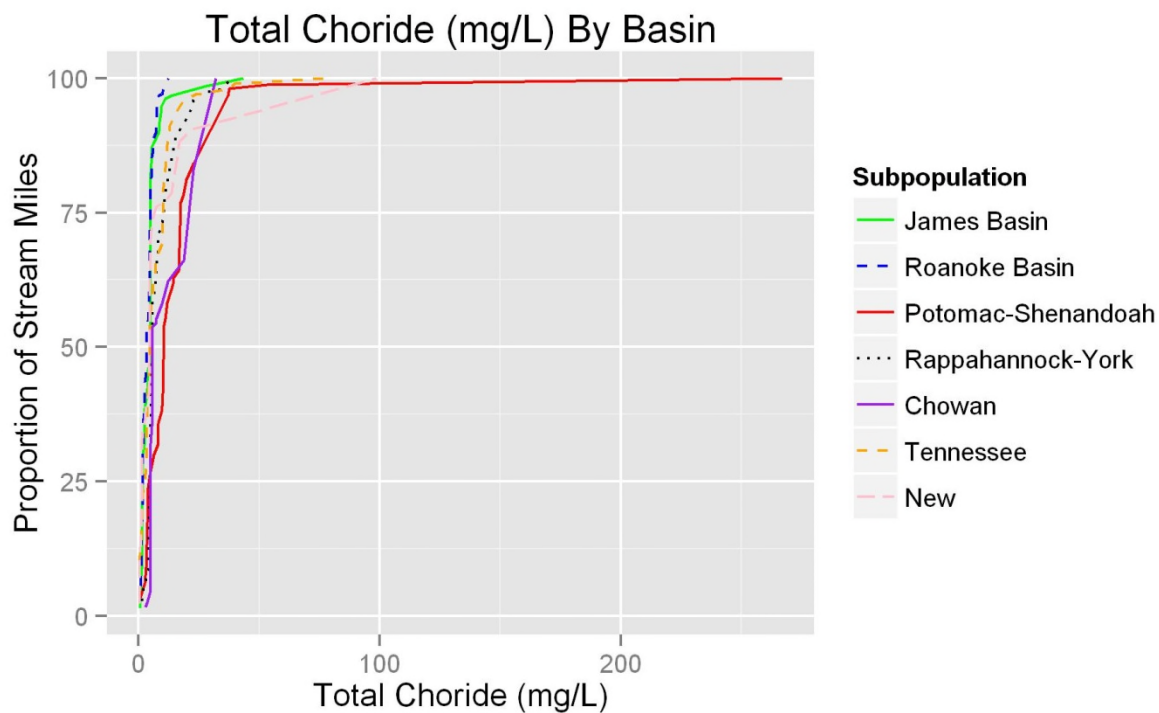


Figure 60. Dissolved Chloride by Major Basin CDF graph.

Figure 60 and Table 38 show total chloride cdf curves by basin. Eighty-five percent of Potomac-Shenandoah stream miles are below 22 mg/L and 25 mg/L total chloride is the threshold for medium probability of risk to aquatic life (Table 37). Ninety-six percent of Rappahannock-York, 97% of Tennessee Basin, and 83% of Chowan stream miles have total chlorides below 23 mg/L. The 98<sup>th</sup> percentile of James Basin stream miles is 27.9 mg/L and 100% of Roanoke Basin stream miles are below 12.3 mg/L total chlorides. Ninety percent of New River Basin stream miles are below 21.8 mg/L.

Table 38. Dissolved Chloride Population Estimates by Major River Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	Dissolved chloride	0.50	1	1.43	0.00	3.85
James Basin	Dissolved chloride	1.00	2	7.45	0.00	16.40
James Basin	Dissolved chloride	1.16	3	8.04	0.00	17.01
James Basin	Dissolved chloride	1.23	4	8.62	0.00	17.66
James Basin	Dissolved chloride	1.36	5	14.65	2.74	26.56
James Basin	Dissolved chloride	1.38	6	16.07	4.00	28.14
James Basin	Dissolved chloride	1.40	7	22.10	7.44	36.76
James Basin	Dissolved chloride	1.62	8	22.45	7.87	37.02
James Basin	Dissolved chloride	1.63	9	23.48	8.85	38.11
James Basin	Dissolved chloride	1.73	10	24.52	9.87	39.16

James Basin	Dissolved chloride	1.77	11	25.94	11.30	40.58
James Basin	Dissolved chloride	1.84	12	27.37	12.54	42.19
James Basin	Dissolved chloride	1.85	13	28.79	13.83	43.75
James Basin	Dissolved chloride	1.87	14	30.22	14.99	45.44
James Basin	Dissolved chloride	2.40	15	31.64	16.34	46.94
James Basin	Dissolved chloride	2.43	16	37.67	21.62	53.71
James Basin	Dissolved chloride	2.59	17	38.70	22.51	54.89
James Basin	Dissolved chloride	3.04	18	40.13	23.94	56.31
James Basin	Dissolved chloride	3.34	19	41.16	24.91	57.41
James Basin	Dissolved chloride	3.64	20	41.33	25.07	57.58
James Basin	Dissolved chloride	3.72	21	42.36	26.08	58.65
James Basin	Dissolved chloride	3.79	22	42.95	26.69	59.21
James Basin	Dissolved chloride	3.80	23	44.37	28.06	60.69
James Basin	Dissolved chloride	3.81	24	45.80	29.36	62.24
James Basin	Dissolved chloride	4.74	25	46.83	30.31	63.36
James Basin	Dissolved chloride	4.87	26	52.86	36.41	69.30
James Basin	Dissolved chloride	5.00	38	82.55	75.01	90.09
James Basin	Dissolved chloride	5.21	39	83.14	75.64	90.63
James Basin	Dissolved chloride	5.25	40	84.17	77.03	91.31
James Basin	Dissolved chloride	5.37	41	85.60	78.73	92.46
James Basin	Dissolved chloride	5.39	42	85.94	79.15	92.74
James Basin	Dissolved chloride	5.42	43	87.37	80.92	93.82
James Basin	Dissolved chloride	6.36	44	87.96	81.56	94.35
James Basin	Dissolved chloride	7.33	45	88.99	82.97	95.02
James Basin	Dissolved chloride	8.23	46	89.58	83.75	95.41
James Basin	Dissolved chloride	8.49	47	90.17	84.29	96.05
James Basin	Dissolved chloride	8.56	48	90.51	84.76	96.27
James Basin	Dissolved chloride	8.77	49	91.94	86.44	97.44
James Basin	Dissolved chloride	9.23	50	93.36	88.37	98.35
James Basin	Dissolved chloride	9.33	51	94.79	90.60	98.98
James Basin	Dissolved chloride	10.90	52	96.21	92.85	99.58
James Basin	Dissolved chloride	13.60	53	96.80	93.39	100.00
James Basin	Dissolved chloride	16.30	54	97.15	93.83	100.00
James Basin	Dissolved chloride	27.90	55	98.57	96.09	100.00
James Basin	Dissolved chloride	43.40	56	100.00	100.00	100.00
Roanoke Basin	Dissolved chloride	0.84	1	5.38	0.00	13.26
Roanoke Basin	Dissolved chloride	1.00	2	6.65	0.00	14.72
Roanoke Basin	Dissolved chloride	1.13	3	12.04	0.72	23.35
Roanoke Basin	Dissolved chloride	1.23	4	17.42	4.14	30.69
Roanoke Basin	Dissolved chloride	1.44	5	18.69	5.51	31.88
Roanoke Basin	Dissolved chloride	1.46	6	19.62	6.55	32.68
Roanoke Basin	Dissolved chloride	1.64	7	20.54	7.44	33.64
Roanoke Basin	Dissolved chloride	1.75	8	21.07	8.11	34.02
Roanoke Basin	Dissolved chloride	1.82	9	26.45	12.37	40.52
Roanoke Basin	Dissolved chloride	1.87	10	31.83	16.82	46.84
Roanoke Basin	Dissolved chloride	1.92	11	32.75	17.65	47.85
Roanoke Basin	Dissolved chloride	2.04	12	34.03	18.77	49.28
Roanoke Basin	Dissolved chloride	2.08	13	34.95	19.60	50.30
Roanoke Basin	Dissolved chloride	2.09	14	35.48	20.13	50.83
Roanoke Basin	Dissolved chloride	2.13	15	36.75	21.40	52.09
Roanoke Basin	Dissolved chloride	2.33	16	37.67	22.50	52.85
Roanoke Basin	Dissolved chloride	2.41	17	43.05	27.58	58.53
Roanoke Basin	Dissolved chloride	2.55	18	43.58	28.18	58.98

Roanoke Basin	Dissolved chloride	3.03	19	44.85	29.59	60.11
Roanoke Basin	Dissolved chloride	3.12	20	45.78	30.59	60.97
Roanoke Basin	Dissolved chloride	3.23	21	47.05	31.89	62.21
Roanoke Basin	Dissolved chloride	3.40	22	52.43	37.29	67.58
Roanoke Basin	Dissolved chloride	3.43	23	52.96	37.91	68.00
Roanoke Basin	Dissolved chloride	3.48	24	54.23	39.35	69.10
Roanoke Basin	Dissolved chloride	3.80	25	54.75	39.99	69.52
Roanoke Basin	Dissolved chloride	3.95	26	55.07	40.34	69.79
Roanoke Basin	Dissolved chloride	4.10	27	55.99	41.30	70.68
Roanoke Basin	Dissolved chloride	4.26	28	56.51	41.76	71.27
Roanoke Basin	Dissolved chloride	4.31	29	56.83	42.14	71.51
Roanoke Basin	Dissolved chloride	4.39	30	58.10	43.51	72.69
Roanoke Basin	Dissolved chloride	5.00	40	80.56	70.25	90.87
Roanoke Basin	Dissolved chloride	5.21	41	81.49	71.34	91.63
Roanoke Basin	Dissolved chloride	5.42	42	82.76	72.95	92.57
Roanoke Basin	Dissolved chloride	5.52	43	83.28	73.57	93.00
Roanoke Basin	Dissolved chloride	5.55	44	84.56	75.25	93.87
Roanoke Basin	Dissolved chloride	5.56	45	84.87	75.56	94.18
Roanoke Basin	Dissolved chloride	5.57	46	85.39	76.17	94.61
Roanoke Basin	Dissolved chloride	5.93	47	86.66	77.69	95.64
Roanoke Basin	Dissolved chloride	5.95	48	87.94	79.26	96.62
Roanoke Basin	Dissolved chloride	6.28	49	88.86	80.25	97.47
Roanoke Basin	Dissolved chloride	7.40	50	90.14	81.90	98.37
Roanoke Basin	Dissolved chloride	7.69	51	95.52	92.07	98.97
Roanoke Basin	Dissolved chloride	8.30	52	96.79	94.14	99.44
Roanoke Basin	Dissolved chloride	9.99	53	97.10	94.42	99.78
Roanoke Basin	Dissolved chloride	10.00	54	97.63	95.03	100.00
Roanoke Basin	Dissolved chloride	10.80	55	98.55	96.63	100.00
Roanoke Basin	Dissolved chloride	11.90	56	99.48	98.58	100.00
Roanoke Basin	Dissolved chloride	12.30	57	100.00	100.00	100.00
Potomac-Shenandoah	Dissolved chloride	0.30	1	3.00	0.00	8.00
Potomac-Shenandoah	Dissolved chloride	2.66	2	6.00	0.30	11.71
Potomac-Shenandoah	Dissolved chloride	2.99	3	9.00	1.37	16.63
Potomac-Shenandoah	Dissolved chloride	3.84	4	21.69	2.30	41.07
Potomac-Shenandoah	Dissolved chloride	3.94	5	23.87	4.97	42.77
Potomac-Shenandoah	Dissolved chloride	5.00	6	26.87	8.53	45.21
Potomac-Shenandoah	Dissolved chloride	6.35	7	29.87	10.54	49.20
Potomac-Shenandoah	Dissolved chloride	8.00	8	32.05	12.69	51.40
Potomac-Shenandoah	Dissolved chloride	8.03	9	32.78	13.61	51.95
Potomac-Shenandoah	Dissolved chloride	8.23	10	35.78	16.88	54.69
Potomac-Shenandoah	Dissolved chloride	9.47	11	37.96	19.67	56.26
Potomac-Shenandoah	Dissolved chloride	9.88	12	40.14	21.04	59.24
Potomac-Shenandoah	Dissolved chloride	9.97	13	41.38	22.24	60.52
Potomac-Shenandoah	Dissolved chloride	10.40	14	54.06	34.41	73.72
Potomac-Shenandoah	Dissolved chloride	11.00	15	55.30	35.27	75.33
Potomac-Shenandoah	Dissolved chloride	11.80	16	58.30	37.13	79.47
Potomac-Shenandoah	Dissolved chloride	13.40	17	60.48	38.86	82.10
Potomac-Shenandoah	Dissolved chloride	14.30	18	61.71	40.07	83.36
Potomac-Shenandoah	Dissolved chloride	14.40	19	62.95	41.30	84.61
Potomac-Shenandoah	Dissolved chloride	16.70	20	64.19	42.01	86.36
Potomac-Shenandoah	Dissolved chloride	17.30	21	76.87	59.42	94.33
Potomac-Shenandoah	Dissolved chloride	18.50	22	78.11	60.87	95.34
Potomac-Shenandoah	Dissolved chloride	19.80	23	81.11	63.56	98.65

Potomac-Shenandoah	Dissolved chloride	22.80	24	84.11	66.45	100.00
Potomac-Shenandoah	Dissolved chloride	37.00	25	96.79	93.39	100.00
Potomac-Shenandoah	Dissolved chloride	37.70	26	98.03	95.73	100.00
Potomac-Shenandoah	Dissolved chloride	53.20	27	98.76	96.63	100.00
Potomac-Shenandoah	Dissolved chloride	267.00	28	100.00	100.00	100.00
Rappahannock-York	Dissolved chloride	1.45	1	2.74	0.00	7.45
Rappahannock-York	Dissolved chloride	2.06	2	4.72	0.00	10.61
Rappahannock-York	Dissolved chloride	2.33	3	5.85	0.00	12.20
Rappahannock-York	Dissolved chloride	3.20	4	6.98	0.29	13.66
Rappahannock-York	Dissolved chloride	3.91	5	7.65	0.86	14.43
Rappahannock-York	Dissolved chloride	4.11	6	9.63	2.17	17.10
Rappahannock-York	Dissolved chloride	4.25	7	11.62	3.05	20.19
Rappahannock-York	Dissolved chloride	5.00	12	31.02	15.35	46.70
Rappahannock-York	Dissolved chloride	5.13	13	42.59	25.60	59.58
Rappahannock-York	Dissolved chloride	5.49	14	44.57	28.58	60.57
Rappahannock-York	Dissolved chloride	5.56	15	45.24	28.90	61.59
Rappahannock-York	Dissolved chloride	5.80	16	56.81	38.64	74.98
Rappahannock-York	Dissolved chloride	5.82	17	58.80	41.19	76.40
Rappahannock-York	Dissolved chloride	6.35	18	59.46	41.80	77.13
Rappahannock-York	Dissolved chloride	6.86	19	60.59	42.72	78.47
Rappahannock-York	Dissolved chloride	6.99	20	61.26	43.36	79.15
Rappahannock-York	Dissolved chloride	7.13	21	61.93	44.23	79.63
Rappahannock-York	Dissolved chloride	7.28	22	64.66	47.10	82.22
Rappahannock-York	Dissolved chloride	7.54	23	65.79	48.00	83.58
Rappahannock-York	Dissolved chloride	8.01	24	68.53	51.13	85.92
Rappahannock-York	Dissolved chloride	8.25	25	71.26	54.21	88.31
Rappahannock-York	Dissolved chloride	9.38	26	72.39	55.71	89.07
Rappahannock-York	Dissolved chloride	10.60	27	75.13	58.65	91.60
Rappahannock-York	Dissolved chloride	10.80	28	77.86	61.97	93.75
Rappahannock-York	Dissolved chloride	15.50	29	89.43	80.60	98.26
Rappahannock-York	Dissolved chloride	18.40	30	91.41	83.41	99.41
Rappahannock-York	Dissolved chloride	21.60	31	94.15	87.99	100.00
Rappahannock-York	Dissolved chloride	23.20	32	96.89	92.71	100.00
Rappahannock-York	Dissolved chloride	34.20	33	98.01	94.44	100.00
Rappahannock-York	Dissolved chloride	38.70	34	100.00	100.00	100.00
Chowan	Dissolved chloride	2.90	1	1.65	0.00	4.60
Chowan	Dissolved chloride	3.54	2	2.63	0.00	6.30
Chowan	Dissolved chloride	4.66	3	4.27	0.00	9.32
Chowan	Dissolved chloride	5.00	8	31.97	8.17	55.78
Chowan	Dissolved chloride	5.32	9	33.62	9.78	57.46
Chowan	Dissolved chloride	5.51	10	35.27	12.21	58.33
Chowan	Dissolved chloride	5.67	11	52.18	23.23	81.13
Chowan	Dissolved chloride	5.77	12	53.83	24.91	82.75
Chowan	Dissolved chloride	7.04	13	54.30	25.34	83.25
Chowan	Dissolved chloride	7.38	14	55.27	25.93	84.62
Chowan	Dissolved chloride	9.77	15	58.18	29.23	87.12
Chowan	Dissolved chloride	12.10	16	62.18	33.53	90.83
Chowan	Dissolved chloride	18.70	17	66.18	36.70	95.66
Chowan	Dissolved chloride	22.70	18	83.09	58.38	100.00
Chowan	Dissolved chloride	32.00	19	100.00	100.00	100.00
Tennessee	Dissolved chloride	0.22	1	10.24	0.00	23.77
Tennessee	Dissolved chloride	1.06	2	12.67	0.00	26.61
Tennessee	Dissolved chloride	1.77	3	22.91	3.55	42.27



Tennessee	Dissolved chloride	2.56	4	24.67	5.36	43.98
Tennessee	Dissolved chloride	2.81	5	26.43	7.37	45.49
Tennessee	Dissolved chloride	3.08	6	27.43	8.26	46.60
Tennessee	Dissolved chloride	3.22	7	28.43	9.26	47.59
Tennessee	Dissolved chloride	3.36	8	30.19	10.85	49.52
Tennessee	Dissolved chloride	3.58	9	40.43	20.15	60.72
Tennessee	Dissolved chloride	3.84	10	41.43	21.27	61.59
Tennessee	Dissolved chloride	4.20	11	42.43	22.42	62.44
Tennessee	Dissolved chloride	5.00	18	56.74	38.78	74.70
Tennessee	Dissolved chloride	5.11	19	58.50	40.82	76.18
Tennessee	Dissolved chloride	5.95	20	59.50	41.98	77.01
Tennessee	Dissolved chloride	5.98	22	61.85	44.47	79.22
Tennessee	Dissolved chloride	6.76	23	63.61	46.54	80.68
Tennessee	Dissolved chloride	7.11	24	66.03	48.90	83.17
Tennessee	Dissolved chloride	8.50	25	67.79	50.81	84.78
Tennessee	Dissolved chloride	10.10	26	69.55	53.01	86.09
Tennessee	Dissolved chloride	10.30	27	79.80	68.74	90.86
Tennessee	Dissolved chloride	11.10	29	83.32	73.23	93.40
Tennessee	Dissolved chloride	11.70	31	86.74	78.34	95.14
Tennessee	Dissolved chloride	11.90	32	87.74	79.46	96.02
Tennessee	Dissolved chloride	12.50	33	90.16	82.83	97.49
Tennessee	Dissolved chloride	12.90	34	91.16	84.13	98.19
Tennessee	Dissolved chloride	15.40	35	93.58	88.03	99.14
Tennessee	Dissolved chloride	19.00	36	96.01	92.55	99.46
Tennessee	Dissolved chloride	23.90	37	97.00	94.26	99.74
Tennessee	Dissolved chloride	36.80	38	98.00	95.49	100.00
Tennessee	Dissolved chloride	40.00	39	99.00	97.32	100.00
Tennessee	Dissolved chloride	79.30	40	100.00	100.00	100.00
New	Dissolved chloride	0.30	1	2.25	0.00	6.07
New	Dissolved chloride	0.31	2	11.77	0.00	24.31
New	Dissolved chloride	0.82	3	14.02	1.79	26.25
New	Dissolved chloride	1.39	4	23.53	6.07	40.99
New	Dissolved chloride	1.42	5	33.05	12.62	53.47
New	Dissolved chloride	1.88	6	34.68	14.13	55.23
New	Dissolved chloride	2.51	7	36.31	16.03	56.60
New	Dissolved chloride	2.75	8	37.95	17.76	58.14
New	Dissolved chloride	3.41	9	39.58	19.29	59.88
New	Dissolved chloride	3.65	10	40.13	19.89	60.38
New	Dissolved chloride	4.07	11	41.06	20.62	61.50
New	Dissolved chloride	4.30	12	41.99	21.35	62.63
New	Dissolved chloride	5.00	18	70.02	50.81	89.23
New	Dissolved chloride	5.18	19	71.66	52.06	91.25
New	Dissolved chloride	5.85	20	73.91	54.34	93.47
New	Dissolved chloride	7.19	21	76.16	56.57	95.74
New	Dissolved chloride	10.90	22	77.09	57.37	96.80
New	Dissolved chloride	13.60	23	78.72	58.94	98.50
New	Dissolved chloride	17.00	24	88.23	72.77	100.00
New	Dissolved chloride	21.80	25	90.49	75.26	100.00
New	Dissolved chloride	98.70	26	100.00	100.00	100.00

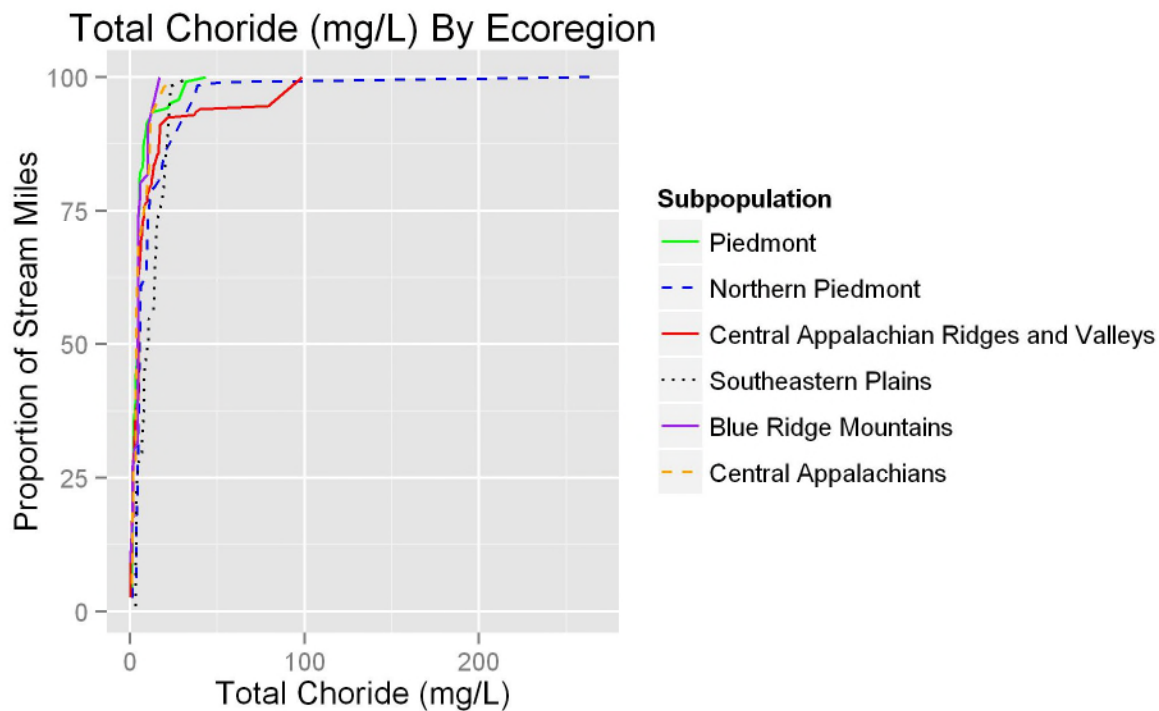


Figure 61. Dissolved Chloride by Major Ecoregion (Level III) CDF graph.

Figure 61 and Table 39 contain total chloride values and percentiles by Level III ecoregion. CDF curves remain tight together for all ecoregions through the 50<sup>th</sup> percentile. Ninety-six percent of Northern Piedmont streams have total chlorides less than 37 mg/L. As evident by the Northern Piedmont CDF, the concentration increases such that 100% of streams are less than 267 mg/L. The Central Appalachians Ridges and Valleys ecoregion shows 92% of stream miles with total chlorides less than 21.8 mg/L. The Central Appalachian Ridges and Valley CDF curve sharply increases from the 94<sup>th</sup> percentile at 40 mg/L to 100% of stream miles less than 98.7 mg/L.

Table 39. Dissolved Chloride Population Estimates by Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Dissolved chloride	0.84	1	3.38	0.00	8.41
Piedmont	Dissolved chloride	1.00	2	4.18	0.00	9.32
Piedmont	Dissolved chloride	1.13	3	7.55	0.10	15.01
Piedmont	Dissolved chloride	1.23	4	10.93	2.08	19.78
Piedmont	Dissolved chloride	1.36	5	14.31	4.38	24.24
Piedmont	Dissolved chloride	1.40	6	17.68	7.14	28.22
Piedmont	Dissolved chloride	1.44	7	18.48	7.99	28.97
Piedmont	Dissolved chloride	1.45	8	19.28	8.76	29.80
Piedmont	Dissolved chloride	1.46	9	19.86	9.41	30.31
Piedmont	Dissolved chloride	1.62	10	20.06	9.64	30.48

Piedmont	Dissolved chloride	1.64	11	20.64	10.21	31.06
Piedmont	Dissolved chloride	1.75	12	20.97	10.61	31.32
Piedmont	Dissolved chloride	1.84	13	21.77	11.35	32.19
Piedmont	Dissolved chloride	1.87	14	25.14	14.02	36.26
Piedmont	Dissolved chloride	1.92	15	25.72	14.58	36.87
Piedmont	Dissolved chloride	2.04	16	26.52	15.28	37.76
Piedmont	Dissolved chloride	2.06	17	27.10	15.88	38.32
Piedmont	Dissolved chloride	2.08	18	27.68	16.41	38.95
Piedmont	Dissolved chloride	2.09	19	28.01	16.74	39.28
Piedmont	Dissolved chloride	2.13	20	28.81	17.53	40.09
Piedmont	Dissolved chloride	2.33	21	29.39	18.20	40.58
Piedmont	Dissolved chloride	2.41	22	32.77	21.19	44.35
Piedmont	Dissolved chloride	2.43	23	36.14	24.41	47.88
Piedmont	Dissolved chloride	2.55	24	36.47	24.80	48.15
Piedmont	Dissolved chloride	2.59	25	37.05	25.34	48.77
Piedmont	Dissolved chloride	2.90	26	37.38	25.66	49.11
Piedmont	Dissolved chloride	3.03	27	38.18	26.51	49.85
Piedmont	Dissolved chloride	3.12	28	38.76	27.18	50.35
Piedmont	Dissolved chloride	3.23	29	39.56	27.99	51.13
Piedmont	Dissolved chloride	3.34	30	40.14	28.57	51.72
Piedmont	Dissolved chloride	3.40	31	43.52	31.89	55.14
Piedmont	Dissolved chloride	3.43	32	43.85	32.27	55.42
Piedmont	Dissolved chloride	3.48	33	44.65	33.17	56.13
Piedmont	Dissolved chloride	3.64	34	44.74	33.26	56.22
Piedmont	Dissolved chloride	3.80	36	45.87	34.45	57.28
Piedmont	Dissolved chloride	3.91	37	46.06	34.65	57.48
Piedmont	Dissolved chloride	3.94	38	46.64	35.20	58.08
Piedmont	Dissolved chloride	4.10	39	47.22	35.84	58.61
Piedmont	Dissolved chloride	4.26	40	47.55	36.07	59.03
Piedmont	Dissolved chloride	4.31	41	47.75	36.31	59.19
Piedmont	Dissolved chloride	4.39	42	48.55	37.15	59.95
Piedmont	Dissolved chloride	4.66	43	48.88	37.46	60.30
Piedmont	Dissolved chloride	4.87	44	52.25	40.89	63.62
Piedmont	Dissolved chloride	5.00	65	73.89	64.45	83.33
Piedmont	Dissolved chloride	5.21	67	74.80	65.44	84.16
Piedmont	Dissolved chloride	5.32	68	75.13	65.78	84.48
Piedmont	Dissolved chloride	5.39	69	75.32	66.00	84.64
Piedmont	Dissolved chloride	5.42	70	76.12	66.90	85.34
Piedmont	Dissolved chloride	5.51	71	76.45	67.28	85.62
Piedmont	Dissolved chloride	5.52	72	76.78	67.65	85.91
Piedmont	Dissolved chloride	5.55	73	77.58	68.42	86.74
Piedmont	Dissolved chloride	5.57	74	77.91	68.79	87.03
Piedmont	Dissolved chloride	5.67	75	81.28	72.81	89.75
Piedmont	Dissolved chloride	5.77	76	81.61	73.17	90.06
Piedmont	Dissolved chloride	5.93	77	82.41	74.08	90.74
Piedmont	Dissolved chloride	7.28	78	83.21	74.91	91.51
Piedmont	Dissolved chloride	7.40	79	84.01	75.89	92.13
Piedmont	Dissolved chloride	7.69	80	87.39	80.65	94.13
Piedmont	Dissolved chloride	8.01	81	88.19	81.59	94.79
Piedmont	Dissolved chloride	8.49	82	88.51	81.89	95.14
Piedmont	Dissolved chloride	8.56	83	88.71	82.11	95.31
Piedmont	Dissolved chloride	9.23	84	89.51	83.05	95.97
Piedmont	Dissolved chloride	9.33	85	90.31	84.03	96.58

Piedmont	Dissolved chloride	9.47	86	90.89	84.58	97.19
Piedmont	Dissolved chloride	9.77	87	91.47	85.25	97.68
Piedmont	Dissolved chloride	10.80	88	92.05	85.92	98.17
Piedmont	Dissolved chloride	11.90	89	92.63	86.63	98.63
Piedmont	Dissolved chloride	12.10	90	93.43	87.57	99.29
Piedmont	Dissolved chloride	21.60	91	94.23	88.47	99.99
Piedmont	Dissolved chloride	22.80	92	95.03	89.40	100.00
Piedmont	Dissolved chloride	27.90	93	95.82	90.29	100.00
Piedmont	Dissolved chloride	32.00	94	99.20	97.92	100.00
Piedmont	Dissolved chloride	43.40	95	100.00	100.00	100.00
Northern Piedmont	Dissolved chloride	1.38	1	2.49	0.00	6.89
Northern Piedmont	Dissolved chloride	1.63	2	4.30	0.00	9.22
Northern Piedmont	Dissolved chloride	2.33	3	5.33	0.00	10.67
Northern Piedmont	Dissolved chloride	3.20	4	6.35	0.69	12.02
Northern Piedmont	Dissolved chloride	3.79	5	7.38	1.90	12.86
Northern Piedmont	Dissolved chloride	3.84	6	17.91	3.87	31.96
Northern Piedmont	Dissolved chloride	4.11	7	19.72	5.46	33.99
Northern Piedmont	Dissolved chloride	5.00	8	30.26	12.27	48.24
Northern Piedmont	Dissolved chloride	5.13	9	40.79	20.66	60.92
Northern Piedmont	Dissolved chloride	5.25	10	42.60	22.69	62.51
Northern Piedmont	Dissolved chloride	5.37	11	45.09	25.40	64.78
Northern Piedmont	Dissolved chloride	5.49	12	46.90	27.63	66.17
Northern Piedmont	Dissolved chloride	5.56	13	47.51	28.10	66.93
Northern Piedmont	Dissolved chloride	5.80	14	58.04	38.83	77.26
Northern Piedmont	Dissolved chloride	5.82	15	59.85	40.94	78.77
Northern Piedmont	Dissolved chloride	6.36	16	60.88	42.04	79.72
Northern Piedmont	Dissolved chloride	7.13	17	61.49	42.79	80.19
Northern Piedmont	Dissolved chloride	8.03	18	62.10	43.54	80.65
Northern Piedmont	Dissolved chloride	9.38	19	63.12	44.89	81.36
Northern Piedmont	Dissolved chloride	10.40	20	73.66	57.99	89.32
Northern Piedmont	Dissolved chloride	10.90	21	76.15	61.06	91.24
Northern Piedmont	Dissolved chloride	11.80	22	78.64	62.94	94.34
Northern Piedmont	Dissolved chloride	14.30	23	79.67	63.79	95.54
Northern Piedmont	Dissolved chloride	16.70	24	80.69	64.30	97.08
Northern Piedmont	Dissolved chloride	18.40	25	82.50	66.57	98.43
Northern Piedmont	Dissolved chloride	18.50	26	83.53	67.57	99.49
Northern Piedmont	Dissolved chloride	19.80	27	86.02	69.98	100.00
Northern Piedmont	Dissolved chloride	37.00	28	96.55	92.69	100.00
Northern Piedmont	Dissolved chloride	38.70	29	98.36	96.58	100.00
Northern Piedmont	Dissolved chloride	53.20	30	98.97	97.22	100.00
Northern Piedmont	Dissolved chloride	267.00	31	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	0.30	2	2.58	0.00	5.71
Central Appalachian Ridges and Valleys	Dissolved chloride	0.31	3	8.05	0.00	16.55
Central Appalachian Ridges and Valleys	Dissolved chloride	0.50	4	9.34	0.58	18.10
Central Appalachian Ridges and Valleys	Dissolved chloride	0.82	5	10.63	1.98	19.29
Central Appalachian Ridges and Valleys	Dissolved chloride	1.00	6	16.10	5.30	26.90
Central Appalachian Ridges and Valleys	Dissolved chloride	1.16	7	16.63	5.80	27.46
Central Appalachian Ridges and Valleys	Dissolved chloride	1.23	8	17.16	6.30	28.02
Central Appalachian Ridges and Valleys	Dissolved chloride	1.73	9	18.10	7.21	28.99
Central Appalachian Ridges and Valleys	Dissolved chloride	1.77	10	19.39	8.50	30.29
Central Appalachian Ridges and Valleys	Dissolved chloride	1.82	11	24.86	12.30	37.41
Central Appalachian Ridges and Valleys	Dissolved chloride	1.85	12	26.15	13.52	38.78
Central Appalachian Ridges and Valleys	Dissolved chloride	1.87	13	27.44	14.62	40.27

Central Appalachian Ridges and Valleys	Dissolved chloride	1.88	14	28.38	15.49	41.27
Central Appalachian Ridges and Valleys	Dissolved chloride	2.40	15	29.67	16.78	42.57
Central Appalachian Ridges and Valleys	Dissolved chloride	2.56	16	30.61	17.66	43.56
Central Appalachian Ridges and Valleys	Dissolved chloride	2.66	17	31.90	18.96	44.85
Central Appalachian Ridges and Valleys	Dissolved chloride	2.81	18	32.84	19.88	45.81
Central Appalachian Ridges and Valleys	Dissolved chloride	2.99	19	34.14	21.08	47.19
Central Appalachian Ridges and Valleys	Dissolved chloride	3.04	20	35.43	22.31	48.54
Central Appalachian Ridges and Valleys	Dissolved chloride	3.08	21	35.96	22.83	49.09
Central Appalachian Ridges and Valleys	Dissolved chloride	3.41	22	36.90	23.72	50.08
Central Appalachian Ridges and Valleys	Dissolved chloride	3.65	23	37.22	24.11	50.32
Central Appalachian Ridges and Valleys	Dissolved chloride	3.72	24	38.15	25.03	51.28
Central Appalachian Ridges and Valleys	Dissolved chloride	3.95	25	38.47	25.36	51.58
Central Appalachian Ridges and Valleys	Dissolved chloride	4.20	26	39.00	25.87	52.13
Central Appalachian Ridges and Valleys	Dissolved chloride	4.30	27	39.53	26.30	52.77
Central Appalachian Ridges and Valleys	Dissolved chloride	4.74	28	40.47	27.28	53.67
Central Appalachian Ridges and Valleys	Dissolved chloride	5.00	41	63.04	51.22	74.85
Central Appalachian Ridges and Valleys	Dissolved chloride	5.11	42	63.98	52.23	75.72
Central Appalachian Ridges and Valleys	Dissolved chloride	5.42	43	65.27	53.58	76.96
Central Appalachian Ridges and Valleys	Dissolved chloride	5.56	44	65.58	53.88	77.29
Central Appalachian Ridges and Valleys	Dissolved chloride	5.95	45	66.12	54.39	77.84
Central Appalachian Ridges and Valleys	Dissolved chloride	5.98	47	67.37	55.75	79.00
Central Appalachian Ridges and Valleys	Dissolved chloride	6.28	48	68.31	56.75	79.87
Central Appalachian Ridges and Valleys	Dissolved chloride	6.35	49	69.60	57.81	81.39
Central Appalachian Ridges and Valleys	Dissolved chloride	7.11	50	70.89	59.04	82.75
Central Appalachian Ridges and Valleys	Dissolved chloride	7.19	51	72.19	60.45	83.93
Central Appalachian Ridges and Valleys	Dissolved chloride	7.33	52	73.13	61.39	84.86
Central Appalachian Ridges and Valleys	Dissolved chloride	8.00	53	74.06	62.34	85.79
Central Appalachian Ridges and Valleys	Dissolved chloride	8.23	54	74.60	62.91	86.29
Central Appalachian Ridges and Valleys	Dissolved chloride	8.30	55	75.89	64.31	87.47
Central Appalachian Ridges and Valleys	Dissolved chloride	9.88	56	76.83	64.95	88.70
Central Appalachian Ridges and Valleys	Dissolved chloride	9.97	57	77.36	65.49	89.23
Central Appalachian Ridges and Valleys	Dissolved chloride	9.99	58	77.68	65.79	89.56
Central Appalachian Ridges and Valleys	Dissolved chloride	10.00	59	78.21	66.34	90.08
Central Appalachian Ridges and Valleys	Dissolved chloride	10.90	60	78.74	66.85	90.64
Central Appalachian Ridges and Valleys	Dissolved chloride	11.00	61	79.27	67.25	91.30
Central Appalachian Ridges and Valleys	Dissolved chloride	12.30	62	79.81	67.80	91.81
Central Appalachian Ridges and Valleys	Dissolved chloride	12.50	63	81.10	69.14	93.06
Central Appalachian Ridges and Valleys	Dissolved chloride	12.90	64	81.63	69.66	93.61
Central Appalachian Ridges and Valleys	Dissolved chloride	13.40	65	82.57	70.41	94.73
Central Appalachian Ridges and Valleys	Dissolved chloride	13.60	66	83.51	71.21	95.81
Central Appalachian Ridges and Valleys	Dissolved chloride	14.40	67	84.04	71.75	96.33
Central Appalachian Ridges and Valleys	Dissolved chloride	15.40	68	85.33	73.13	97.54
Central Appalachian Ridges and Valleys	Dissolved chloride	16.30	69	85.65	73.47	97.83
Central Appalachian Ridges and Valleys	Dissolved chloride	17.30	70	91.11	81.93	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	21.80	71	92.41	83.48	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	36.80	72	92.94	84.01	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	37.70	73	93.47	84.58	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	40.00	74	94.00	85.14	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	79.30	75	94.54	85.70	100.00
Central Appalachian Ridges and Valleys	Dissolved chloride	98.70	76	100.00	100.00	100.00
Southeastern Plains	Dissolved chloride	3.54	1	0.98	0.00	2.81
Southeastern Plains	Dissolved chloride	3.61	2	17.97	0.00	41.85
Southeastern Plains	Dissolved chloride	3.81	3	21.99	0.00	46.39

Southeastern Plains	Dissolved chloride	4.25	4	24.91	0.70	49.12
Southeastern Plains	Dissolved chloride	5.00	5	27.83	3.78	51.89
Southeastern Plains	Dissolved chloride	6.35	6	28.82	4.66	52.97
Southeastern Plains	Dissolved chloride	6.86	7	30.47	6.27	54.67
Southeastern Plains	Dissolved chloride	6.99	8	31.45	7.18	55.73
Southeastern Plains	Dissolved chloride	7.04	9	31.92	7.57	56.28
Southeastern Plains	Dissolved chloride	7.38	10	32.91	8.32	57.49
Southeastern Plains	Dissolved chloride	7.54	11	34.56	9.53	59.59
Southeastern Plains	Dissolved chloride	8.23	12	38.58	14.85	62.31
Southeastern Plains	Dissolved chloride	8.25	13	42.60	18.38	66.83
Southeastern Plains	Dissolved chloride	8.77	14	46.62	22.24	71.00
Southeastern Plains	Dissolved chloride	10.60	15	50.64	26.37	74.91
Southeastern Plains	Dissolved chloride	10.80	16	54.66	31.59	77.73
Southeastern Plains	Dissolved chloride	13.60	17	56.32	33.11	79.53
Southeastern Plains	Dissolved chloride	15.50	18	73.31	50.83	95.80
Southeastern Plains	Dissolved chloride	18.70	19	77.33	54.02	100.00
Southeastern Plains	Dissolved chloride	22.70	20	94.32	87.42	100.00
Southeastern Plains	Dissolved chloride	23.20	21	98.34	95.30	100.00
Southeastern Plains	Dissolved chloride	34.20	22	100.00	100.00	100.00
Blue Ridge Mountains	Dissolved chloride	0.22	1	9.12	0.00	23.29
Blue Ridge Mountains	Dissolved chloride	1.39	2	18.24	0.00	38.00
Blue Ridge Mountains	Dissolved chloride	1.42	3	27.35	4.06	50.65
Blue Ridge Mountains	Dissolved chloride	2.51	4	28.92	5.83	52.01
Blue Ridge Mountains	Dissolved chloride	2.75	5	30.49	7.43	53.54
Blue Ridge Mountains	Dissolved chloride	4.07	6	31.38	8.18	54.57
Blue Ridge Mountains	Dissolved chloride	5.00	13	74.32	55.12	93.51
Blue Ridge Mountains	Dissolved chloride	5.18	14	75.88	56.51	95.26
Blue Ridge Mountains	Dissolved chloride	5.85	15	78.04	58.73	97.35
Blue Ridge Mountains	Dissolved chloride	5.95	16	80.20	61.40	98.99
Blue Ridge Mountains	Dissolved chloride	10.10	17	81.76	62.59	100.00
Blue Ridge Mountains	Dissolved chloride	10.30	18	90.88	76.71	100.00
Blue Ridge Mountains	Dissolved chloride	17.00	19	100.00	100.00	100.00
Central Appalachians	Dissolved chloride	1.06	1	5.10	0.00	13.68
Central Appalachians	Dissolved chloride	1.77	2	26.67	0.00	56.61
Central Appalachians	Dissolved chloride	3.22	3	28.77	0.00	58.57
Central Appalachians	Dissolved chloride	3.36	4	32.48	2.33	62.63
Central Appalachians	Dissolved chloride	3.58	5	54.05	25.10	83.00
Central Appalachians	Dissolved chloride	3.84	6	56.15	27.82	84.48
Central Appalachians	Dissolved chloride	5.00	9	68.66	46.38	90.95
Central Appalachians	Dissolved chloride	6.76	10	72.37	52.09	92.65
Central Appalachians	Dissolved chloride	8.50	11	76.08	57.26	94.90
Central Appalachians	Dissolved chloride	11.10	13	83.49	67.88	99.09
Central Appalachians	Dissolved chloride	11.70	15	90.69	80.52	100.00
Central Appalachians	Dissolved chloride	11.90	16	92.80	82.82	100.00
Central Appalachians	Dissolved chloride	19.00	17	97.90	93.87	100.00
Central Appalachians	Dissolved chloride	23.90	18	100.00	100.00	100.00

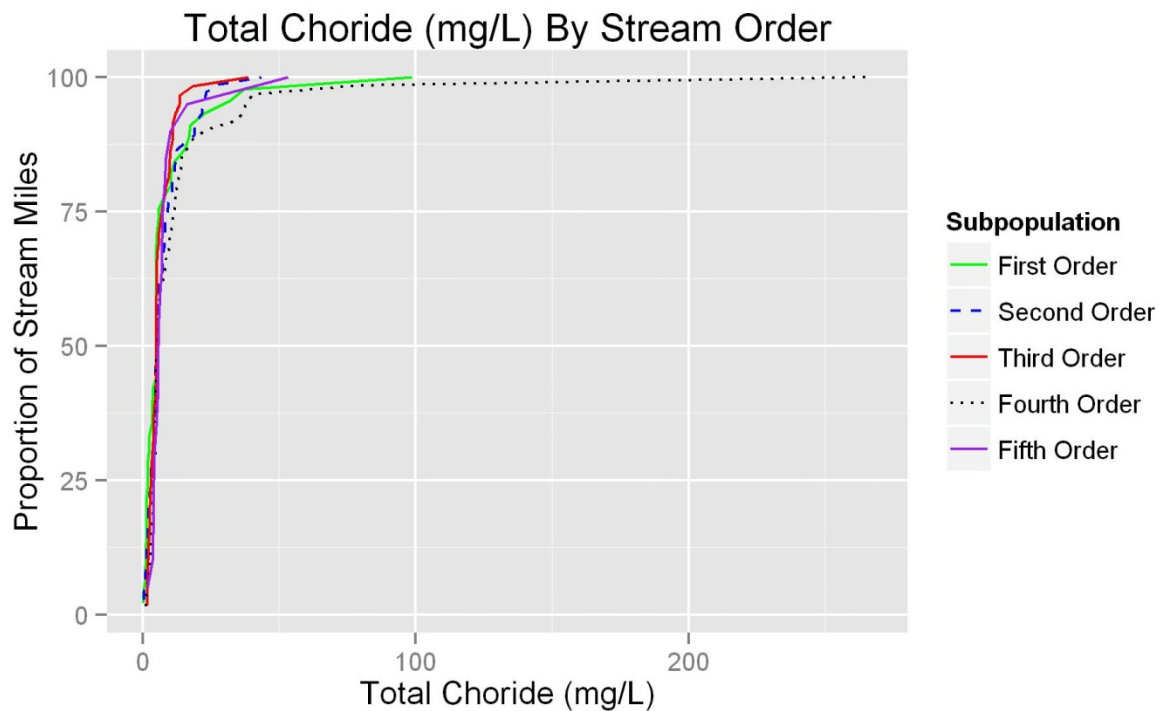


Figure 62. Dissolved Chloride by Stream Order CDF graph.

Figure 62 and Table 40 depict dissolved chloride values and percentiles by stream order. Ninety-three percent of first order, 95% of second order, and 90% of fourth order stream miles have total chlorides less than 24 mg/L. One hundred percent of fifth order streams have total chloride concentrations below 53.2 mg/L and 100% of third order stream miles have total chlorides less than 38.7 mg/L.

Table 40. Dissolved Chloride Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Dissolved chloride	0.22	1	2.22	0.00	5.98
First Order	Dissolved chloride	0.31	2	4.44	0.00	9.48
First Order	Dissolved chloride	0.84	3	6.67	0.36	12.98
First Order	Dissolved chloride	1.00	4	8.89	1.59	16.18
First Order	Dissolved chloride	1.13	5	11.11	3.30	18.92
First Order	Dissolved chloride	1.23	6	13.33	5.54	21.12
First Order	Dissolved chloride	1.36	7	15.56	6.95	24.17
First Order	Dissolved chloride	1.39	8	17.78	8.39	27.17
First Order	Dissolved chloride	1.40	9	20.00	9.91	30.09
First Order	Dissolved chloride	1.42	10	22.22	11.79	32.65
First Order	Dissolved chloride	1.77	11	24.44	13.78	35.11
First Order	Dissolved chloride	1.82	12	26.67	16.17	37.16
First Order	Dissolved chloride	1.87	13	28.89	18.76	39.02
First Order	Dissolved chloride	2.41	14	31.11	20.35	41.87
First Order	Dissolved chloride	2.43	15	33.33	22.44	44.22



First Order	Dissolved chloride	3.40	16	35.56	24.41	46.70
First Order	Dissolved chloride	3.58	17	37.78	26.88	48.68
First Order	Dissolved chloride	3.61	18	40.00	28.52	51.48
First Order	Dissolved chloride	3.84	19	42.22	30.28	54.17
First Order	Dissolved chloride	4.87	20	44.44	32.64	56.25
First Order	Dissolved chloride	5.00	31	68.89	58.50	79.28
First Order	Dissolved chloride	5.13	32	71.11	60.30	81.92
First Order	Dissolved chloride	5.67	33	73.33	62.61	84.05
First Order	Dissolved chloride	5.80	34	75.56	64.88	86.23
First Order	Dissolved chloride	7.69	35	77.78	67.63	87.93
First Order	Dissolved chloride	10.30	36	80.00	70.48	89.52
First Order	Dissolved chloride	10.40	37	82.22	72.73	91.72
First Order	Dissolved chloride	11.80	38	84.44	75.01	93.88
First Order	Dissolved chloride	15.50	39	86.67	77.89	95.44
First Order	Dissolved chloride	17.00	40	88.89	80.68	97.10
First Order	Dissolved chloride	17.30	41	91.11	83.60	98.62
First Order	Dissolved chloride	22.70	42	93.33	86.72	99.95
First Order	Dissolved chloride	32.00	43	95.56	90.22	100.00
First Order	Dissolved chloride	37.00	44	97.78	93.88	100.00
First Order	Dissolved chloride	98.70	45	100.00	100.00	100.00
Second Order	Dissolved chloride	0.30	2	2.70	0.00	5.94
Second Order	Dissolved chloride	0.50	3	4.05	0.03	8.07
Second Order	Dissolved chloride	0.82	4	5.41	0.91	9.90
Second Order	Dissolved chloride	1.00	5	6.76	1.68	11.84
Second Order	Dissolved chloride	1.06	6	8.11	2.58	13.64
Second Order	Dissolved chloride	1.38	7	9.46	3.52	15.40
Second Order	Dissolved chloride	1.44	8	10.81	4.59	17.04
Second Order	Dissolved chloride	1.45	9	12.16	5.52	18.80
Second Order	Dissolved chloride	1.77	10	13.51	6.67	20.36
Second Order	Dissolved chloride	1.84	11	14.86	7.96	21.77
Second Order	Dissolved chloride	1.85	12	16.22	9.27	23.16
Second Order	Dissolved chloride	1.87	13	17.57	10.78	24.35
Second Order	Dissolved chloride	2.04	14	18.92	11.72	26.11
Second Order	Dissolved chloride	2.13	15	20.27	12.72	27.82
Second Order	Dissolved chloride	2.40	16	21.62	14.36	28.89
Second Order	Dissolved chloride	2.66	17	22.97	15.63	30.32
Second Order	Dissolved chloride	2.99	18	24.32	16.98	31.67
Second Order	Dissolved chloride	3.03	19	25.68	18.16	33.19
Second Order	Dissolved chloride	3.04	20	27.03	19.20	34.85
Second Order	Dissolved chloride	3.23	21	28.38	20.62	36.14
Second Order	Dissolved chloride	3.48	22	29.73	21.83	37.63
Second Order	Dissolved chloride	3.80	23	31.08	22.92	39.24
Second Order	Dissolved chloride	3.81	24	32.43	23.95	40.91
Second Order	Dissolved chloride	4.39	25	33.78	25.44	42.13
Second Order	Dissolved chloride	5.00	38	51.35	42.52	60.19
Second Order	Dissolved chloride	5.37	39	52.70	43.95	61.46
Second Order	Dissolved chloride	5.42	41	55.41	46.97	63.84
Second Order	Dissolved chloride	5.55	42	56.76	48.53	64.98
Second Order	Dissolved chloride	5.85	43	58.11	49.90	66.32
Second Order	Dissolved chloride	5.93	44	59.46	51.36	67.56
Second Order	Dissolved chloride	5.95	45	60.81	52.99	68.63
Second Order	Dissolved chloride	6.35	46	62.16	54.04	70.28
Second Order	Dissolved chloride	7.11	47	63.51	55.31	71.71



Second Order	Dissolved chloride	7.19	48	64.86	56.94	72.79
Second Order	Dissolved chloride	7.28	49	66.22	58.01	74.42
Second Order	Dissolved chloride	7.40	50	67.57	59.67	75.46
Second Order	Dissolved chloride	8.01	51	68.92	61.00	76.84
Second Order	Dissolved chloride	8.23	52	70.27	62.12	78.42
Second Order	Dissolved chloride	8.25	53	71.62	63.43	79.81
Second Order	Dissolved chloride	8.30	54	72.97	64.87	81.08
Second Order	Dissolved chloride	8.77	55	74.32	66.17	82.48
Second Order	Dissolved chloride	9.23	56	75.68	67.54	83.81
Second Order	Dissolved chloride	9.33	57	77.03	69.21	84.84
Second Order	Dissolved chloride	10.60	58	78.38	70.71	86.05
Second Order	Dissolved chloride	10.80	59	79.73	72.40	87.06
Second Order	Dissolved chloride	10.90	60	81.08	74.14	88.03
Second Order	Dissolved chloride	11.70	61	82.43	75.63	89.23
Second Order	Dissolved chloride	11.80	62	83.78	76.88	90.69
Second Order	Dissolved chloride	12.10	63	85.14	78.43	91.85
Second Order	Dissolved chloride	12.50	64	86.49	80.12	92.85
Second Order	Dissolved chloride	15.40	65	87.84	81.87	93.81
Second Order	Dissolved chloride	18.70	66	89.19	83.63	94.75
Second Order	Dissolved chloride	19.00	67	90.54	85.48	95.60
Second Order	Dissolved chloride	19.80	68	91.89	86.99	96.79
Second Order	Dissolved chloride	21.60	69	93.24	88.59	97.90
Second Order	Dissolved chloride	21.80	70	94.59	90.52	98.67
Second Order	Dissolved chloride	22.80	71	95.95	92.56	99.33
Second Order	Dissolved chloride	23.20	72	97.30	94.77	99.82
Second Order	Dissolved chloride	27.90	73	98.65	96.44	100.00
Second Order	Dissolved chloride	43.40	74	100.00	100.00	100.00
Third Order	Dissolved chloride	1.46	1	1.69	0.00	4.57
Third Order	Dissolved chloride	1.63	2	3.39	0.00	7.46
Third Order	Dissolved chloride	1.64	3	5.08	0.43	9.74
Third Order	Dissolved chloride	1.73	4	6.78	1.37	12.19
Third Order	Dissolved chloride	1.88	5	8.47	2.39	14.55
Third Order	Dissolved chloride	1.92	6	10.17	3.45	16.89
Third Order	Dissolved chloride	2.06	7	11.86	4.52	19.20
Third Order	Dissolved chloride	2.08	8	13.56	6.05	21.06
Third Order	Dissolved chloride	2.33	9	15.25	7.82	22.69
Third Order	Dissolved chloride	2.51	10	16.95	9.04	24.86
Third Order	Dissolved chloride	2.56	11	18.64	10.26	27.03
Third Order	Dissolved chloride	2.59	12	20.34	11.79	28.89
Third Order	Dissolved chloride	2.75	13	22.03	13.44	30.63
Third Order	Dissolved chloride	2.81	14	23.73	14.64	32.82
Third Order	Dissolved chloride	3.12	15	25.42	16.05	34.79
Third Order	Dissolved chloride	3.34	16	27.12	17.52	36.72
Third Order	Dissolved chloride	3.36	17	28.81	18.81	38.81
Third Order	Dissolved chloride	3.41	18	30.51	20.61	40.41
Third Order	Dissolved chloride	3.72	19	32.20	22.14	42.27
Third Order	Dissolved chloride	3.94	20	33.90	23.45	44.35
Third Order	Dissolved chloride	4.10	21	35.59	24.93	46.26
Third Order	Dissolved chloride	4.11	22	37.29	26.33	48.24
Third Order	Dissolved chloride	4.25	23	38.98	27.98	49.99
Third Order	Dissolved chloride	4.74	24	40.68	29.71	51.65
Third Order	Dissolved chloride	5.00	35	59.32	49.01	69.63
Third Order	Dissolved chloride	5.11	36	61.02	50.53	71.50

Third Order	Dissolved chloride	5.18	37	62.71	52.43	73.00
Third Order	Dissolved chloride	5.21	38	64.41	54.24	74.57
Third Order	Dissolved chloride	5.25	39	66.10	56.03	76.18
Third Order	Dissolved chloride	5.49	40	67.80	57.52	78.08
Third Order	Dissolved chloride	5.82	41	69.49	59.32	79.66
Third Order	Dissolved chloride	5.98	42	71.19	61.25	81.12
Third Order	Dissolved chloride	6.28	43	72.88	63.15	82.61
Third Order	Dissolved chloride	6.76	44	74.58	65.08	84.08
Third Order	Dissolved chloride	7.33	45	76.27	67.14	85.40
Third Order	Dissolved chloride	8.00	46	77.97	69.02	86.91
Third Order	Dissolved chloride	8.50	47	79.66	70.81	88.52
Third Order	Dissolved chloride	9.47	48	81.36	72.80	89.92
Third Order	Dissolved chloride	9.77	49	83.05	74.93	91.17
Third Order	Dissolved chloride	9.88	50	84.75	76.65	92.84
Third Order	Dissolved chloride	10.10	51	86.44	78.62	94.26
Third Order	Dissolved chloride	10.80	52	88.14	80.91	95.36
Third Order	Dissolved chloride	11.10	54	91.53	85.26	97.79
Third Order	Dissolved chloride	11.90	55	93.22	87.61	98.83
Third Order	Dissolved chloride	13.40	56	94.92	89.98	99.85
Third Order	Dissolved chloride	13.60	57	96.61	92.51	100.00
Third Order	Dissolved chloride	18.40	58	98.31	95.26	100.00
Third Order	Dissolved chloride	38.70	59	100.00	100.00	100.00
Fourth Order	Dissolved chloride	1.16	1	1.61	0.00	4.28
Fourth Order	Dissolved chloride	1.23	2	3.23	0.13	6.32
Fourth Order	Dissolved chloride	1.75	3	4.84	0.76	8.92
Fourth Order	Dissolved chloride	2.09	4	6.45	1.52	11.38
Fourth Order	Dissolved chloride	2.33	5	8.06	2.48	13.65
Fourth Order	Dissolved chloride	2.55	6	9.68	3.94	15.41
Fourth Order	Dissolved chloride	2.90	7	11.29	4.90	17.68
Fourth Order	Dissolved chloride	3.08	8	12.90	5.94	19.87
Fourth Order	Dissolved chloride	3.20	9	14.52	7.47	21.56
Fourth Order	Dissolved chloride	3.22	10	16.13	8.57	23.69
Fourth Order	Dissolved chloride	3.43	11	17.74	9.98	25.50
Fourth Order	Dissolved chloride	3.79	12	19.35	11.13	27.58
Fourth Order	Dissolved chloride	3.80	13	20.97	12.73	29.20
Fourth Order	Dissolved chloride	3.84	14	22.58	14.07	31.10
Fourth Order	Dissolved chloride	4.07	15	24.19	15.29	33.09
Fourth Order	Dissolved chloride	4.20	16	25.81	16.92	34.70
Fourth Order	Dissolved chloride	4.26	17	27.42	18.25	36.59
Fourth Order	Dissolved chloride	4.30	18	29.03	19.82	38.25
Fourth Order	Dissolved chloride	4.66	19	30.65	21.11	40.18
Fourth Order	Dissolved chloride	5.00	29	46.77	37.87	55.67
Fourth Order	Dissolved chloride	5.21	30	48.39	39.32	57.46
Fourth Order	Dissolved chloride	5.32	31	50.00	40.92	59.08
Fourth Order	Dissolved chloride	5.51	32	51.61	42.68	60.55
Fourth Order	Dissolved chloride	5.52	33	53.23	44.67	61.79
Fourth Order	Dissolved chloride	5.57	34	54.84	46.69	62.99
Fourth Order	Dissolved chloride	5.77	35	56.45	48.65	64.26
Fourth Order	Dissolved chloride	5.95	36	58.06	50.20	65.93
Fourth Order	Dissolved chloride	6.36	37	59.68	51.85	67.50
Fourth Order	Dissolved chloride	6.86	38	61.29	53.08	69.50
Fourth Order	Dissolved chloride	7.54	39	62.90	54.74	71.06
Fourth Order	Dissolved chloride	8.23	40	64.52	56.39	72.65

Fourth Order	Dissolved chloride	8.49	41	66.13	58.20	74.06
Fourth Order	Dissolved chloride	9.38	42	67.74	59.54	75.94
Fourth Order	Dissolved chloride	9.97	43	69.35	61.26	77.45
Fourth Order	Dissolved chloride	10.00	44	70.97	63.05	78.88
Fourth Order	Dissolved chloride	10.90	45	72.58	65.08	80.08
Fourth Order	Dissolved chloride	11.00	46	74.19	66.44	81.95
Fourth Order	Dissolved chloride	11.70	47	75.81	67.83	83.78
Fourth Order	Dissolved chloride	11.90	48	77.42	69.72	85.11
Fourth Order	Dissolved chloride	12.30	49	79.03	71.85	86.22
Fourth Order	Dissolved chloride	12.90	50	80.65	73.51	87.78
Fourth Order	Dissolved chloride	13.60	51	82.26	75.46	89.06
Fourth Order	Dissolved chloride	14.30	52	83.87	76.74	91.00
Fourth Order	Dissolved chloride	14.40	53	85.48	78.91	92.06
Fourth Order	Dissolved chloride	16.70	54	87.10	80.54	93.65
Fourth Order	Dissolved chloride	18.50	55	88.71	82.28	95.14
Fourth Order	Dissolved chloride	23.90	56	90.32	84.04	96.60
Fourth Order	Dissolved chloride	34.20	57	91.94	86.27	97.61
Fourth Order	Dissolved chloride	36.80	58	93.55	88.19	98.90
Fourth Order	Dissolved chloride	37.70	59	95.16	90.50	99.83
Fourth Order	Dissolved chloride	40.00	60	96.77	92.90	100.00
Fourth Order	Dissolved chloride	79.30	61	98.39	95.77	100.00
Fourth Order	Dissolved chloride	267.00	62	100.00	100.00	100.00
Fifth Order	Dissolved chloride	1.62	1	5.00	0.00	13.55
Fifth Order	Dissolved chloride	3.54	2	10.00	0.00	21.66
Fifth Order	Dissolved chloride	3.65	3	15.00	0.58	29.42
Fifth Order	Dissolved chloride	3.91	4	20.00	3.60	36.40
Fifth Order	Dissolved chloride	3.95	5	25.00	7.20	42.80
Fifth Order	Dissolved chloride	4.31	6	30.00	11.54	48.46
Fifth Order	Dissolved chloride	5.00	7	35.00	16.53	53.47
Fifth Order	Dissolved chloride	5.39	8	40.00	21.79	58.21
Fifth Order	Dissolved chloride	5.56	10	50.00	30.07	69.93
Fifth Order	Dissolved chloride	5.98	11	55.00	36.26	73.74
Fifth Order	Dissolved chloride	6.35	12	60.00	41.23	78.77
Fifth Order	Dissolved chloride	6.99	13	65.00	47.23	82.77
Fifth Order	Dissolved chloride	7.13	14	70.00	51.92	88.08
Fifth Order	Dissolved chloride	7.38	15	75.00	58.80	91.20
Fifth Order	Dissolved chloride	8.03	16	80.00	64.28	95.72
Fifth Order	Dissolved chloride	8.56	17	85.00	71.37	98.63
Fifth Order	Dissolved chloride	9.99	18	90.00	78.31	100.00
Fifth Order	Dissolved chloride	16.30	19	95.00	86.90	100.00
Fifth Order	Dissolved chloride	53.20	20	100.00	100.00	100.00

## Appendix H. Dissolved Potassium Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by dissolved potassium in this appendix) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Dissolved potassium over 3.5 mg/L increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). Figure 63 shows declining VSCI scores with increasing dissolved Potassium. The case for this increased risk to the aquatic community is presented in this appendix.

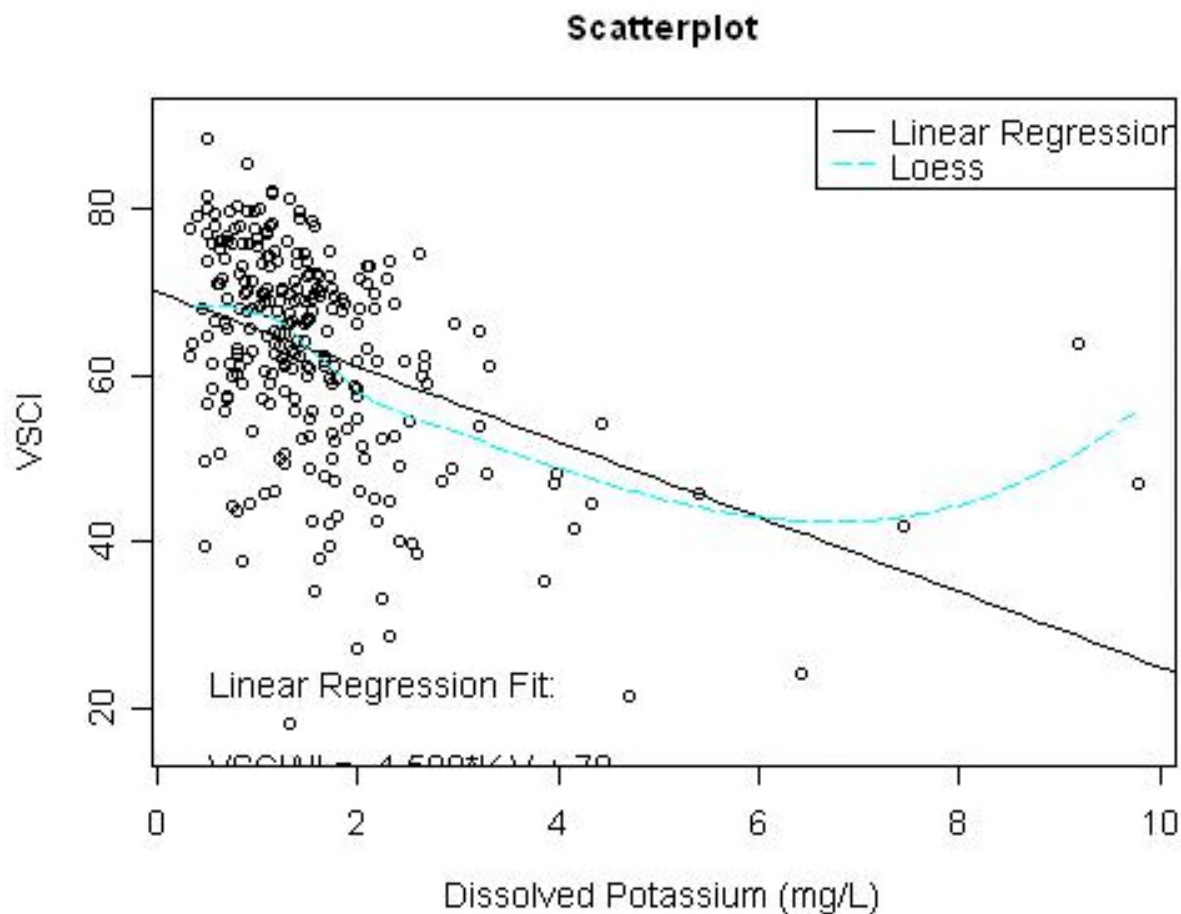


Figure 63. Dissolved Potassium Stressor Gradient Scatterplot.

### *Total Dissolved Potassium Relative Risk Results*

An optimal level of less than 2 mg/L was selected based on its low probability of stress to aquatic life. VDEQ estimates 84.6% of Virginia streams have dissolved potassium less than 2 mg/L (Table A.43). Dissolved potassium above 3.5 mg/L is considered suboptimal based on

declining VSCI scores observed in categorical boxplots (Figure 64) and scatter plot graphs. Only 2.8% of Virginia streams have a dissolved potassium concentration above 3.5 mg/L (Table 41, Figure \_\_\_\_). VDEQ relative risk calculations found that a VSCI score is 5 times more likely to be below 50 when dissolved potassium are above 3.5 mg/L than when the potassium levels are below 2 mg/L (Figure 65).

Table 41. **Dissolved Potassium** Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Dissolved Potassium (mg/L)	<2	>3.5

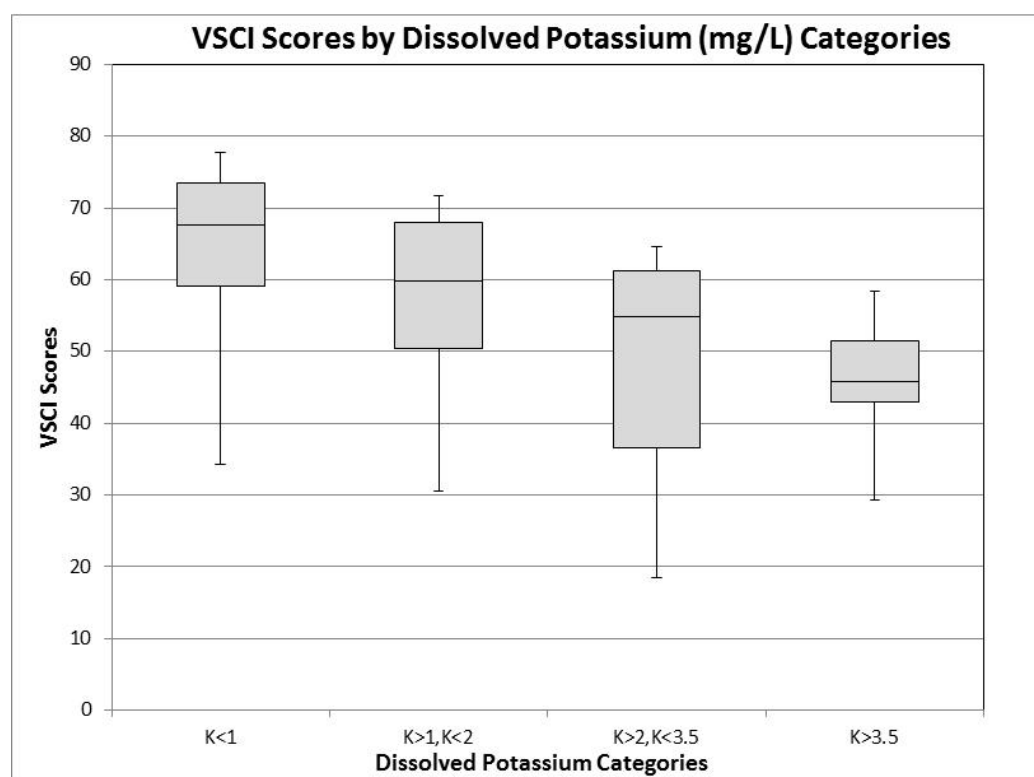


Figure 64. VSCI Scores by Dissolved Potassium Categories.

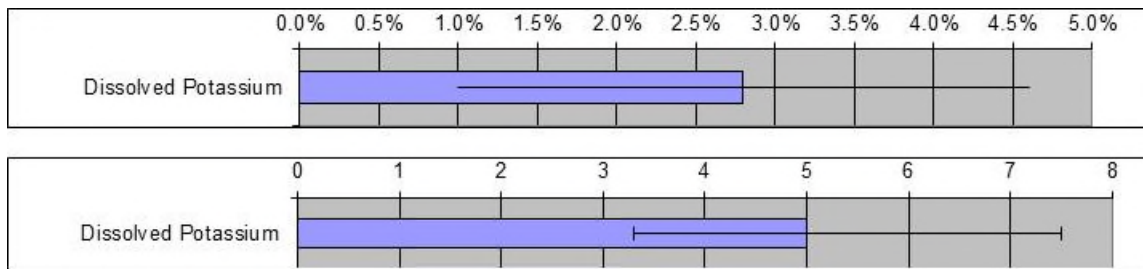


Figure 65. Dissolved Potassium Relative Extent (Dissolved Potassium > 3.5 mg/L) and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 12 sites with dissolved potassium over 3.5 mg/L. One site out of twelve has a VSCI over 60. The probability of having VSCI score less than 60 when dissolved potassium are 3.5 mg/L is 90% (Figure 66).

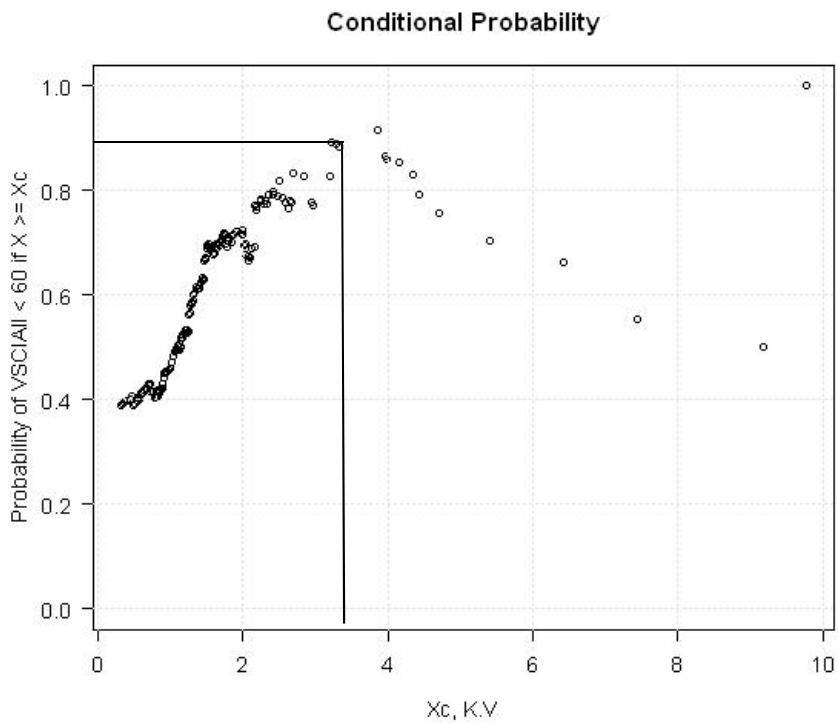


Figure 66. Probability of VSCI less than 60 if Dissolved Potassium > 3.5 mg/L.

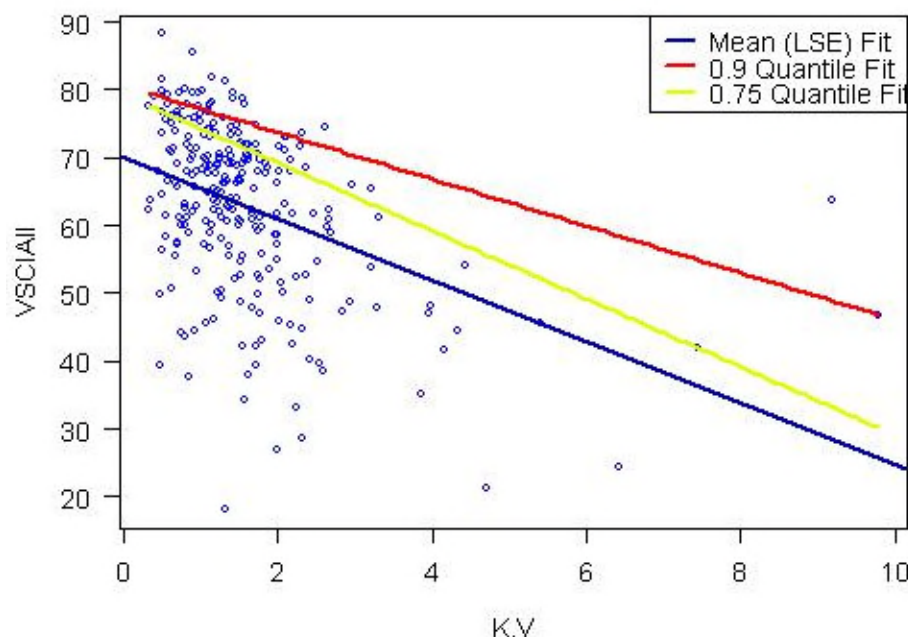


Figure 67. Quantile Regression VSCI versus Dissolved Potassium (mg/L).

Quantile regression techniques are applied to dissolved potassium by first fitting a regression to the 90<sup>th</sup> quantile in order to remove the effects of other stressor variables to biological metrics. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to dissolved potassium mg/L values. The 50<sup>th</sup> percentile of percentile of reference crosses at 2.5 mg/L, 25th percentile intersects at 4.2 mg/L, and the 10<sup>th</sup> percentile is equal to 6.0 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed (Figure A.63).

### *Dissolved Potassium and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from dissolved potassium concentrations below 1 mg/L (Table 42). Streams with dissolved potassium above 3.5 mg/L do not support health benthic communities and are associated with VSCI scores less than 60.

Table 42. Dissolved Potassium (mg/L) concentrations and probability of stress to aquatic life (based on VSCI Scores).

Dissolved Potassium	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 10
Medium	> 2, < 10
Low	> 1, < 2
None	< 1

### *Dissolved Potassium Cumulative Distribution Function curves*

Dissolved Potassium cumulative distribution function (CDF) curves and supporting data are presented in Figure 68 and Table 43, respectively. Figures 69-72 display dissolved potassium CDF curves statewide, by major basin, major ecoregion (level III), and stream order. Tables 43-46 correspond to the aforementioned figures.

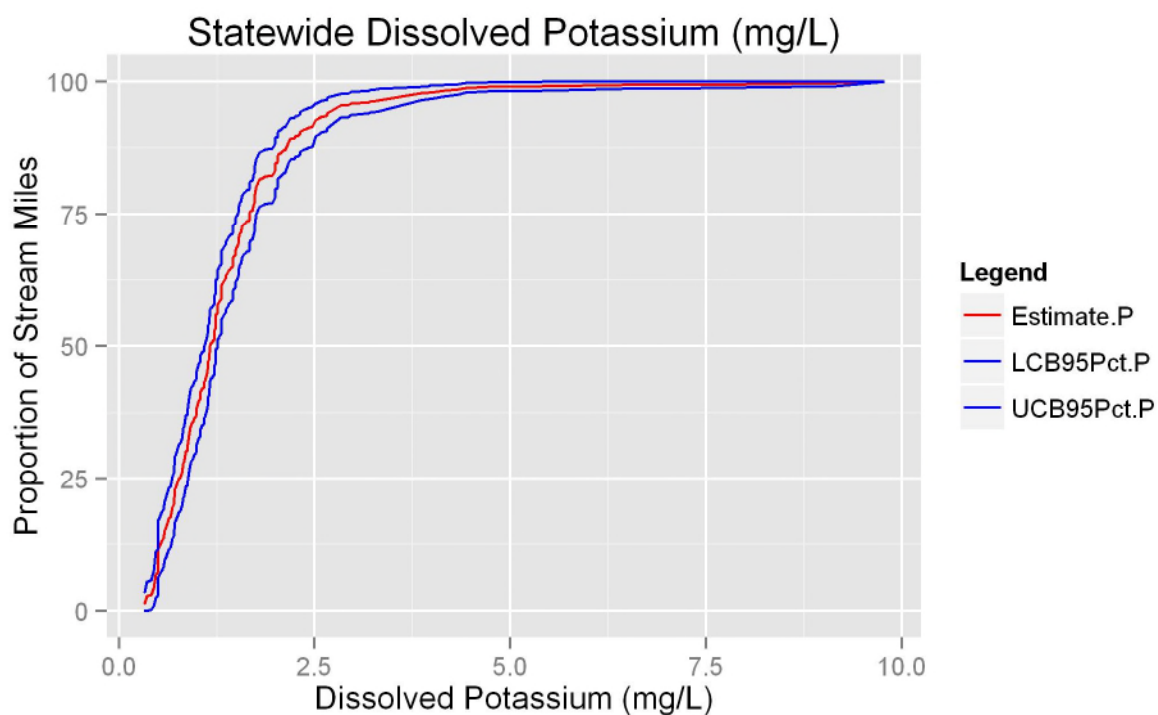


Figure 68. Dissolved Potassium Statewide CDF graph.



Statewide dissolved potassium CDF curve is shown in Figure 68. Table 43 corresponds to Figure 68. Eighty-four percent of stream miles have dissolved potassium concentrations less than 2 mg/L.

Table 43. Dissolved Potassium Statewide Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Diss Potassium	0.32	1	1.25	0.00	3.34
Virginia	Diss Potassium	0.33	2	1.47	0.00	3.58
Virginia	Diss Potassium	0.35	3	2.72	0.00	5.45
Virginia	Diss Potassium	0.41	4	3.01	0.24	5.79
Virginia	Diss Potassium	0.44	5	4.27	0.92	7.61
Virginia	Diss Potassium	0.47	7	6.77	2.43	11.10
Virginia	Diss Potassium	0.49	8	7.07	2.70	11.43
Virginia	Diss Potassium	0.50	14	11.71	6.41	17.01
Virginia	Diss Potassium	0.54	15	12.96	7.47	18.45
Virginia	Diss Potassium	0.55	16	13.08	7.62	18.55
Virginia	Diss Potassium	0.56	17	13.38	7.94	18.82
Virginia	Diss Potassium	0.57	18	13.59	8.14	19.04
Virginia	Diss Potassium	0.58	20	15.06	9.50	20.62
Virginia	Diss Potassium	0.59	21	15.36	9.77	20.94
Virginia	Diss Potassium	0.62	23	16.82	11.05	22.59
Virginia	Diss Potassium	0.63	25	17.24	11.48	23.00
Virginia	Diss Potassium	0.64	26	17.36	11.60	23.12
Virginia	Diss Potassium	0.66	27	17.66	11.88	23.43
Virginia	Diss Potassium	0.68	30	19.42	13.46	25.39
Virginia	Diss Potassium	0.69	31	19.72	13.74	25.69
Virginia	Diss Potassium	0.70	32	19.93	13.96	25.90
Virginia	Diss Potassium	0.71	36	22.95	16.62	29.28
Virginia	Diss Potassium	0.72	38	23.19	16.86	29.52
Virginia	Diss Potassium	0.76	41	24.95	18.47	31.43
Virginia	Diss Potassium	0.78	42	25.17	18.68	31.66
Virginia	Diss Potassium	0.79	43	25.46	19.00	31.93
Virginia	Diss Potassium	0.80	47	26.22	19.77	32.66
Virginia	Diss Potassium	0.82	50	27.90	21.29	34.51
Virginia	Diss Potassium	0.83	51	28.12	21.50	34.73
Virginia	Diss Potassium	0.84	53	28.71	22.07	35.35
Virginia	Diss Potassium	0.85	55	30.18	23.41	36.95
Virginia	Diss Potassium	0.87	56	30.25	23.48	37.01
Virginia	Diss Potassium	0.88	57	31.50	24.66	38.34
Virginia	Diss Potassium	0.89	60	33.18	26.30	40.06
Virginia	Diss Potassium	0.91	62	34.65	27.68	41.61
Virginia	Diss Potassium	0.92	64	35.07	28.14	41.99
Virginia	Diss Potassium	0.93	65	35.36	28.43	42.29
Virginia	Diss Potassium	0.94	66	35.66	28.75	42.57
Virginia	Diss Potassium	0.96	70	36.33	29.45	43.22
Virginia	Diss Potassium	0.98	72	36.84	29.96	43.72
Virginia	Diss Potassium	0.99	74	38.39	31.47	45.31
Virginia	Diss Potassium	1.02	75	39.64	32.65	46.63
Virginia	Diss Potassium	1.03	76	39.86	32.87	46.84
Virginia	Diss Potassium	1.04	78	41.41	34.44	48.37

Virginia	Diss Potassium	1.05	79	41.53	34.58	48.48
Virginia	Diss Potassium	1.06	81	41.95	35.02	48.87
Virginia	Diss Potassium	1.07	82	42.07	35.16	48.98
Virginia	Diss Potassium	1.08	83	42.19	35.27	49.10
Virginia	Diss Potassium	1.09	88	43.25	36.43	50.07
Virginia	Diss Potassium	1.10	89	43.55	36.76	50.34
Virginia	Diss Potassium	1.12	91	44.87	38.07	51.67
Virginia	Diss Potassium	1.13	95	45.50	38.70	52.29
Virginia	Diss Potassium	1.14	98	47.17	40.42	53.91
Virginia	Diss Potassium	1.15	99	47.38	40.64	54.12
Virginia	Diss Potassium	1.16	102	50.18	43.45	56.91
Virginia	Diss Potassium	1.17	104	50.52	43.83	57.21
Virginia	Diss Potassium	1.19	105	50.64	43.96	57.32
Virginia	Diss Potassium	1.20	106	50.94	44.29	57.59
Virginia	Diss Potassium	1.21	107	51.15	44.50	57.80
Virginia	Diss Potassium	1.22	110	52.99	46.39	59.60
Virginia	Diss Potassium	1.23	111	53.12	46.51	59.72
Virginia	Diss Potassium	1.24	114	55.92	49.38	62.45
Virginia	Diss Potassium	1.25	115	56.13	49.60	62.67
Virginia	Diss Potassium	1.26	119	57.87	51.31	64.43
Virginia	Diss Potassium	1.27	120	58.00	51.41	64.58
Virginia	Diss Potassium	1.28	121	58.29	51.71	64.88
Virginia	Diss Potassium	1.29	122	58.51	51.92	65.10
Virginia	Diss Potassium	1.30	123	58.72	52.15	65.29
Virginia	Diss Potassium	1.31	127	61.56	55.09	68.03
Virginia	Diss Potassium	1.32	128	61.68	55.22	68.15
Virginia	Diss Potassium	1.34	131	62.41	55.99	68.83
Virginia	Diss Potassium	1.36	132	62.71	56.29	69.12
Virginia	Diss Potassium	1.37	136	63.32	56.93	69.71
Virginia	Diss Potassium	1.38	137	63.53	57.14	69.92
Virginia	Diss Potassium	1.39	140	63.94	57.57	70.32
Virginia	Diss Potassium	1.40	141	64.24	57.88	70.60
Virginia	Diss Potassium	1.42	142	64.45	58.11	70.80
Virginia	Diss Potassium	1.43	145	64.77	58.44	71.10
Virginia	Diss Potassium	1.45	146	64.89	58.56	71.22
Virginia	Diss Potassium	1.46	149	66.74	60.60	72.87
Virginia	Diss Potassium	1.47	150	66.81	60.68	72.94
Virginia	Diss Potassium	1.48	151	67.02	60.92	73.13
Virginia	Diss Potassium	1.49	156	68.20	62.11	74.29
Virginia	Diss Potassium	1.50	157	68.50	62.41	74.58
Virginia	Diss Potassium	1.51	158	68.62	62.54	74.69
Virginia	Diss Potassium	1.52	161	69.25	63.20	75.30
Virginia	Diss Potassium	1.53	163	70.57	64.65	76.50
Virginia	Diss Potassium	1.54	165	71.09	65.16	77.01
Virginia	Diss Potassium	1.55	168	71.28	65.36	77.20
Virginia	Diss Potassium	1.56	169	71.40	65.49	77.31
Virginia	Diss Potassium	1.57	170	72.65	66.77	78.53
Virginia	Diss Potassium	1.58	171	72.72	66.84	78.61
Virginia	Diss Potassium	1.60	173	73.14	67.26	79.02
Virginia	Diss Potassium	1.62	175	73.38	67.53	79.24
Virginia	Diss Potassium	1.63	177	73.63	67.77	79.49
Virginia	Diss Potassium	1.66	178	73.75	67.89	79.61
Virginia	Diss Potassium	1.67	180	75.30	69.62	80.97

Virginia	Diss Potassium	1.68	181	75.59	69.94	81.25
Virginia	Diss Potassium	1.70	182	75.72	70.07	81.36
Virginia	Diss Potassium	1.71	184	76.23	70.59	81.87
Virginia	Diss Potassium	1.72	186	76.74	71.09	82.38
Virginia	Diss Potassium	1.73	187	77.03	71.38	82.69
Virginia	Diss Potassium	1.74	190	78.80	73.30	84.30
Virginia	Diss Potassium	1.75	192	80.17	74.96	85.38
Virginia	Diss Potassium	1.76	193	80.39	75.19	85.58
Virginia	Diss Potassium	1.77	194	80.68	75.51	85.86
Virginia	Diss Potassium	1.78	196	81.02	75.86	86.18
Virginia	Diss Potassium	1.79	198	81.45	76.31	86.59
Virginia	Diss Potassium	1.80	199	81.57	76.43	86.71
Virginia	Diss Potassium	1.84	200	81.87	76.74	86.99
Virginia	Diss Potassium	1.85	201	81.94	76.82	87.06
Virginia	Diss Potassium	1.87	202	82.06	76.92	87.20
Virginia	Diss Potassium	1.90	203	82.18	77.05	87.31
Virginia	Diss Potassium	1.96	204	82.31	77.18	87.44
Virginia	Diss Potassium	1.99	208	83.06	77.97	88.16
Virginia	Diss Potassium	2.00	210	84.61	79.82	89.40
Virginia	Diss Potassium	2.02	211	84.68	79.89	89.47
Virginia	Diss Potassium	2.03	213	86.05	81.67	90.43
Virginia	Diss Potassium	2.04	214	86.27	81.90	90.64
Virginia	Diss Potassium	2.07	215	86.57	82.20	90.93
Virginia	Diss Potassium	2.08	216	86.69	82.33	91.04
Virginia	Diss Potassium	2.10	218	87.02	82.69	91.36
Virginia	Diss Potassium	2.12	219	87.10	82.76	91.43
Virginia	Diss Potassium	2.16	221	88.42	84.45	92.39
Virginia	Diss Potassium	2.17	222	88.64	84.69	92.58
Virginia	Diss Potassium	2.18	223	88.93	85.01	92.86
Virginia	Diss Potassium	2.19	224	89.23	85.33	93.12
Virginia	Diss Potassium	2.24	225	89.35	85.45	93.25
Virginia	Diss Potassium	2.25	226	89.65	85.78	93.51
Virginia	Diss Potassium	2.28	227	89.72	85.86	93.58
Virginia	Diss Potassium	2.31	228	90.01	86.19	93.84
Virginia	Diss Potassium	2.32	230	90.53	86.75	94.30
Virginia	Diss Potassium	2.36	232	90.86	87.12	94.61
Virginia	Diss Potassium	2.41	233	91.16	87.45	94.87
Virginia	Diss Potassium	2.42	234	91.23	87.50	94.97
Virginia	Diss Potassium	2.47	235	91.53	87.82	95.23
Virginia	Diss Potassium	2.51	236	92.78	89.73	95.83
Virginia	Diss Potassium	2.55	237	93.07	90.07	96.08
Virginia	Diss Potassium	2.59	238	93.37	90.42	96.32
Virginia	Diss Potassium	2.62	239	93.49	90.55	96.43
Virginia	Diss Potassium	2.65	240	93.57	90.63	96.50
Virginia	Diss Potassium	2.66	242	93.98	91.10	96.87
Virginia	Diss Potassium	2.68	243	94.20	91.34	97.06
Virginia	Diss Potassium	2.83	244	95.45	93.17	97.73
Virginia	Diss Potassium	2.94	245	95.57	93.31	97.83
Virginia	Diss Potassium	2.96	246	95.87	93.66	98.07
Virginia	Diss Potassium	3.20	247	96.16	94.03	98.30
Virginia	Diss Potassium	3.21	248	96.29	94.16	98.41
Virginia	Diss Potassium	3.28	249	96.41	94.28	98.54
Virginia	Diss Potassium	3.32	250	96.53	94.41	98.65

Virginia	Diss Potassium	3.85	251	97.78	96.52	99.04
Virginia	Diss Potassium	3.96	252	97.90	96.66	99.14
Virginia	Diss Potassium	3.98	253	97.98	96.75	99.21
Virginia	Diss Potassium	4.16	254	98.27	97.16	99.38
Virginia	Diss Potassium	4.34	255	98.57	97.59	99.55
Virginia	Diss Potassium	4.43	256	98.78	97.87	99.70
Virginia	Diss Potassium	4.71	257	99.00	98.18	99.82
Virginia	Diss Potassium	5.41	258	99.12	98.32	99.92
Virginia	Diss Potassium	6.43	259	99.34	98.63	100.00
Virginia	Diss Potassium	7.44	260	99.41	98.71	100.00
Virginia	Diss Potassium	9.17	261	99.70	99.19	100.00
Virginia	Diss Potassium	9.78	262	100.00	100.00	100.00

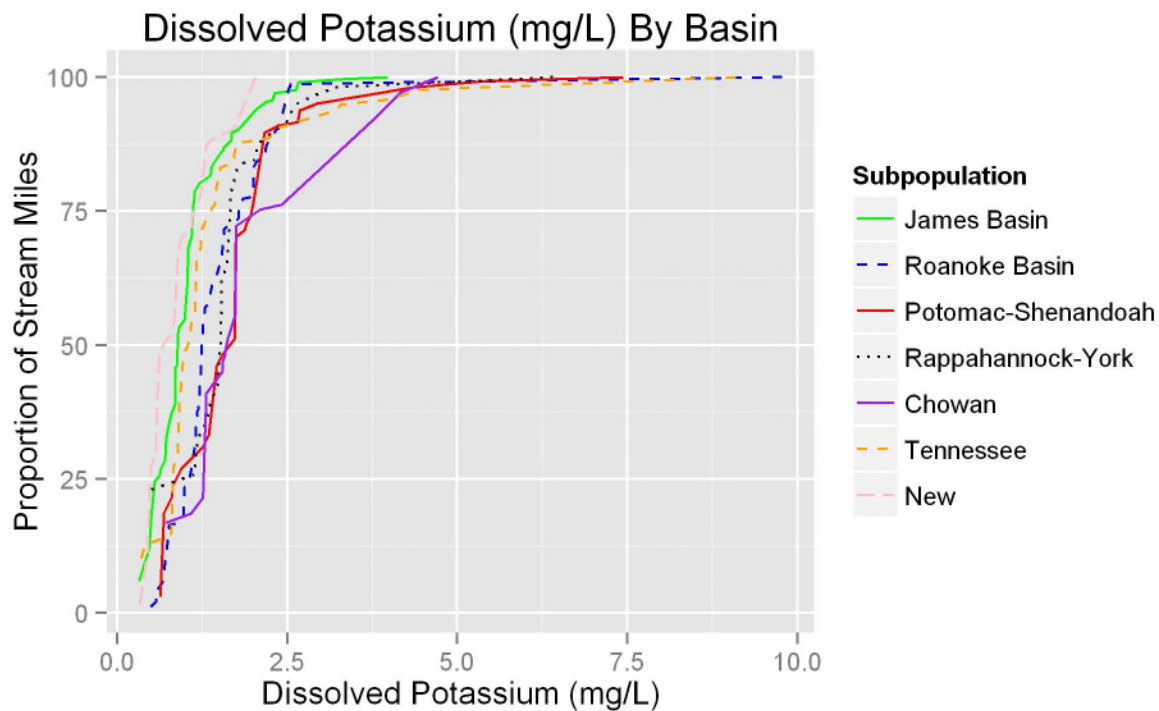


Figure 68. Dissolved Potassium by Major Basin CDF graph.

Figure 68 shows dissolved potassium by basin and Table 43 contains the corresponding percentiles and values. One hundred percent of stream miles in all of the basins are below 10 mg/L (the upper threshold for medium probability of stress to aquatic life, Table 42).

Table 43. Dissolved Potassium Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	Diss Potassium	0.32	1	6.02	0.00	15.75
James Basin	Diss Potassium	0.47	2	12.05	0.00	25.24
James Basin	Diss Potassium	0.50	3	18.07	3.29	32.86
James Basin	Diss Potassium	0.54	4	24.10	8.16	40.04
James Basin	Diss Potassium	0.55	5	24.68	8.98	40.39
James Basin	Diss Potassium	0.62	6	25.72	10.01	41.43
James Basin	Diss Potassium	0.63	7	26.31	10.76	41.85
James Basin	Diss Potassium	0.64	8	26.89	11.35	42.43
James Basin	Diss Potassium	0.69	9	28.32	12.89	43.75
James Basin	Diss Potassium	0.70	10	29.35	14.01	44.70
James Basin	Diss Potassium	0.71	12	31.81	16.44	47.19
James Basin	Diss Potassium	0.72	14	32.99	17.61	48.37
James Basin	Diss Potassium	0.76	16	35.45	20.10	50.80
James Basin	Diss Potassium	0.79	17	36.87	21.75	52.00
James Basin	Diss Potassium	0.80	18	37.46	22.35	52.57
James Basin	Diss Potassium	0.84	19	38.89	23.80	53.97
James Basin	Diss Potassium	0.85	21	45.94	30.28	61.61

James Basin	Diss Potassium	0.87	22	46.29	30.61	61.97
James Basin	Diss Potassium	0.89	23	52.32	36.82	67.82
James Basin	Diss Potassium	0.91	24	53.35	37.96	68.74
James Basin	Diss Potassium	0.99	25	54.78	39.56	69.99
James Basin	Diss Potassium	1.02	26	60.80	46.26	75.35
James Basin	Diss Potassium	1.04	28	68.25	56.17	80.33
James Basin	Diss Potassium	1.09	30	70.26	58.93	81.60
James Basin	Diss Potassium	1.12	31	76.29	66.82	85.75
James Basin	Diss Potassium	1.13	32	77.32	68.08	86.57
James Basin	Diss Potassium	1.14	33	78.75	69.97	87.52
James Basin	Diss Potassium	1.20	34	80.17	71.95	88.40
James Basin	Diss Potassium	1.36	35	81.60	73.63	89.56
James Basin	Diss Potassium	1.37	36	81.95	73.99	89.90
James Basin	Diss Potassium	1.38	37	82.98	75.16	90.80
James Basin	Diss Potassium	1.42	38	84.02	76.54	91.49
James Basin	Diss Potassium	1.49	39	85.44	78.49	92.40
James Basin	Diss Potassium	1.52	40	86.03	79.27	92.79
James Basin	Diss Potassium	1.55	41	86.20	79.41	92.98
James Basin	Diss Potassium	1.56	42	86.78	80.19	93.38
James Basin	Diss Potassium	1.67	43	88.21	82.40	94.02
James Basin	Diss Potassium	1.68	44	89.63	84.09	95.17
James Basin	Diss Potassium	1.78	45	90.22	84.65	95.79
James Basin	Diss Potassium	1.99	48	93.27	88.62	97.91
James Basin	Diss Potassium	2.03	49	93.85	89.41	98.30
James Basin	Diss Potassium	2.18	50	95.28	91.48	99.07
James Basin	Diss Potassium	2.28	51	95.63	91.95	99.30
James Basin	Diss Potassium	2.31	52	97.05	94.21	99.90
James Basin	Diss Potassium	2.62	53	97.64	95.02	100.00
James Basin	Diss Potassium	2.66	54	99.06	97.83	100.00
James Basin	Diss Potassium	3.32	55	99.65	99.02	100.00
James Basin	Diss Potassium	3.98	56	100.00	100.00	100.00
Roanoke Basin	Diss Potassium	0.49	1	1.27	0.00	3.49
Roanoke Basin	Diss Potassium	0.57	2	2.20	0.00	4.94
Roanoke Basin	Diss Potassium	0.58	3	3.12	0.25	5.99
Roanoke Basin	Diss Potassium	0.59	4	4.40	0.73	8.06
Roanoke Basin	Diss Potassium	0.66	5	5.67	1.38	9.96
Roanoke Basin	Diss Potassium	0.71	6	11.05	1.73	20.37
Roanoke Basin	Diss Potassium	0.76	7	16.43	4.17	28.70
Roanoke Basin	Diss Potassium	0.92	8	16.96	4.86	29.06
Roanoke Basin	Diss Potassium	0.98	9	18.23	5.96	30.49
Roanoke Basin	Diss Potassium	0.99	10	23.61	9.96	37.26
Roanoke Basin	Diss Potassium	1.05	11	24.14	10.58	37.69
Roanoke Basin	Diss Potassium	1.06	12	25.41	12.08	38.73
Roanoke Basin	Diss Potassium	1.07	13	25.93	12.74	39.13
Roanoke Basin	Diss Potassium	1.14	14	31.32	17.41	45.22
Roanoke Basin	Diss Potassium	1.16	15	36.70	22.41	50.98
Roanoke Basin	Diss Potassium	1.17	16	37.62	23.53	51.71
Roanoke Basin	Diss Potassium	1.19	17	38.15	24.18	52.11
Roanoke Basin	Diss Potassium	1.24	19	48.91	34.60	63.21
Roanoke Basin	Diss Potassium	1.26	20	54.29	39.92	68.66
Roanoke Basin	Diss Potassium	1.27	21	54.82	40.40	69.23
Roanoke Basin	Diss Potassium	1.28	22	56.09	41.75	70.43
Roanoke Basin	Diss Potassium	1.29	23	57.01	42.62	71.41

Roanoke Basin	Diss Potassium	1.32	24	57.54	43.18	71.89
Roanoke Basin	Diss Potassium	1.34	25	58.81	44.72	72.90
Roanoke Basin	Diss Potassium	1.37	26	60.08	46.20	73.97
Roanoke Basin	Diss Potassium	1.39	28	61.32	47.55	75.09
Roanoke Basin	Diss Potassium	1.43	29	61.84	48.16	75.53
Roanoke Basin	Diss Potassium	1.46	30	63.12	49.82	76.42
Roanoke Basin	Diss Potassium	1.47	31	63.43	50.12	76.73
Roanoke Basin	Diss Potassium	1.49	33	64.66	51.47	77.86
Roanoke Basin	Diss Potassium	1.52	34	65.94	52.80	79.08
Roanoke Basin	Diss Potassium	1.53	35	66.25	53.06	79.43
Roanoke Basin	Diss Potassium	1.57	36	71.63	58.96	84.30
Roanoke Basin	Diss Potassium	1.62	37	72.15	59.59	84.72
Roanoke Basin	Diss Potassium	1.66	38	72.68	60.14	85.22
Roanoke Basin	Diss Potassium	1.78	39	73.60	61.28	85.92
Roanoke Basin	Diss Potassium	1.79	41	75.45	63.38	87.52
Roanoke Basin	Diss Potassium	1.80	42	75.98	63.95	88.01
Roanoke Basin	Diss Potassium	1.84	43	77.25	65.29	89.21
Roanoke Basin	Diss Potassium	1.99	44	77.78	65.86	89.69
Roanoke Basin	Diss Potassium	2.00	45	83.16	73.18	93.13
Roanoke Basin	Diss Potassium	2.04	46	84.08	74.20	93.97
Roanoke Basin	Diss Potassium	2.08	47	84.61	74.79	94.42
Roanoke Basin	Diss Potassium	2.10	48	85.13	75.37	94.89
Roanoke Basin	Diss Potassium	2.17	49	86.06	76.54	95.57
Roanoke Basin	Diss Potassium	2.19	50	87.33	78.04	96.62
Roanoke Basin	Diss Potassium	2.25	51	88.60	79.58	97.63
Roanoke Basin	Diss Potassium	2.32	52	89.87	81.09	98.66
Roanoke Basin	Diss Potassium	2.36	53	90.80	82.19	99.41
Roanoke Basin	Diss Potassium	2.41	54	92.07	83.69	100.00
Roanoke Basin	Diss Potassium	2.51	55	97.45	94.24	100.00
Roanoke Basin	Diss Potassium	2.55	56	98.73	96.49	100.00
Roanoke Basin	Diss Potassium	9.78	57	100.00	100.00	100.00
Potomac-Shenandoah	Diss Potassium	0.63	1	3.00	0.00	8.00
Potomac-Shenandoah	Diss Potassium	0.68	3	18.69	0.00	38.52
Potomac-Shenandoah	Diss Potassium	0.80	4	21.69	1.82	41.55
Potomac-Shenandoah	Diss Potassium	0.82	5	23.87	4.45	43.28
Potomac-Shenandoah	Diss Potassium	0.94	6	26.87	7.89	45.85
Potomac-Shenandoah	Diss Potassium	1.26	8	31.10	11.16	51.05
Potomac-Shenandoah	Diss Potassium	1.34	9	33.28	13.65	52.92
Potomac-Shenandoah	Diss Potassium	1.46	10	45.97	26.11	65.83
Potomac-Shenandoah	Diss Potassium	1.54	11	48.15	28.15	68.14
Potomac-Shenandoah	Diss Potassium	1.72	12	51.15	31.75	70.55
Potomac-Shenandoah	Diss Potassium	1.74	15	69.01	50.52	87.51
Potomac-Shenandoah	Diss Potassium	1.75	16	70.25	51.73	88.77
Potomac-Shenandoah	Diss Potassium	1.87	17	71.49	52.59	90.38
Potomac-Shenandoah	Diss Potassium	1.90	18	72.72	54.16	91.28
Potomac-Shenandoah	Diss Potassium	1.96	19	73.96	55.38	92.54
Potomac-Shenandoah	Diss Potassium	2.00	20	76.96	58.39	95.53
Potomac-Shenandoah	Diss Potassium	2.16	21	89.64	81.09	98.20
Potomac-Shenandoah	Diss Potassium	2.36	22	90.88	82.85	98.91
Potomac-Shenandoah	Diss Potassium	2.65	23	91.61	83.88	99.34
Potomac-Shenandoah	Diss Potassium	2.68	24	93.79	87.17	100.00
Potomac-Shenandoah	Diss Potassium	2.94	25	95.03	89.04	100.00
Potomac-Shenandoah	Diss Potassium	4.34	26	98.03	95.73	100.00

Potomac-Shenandoah	Diss Potassium	5.41	27	99.27	97.93	100.00
Potomac-Shenandoah	Diss Potassium	7.44	28	100.00	100.00	100.00
Rappahannock-York	Diss Potassium	0.50	2	23.13	5.16	41.10
Rappahannock-York	Diss Potassium	1.13	4	25.79	7.70	43.88
Rappahannock-York	Diss Potassium	1.15	5	27.77	10.25	45.29
Rappahannock-York	Diss Potassium	1.16	6	30.51	12.77	48.25
Rappahannock-York	Diss Potassium	1.17	7	31.64	14.38	48.89
Rappahannock-York	Diss Potassium	1.21	8	33.62	16.39	50.85
Rappahannock-York	Diss Potassium	1.31	9	35.61	18.83	52.39
Rappahannock-York	Diss Potassium	1.34	10	37.60	20.68	54.51
Rappahannock-York	Diss Potassium	1.37	12	39.85	23.74	55.96
Rappahannock-York	Diss Potassium	1.43	13	40.98	24.60	57.36
Rappahannock-York	Diss Potassium	1.48	14	42.97	26.45	59.48
Rappahannock-York	Diss Potassium	1.49	15	45.70	29.17	62.23
Rappahannock-York	Diss Potassium	1.50	16	48.44	31.51	65.37
Rappahannock-York	Diss Potassium	1.52	17	50.43	34.47	66.38
Rappahannock-York	Diss Potassium	1.53	18	61.99	44.74	79.24
Rappahannock-York	Diss Potassium	1.60	19	64.73	47.75	81.71
Rappahannock-York	Diss Potassium	1.62	20	65.85	48.92	82.79
Rappahannock-York	Diss Potassium	1.63	21	66.98	49.80	84.16
Rappahannock-York	Diss Potassium	1.67	22	78.55	66.36	90.74
Rappahannock-York	Diss Potassium	1.71	23	80.53	68.68	92.38
Rappahannock-York	Diss Potassium	1.77	24	83.27	72.52	94.02
Rappahannock-York	Diss Potassium	1.85	25	83.94	73.38	94.49
Rappahannock-York	Diss Potassium	2.02	26	84.61	74.10	95.11
Rappahannock-York	Diss Potassium	2.07	27	87.34	77.36	97.33
Rappahannock-York	Diss Potassium	2.12	28	88.01	78.11	97.91
Rappahannock-York	Diss Potassium	2.16	29	88.68	78.92	98.44
Rappahannock-York	Diss Potassium	2.47	30	91.41	83.15	99.68
Rappahannock-York	Diss Potassium	2.59	31	94.15	87.72	100.00
Rappahannock-York	Diss Potassium	2.66	32	95.28	89.28	100.00
Rappahannock-York	Diss Potassium	3.20	33	98.01	94.44	100.00
Rappahannock-York	Diss Potassium	6.43	34	100.00	100.00	100.00
Chowan	Diss Potassium	0.71	1	16.91	0.00	38.64
Chowan	Diss Potassium	1.08	2	18.56	0.00	40.49
Chowan	Diss Potassium	1.25	3	21.46	0.00	43.96
Chowan	Diss Potassium	1.26	4	22.44	0.00	45.12
Chowan	Diss Potassium	1.31	6	41.00	11.86	70.14
Chowan	Diss Potassium	1.54	7	45.00	15.67	74.33
Chowan	Diss Potassium	1.55	9	47.12	18.28	75.95
Chowan	Diss Potassium	1.58	10	48.09	19.01	77.18
Chowan	Diss Potassium	1.60	11	49.74	20.72	78.76
Chowan	Diss Potassium	1.63	12	51.39	22.24	80.54
Chowan	Diss Potassium	1.73	13	55.39	26.01	84.78
Chowan	Diss Potassium	1.75	14	72.30	51.16	93.44
Chowan	Diss Potassium	2.10	15	75.21	54.32	96.09
Chowan	Diss Potassium	2.42	16	76.18	54.59	97.78
Chowan	Diss Potassium	3.85	17	93.09	83.92	100.00
Chowan	Diss Potassium	4.16	18	97.09	91.72	100.00
Chowan	Diss Potassium	4.71	19	100.00	100.00	100.00
Tennessee	Diss Potassium	0.35	1	10.24	0.00	23.77
Tennessee	Diss Potassium	0.41	2	12.67	0.00	26.61
Tennessee	Diss Potassium	0.78	3	14.43	0.25	28.60



Tennessee	Diss Potassium	0.80	4	15.43	1.19	29.66
Tennessee	Diss Potassium	0.82	5	25.67	6.29	45.05
Tennessee	Diss Potassium	0.83	6	27.43	8.15	46.71
Tennessee	Diss Potassium	0.89	7	29.19	10.09	48.28
Tennessee	Diss Potassium	0.91	8	39.43	19.18	59.69
Tennessee	Diss Potassium	0.93	9	41.86	21.87	61.85
Tennessee	Diss Potassium	0.96	12	46.38	27.28	65.47
Tennessee	Diss Potassium	0.98	13	48.14	29.37	66.90
Tennessee	Diss Potassium	1.03	14	49.90	31.44	68.36
Tennessee	Diss Potassium	1.06	15	50.89	32.82	68.97
Tennessee	Diss Potassium	1.09	17	54.41	36.97	71.85
Tennessee	Diss Potassium	1.14	18	55.41	38.40	72.43
Tennessee	Diss Potassium	1.16	19	65.66	50.57	80.75
Tennessee	Diss Potassium	1.22	20	68.08	54.22	81.94
Tennessee	Diss Potassium	1.23	21	69.08	55.40	82.76
Tennessee	Diss Potassium	1.24	22	71.50	58.45	84.55
Tennessee	Diss Potassium	1.30	23	73.26	61.02	85.51
Tennessee	Diss Potassium	1.40	24	75.69	64.29	87.08
Tennessee	Diss Potassium	1.43	25	76.28	65.15	87.41
Tennessee	Diss Potassium	1.45	26	77.28	66.08	88.47
Tennessee	Diss Potassium	1.46	27	79.70	69.15	90.25
Tennessee	Diss Potassium	1.49	28	82.12	71.97	92.27
Tennessee	Diss Potassium	1.51	29	83.12	73.40	92.84
Tennessee	Diss Potassium	1.70	30	84.12	74.80	93.44
Tennessee	Diss Potassium	1.72	31	85.88	77.13	94.63
Tennessee	Diss Potassium	1.76	32	87.64	79.65	95.63
Tennessee	Diss Potassium	2.24	33	88.64	80.63	96.65
Tennessee	Diss Potassium	2.32	34	90.40	83.34	97.45
Tennessee	Diss Potassium	2.96	35	92.82	87.21	98.43
Tennessee	Diss Potassium	3.21	36	93.82	88.53	99.10
Tennessee	Diss Potassium	3.28	37	94.82	89.58	100.00
Tennessee	Diss Potassium	3.96	38	95.82	90.93	100.00
Tennessee	Diss Potassium	4.43	39	97.58	93.74	100.00
Tennessee	Diss Potassium	9.17	40	100.00	100.00	100.00
New	Diss Potassium	0.33	1	1.63	0.00	4.39
New	Diss Potassium	0.44	2	11.15	0.00	25.36
New	Diss Potassium	0.47	3	20.66	2.09	39.24
New	Diss Potassium	0.50	6	27.42	8.44	46.39
New	Diss Potassium	0.56	7	29.67	11.21	48.12
New	Diss Potassium	0.58	8	39.18	19.91	58.45
New	Diss Potassium	0.62	9	48.70	27.74	69.65
New	Diss Potassium	0.68	10	50.33	29.46	71.20
New	Diss Potassium	0.80	11	51.97	31.18	72.75
New	Diss Potassium	0.82	12	53.60	32.73	74.48
New	Diss Potassium	0.84	13	55.85	34.52	77.19
New	Diss Potassium	0.88	14	65.37	45.32	85.42
New	Diss Potassium	0.89	15	67.00	47.09	86.91
New	Diss Potassium	0.92	16	69.25	49.49	89.02
New	Diss Potassium	0.96	17	70.18	50.32	90.04
New	Diss Potassium	1.09	18	71.81	52.12	91.50
New	Diss Potassium	1.10	19	74.06	54.70	93.43
New	Diss Potassium	1.12	20	74.61	55.12	94.11
New	Diss Potassium	1.13	21	75.54	55.97	95.11

New	Diss Potassium	1.22	22	77.79	58.29	97.30
New	Diss Potassium	1.31	23	87.31	71.98	100.00
New	Diss Potassium	1.39	24	88.23	72.77	100.00
New	Diss Potassium	1.71	25	90.49	75.26	100.00
New	Diss Potassium	2.03	26	100.00	100.00	100.00

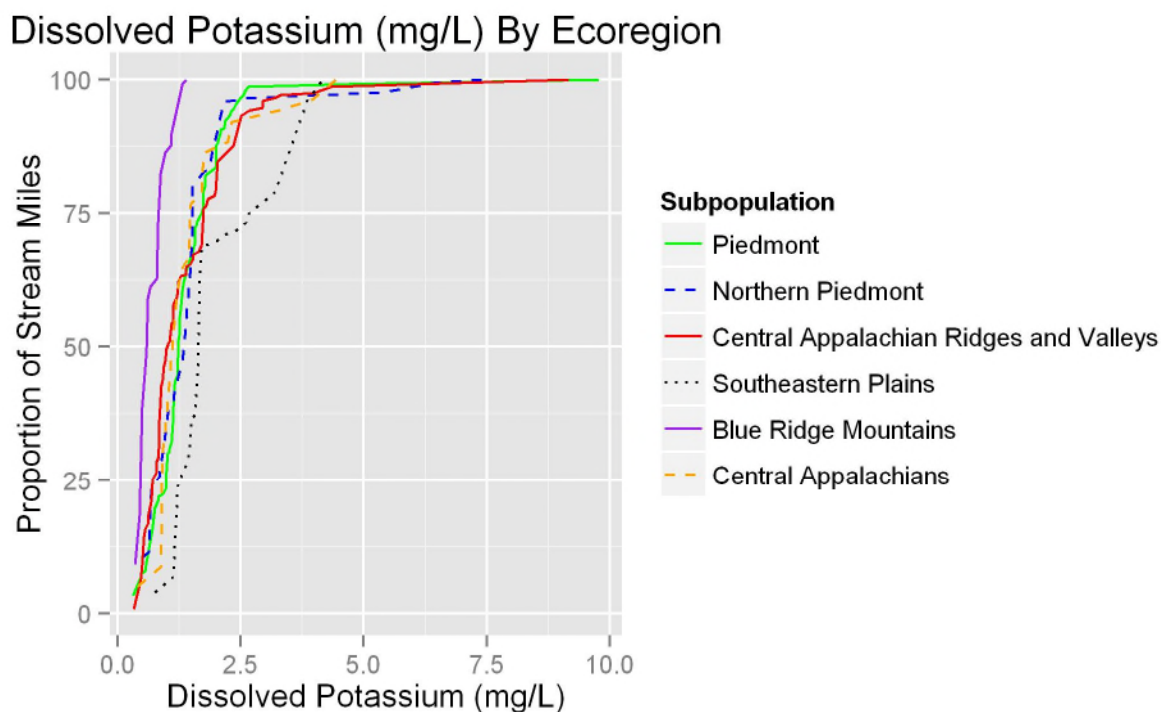


Figure 69. Dissolved Potassium by Major Ecoregion (Level III) CDF graph.

Figure 69 and Table 44 present dissolved potassium by ecoregion. The Blue Ridge Mountain ecoregion has the lowest overall concentrations of dissolved potassium. Eighty-seven percent of Piedmont stream miles and 85% of Northern Piedmont stream miles have dissolved potassium concentrations less than 2 mg/L. Similarly, 84% of Central Appalachian Ridges and Valley and 88% of Central Appalachian stream miles have dissolved potassium concentrations below 2.03 mg/L and 2.24 mg/L, respectively. Sixty-nine percent of Southeastern Plains stream miles show dissolved potassium concentrations less than 2.02 mg/L. One hundred percent of Blue Ridge Mountain stream miles had dissolved potassium concentrations less than 1.39 mg/L.

Table 44. Dissolved Potassium Population Estimates by Major Ecoregion.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Diss Potassium	0.32	1	3.38	0.00	8.93
Piedmont	Diss Potassium	0.47	2	6.75	0.00	13.86
Piedmont	Diss Potassium	0.49	3	7.55	0.33	14.78
Piedmont	Diss Potassium	0.55	4	7.88	0.69	15.07

Piedmont	Diss Potassium	0.57	5	8.46	1.21	15.71
Piedmont	Diss Potassium	0.58	6	9.04	1.79	16.29
Piedmont	Diss Potassium	0.71	8	15.80	6.10	25.49
Piedmont	Diss Potassium	0.76	10	19.75	9.35	30.16
Piedmont	Diss Potassium	0.79	11	20.55	10.31	30.80
Piedmont	Diss Potassium	0.82	12	21.13	10.86	31.41
Piedmont	Diss Potassium	0.84	13	21.93	11.62	32.25
Piedmont	Diss Potassium	0.87	14	22.13	11.84	32.41
Piedmont	Diss Potassium	0.92	15	22.46	12.23	32.68
Piedmont	Diss Potassium	0.98	16	23.26	12.97	33.54
Piedmont	Diss Potassium	0.99	17	26.63	15.82	37.45
Piedmont	Diss Potassium	1.02	18	30.01	18.51	41.51
Piedmont	Diss Potassium	1.05	19	30.34	18.90	41.78
Piedmont	Diss Potassium	1.06	20	31.14	19.78	42.49
Piedmont	Diss Potassium	1.07	21	31.47	20.18	42.75
Piedmont	Diss Potassium	1.08	22	31.80	20.50	43.09
Piedmont	Diss Potassium	1.09	23	32.12	20.89	43.36
Piedmont	Diss Potassium	1.12	24	35.50	24.11	46.89
Piedmont	Diss Potassium	1.14	25	38.88	27.43	50.33
Piedmont	Diss Potassium	1.16	27	43.06	31.69	54.42
Piedmont	Diss Potassium	1.17	28	43.64	32.41	54.86
Piedmont	Diss Potassium	1.19	29	43.96	32.81	55.12
Piedmont	Diss Potassium	1.21	30	44.54	33.42	55.67
Piedmont	Diss Potassium	1.24	32	51.30	40.36	62.24
Piedmont	Diss Potassium	1.25	33	51.88	40.98	62.78
Piedmont	Diss Potassium	1.26	35	55.45	44.62	66.29
Piedmont	Diss Potassium	1.27	36	55.78	44.85	66.71
Piedmont	Diss Potassium	1.28	37	56.58	45.69	67.47
Piedmont	Diss Potassium	1.31	39	60.29	49.44	71.13
Piedmont	Diss Potassium	1.32	40	60.61	49.80	71.43
Piedmont	Diss Potassium	1.34	42	61.99	51.37	72.62
Piedmont	Diss Potassium	1.37	44	62.99	52.50	73.47
Piedmont	Diss Potassium	1.38	45	63.57	53.10	74.03
Piedmont	Diss Potassium	1.39	46	64.15	53.77	74.52
Piedmont	Diss Potassium	1.42	47	64.73	54.46	75.00
Piedmont	Diss Potassium	1.43	48	65.06	54.84	75.28
Piedmont	Diss Potassium	1.46	49	65.86	55.86	75.85
Piedmont	Diss Potassium	1.49	51	66.63	56.71	76.55
Piedmont	Diss Potassium	1.52	52	67.43	57.54	77.32
Piedmont	Diss Potassium	1.54	53	68.23	58.34	78.12
Piedmont	Diss Potassium	1.55	55	68.65	58.82	78.48
Piedmont	Diss Potassium	1.56	56	68.98	59.19	78.77
Piedmont	Diss Potassium	1.57	57	72.36	62.85	81.87
Piedmont	Diss Potassium	1.60	58	72.69	63.20	82.17
Piedmont	Diss Potassium	1.62	60	73.35	63.96	82.73
Piedmont	Diss Potassium	1.63	61	73.68	64.31	83.04
Piedmont	Diss Potassium	1.67	62	74.47	65.30	83.65
Piedmont	Diss Potassium	1.71	63	75.05	65.91	84.20
Piedmont	Diss Potassium	1.73	64	75.85	66.68	85.02
Piedmont	Diss Potassium	1.75	65	79.23	71.48	86.98
Piedmont	Diss Potassium	1.77	66	80.03	72.42	87.64
Piedmont	Diss Potassium	1.78	68	80.94	73.45	88.43
Piedmont	Diss Potassium	1.79	70	82.10	74.74	89.46

Piedmont	Diss Potassium	1.99	73	83.56	76.35	90.76
Piedmont	Diss Potassium	2.00	75	87.73	82.59	92.87
Piedmont	Diss Potassium	2.03	76	88.06	82.99	93.13
Piedmont	Diss Potassium	2.04	77	88.64	83.64	93.64
Piedmont	Diss Potassium	2.07	78	89.44	84.52	94.36
Piedmont	Diss Potassium	2.08	79	89.77	84.90	94.64
Piedmont	Diss Potassium	2.10	81	90.68	85.98	95.38
Piedmont	Diss Potassium	2.16	82	90.87	86.19	95.56
Piedmont	Diss Potassium	2.17	83	91.45	86.96	95.95
Piedmont	Diss Potassium	2.19	84	92.25	87.99	96.52
Piedmont	Diss Potassium	2.25	85	93.05	89.05	97.05
Piedmont	Diss Potassium	2.28	86	93.25	89.28	97.21
Piedmont	Diss Potassium	2.31	87	94.05	90.32	97.77
Piedmont	Diss Potassium	2.36	88	94.63	91.07	98.18
Piedmont	Diss Potassium	2.41	89	95.43	92.15	98.70
Piedmont	Diss Potassium	2.47	90	96.22	93.24	99.21
Piedmont	Diss Potassium	2.55	91	97.02	94.43	99.62
Piedmont	Diss Potassium	2.59	92	97.82	95.65	99.99
Piedmont	Diss Potassium	2.66	93	98.62	96.87	100.00
Piedmont	Diss Potassium	4.71	94	99.20	97.81	100.00
Piedmont	Diss Potassium	9.78	95	100.00	100.00	100.00
Northern Piedmont	Diss Potassium	0.50	1	10.53	0.00	25.05
Northern Piedmont	Diss Potassium	0.64	2	11.56	0.00	26.14
Northern Piedmont	Diss Potassium	0.68	3	22.09	3.94	40.24
Northern Piedmont	Diss Potassium	0.70	4	23.90	5.73	42.08
Northern Piedmont	Diss Potassium	0.85	5	25.71	7.69	43.74
Northern Piedmont	Diss Potassium	1.04	7	38.74	18.93	58.54
Northern Piedmont	Diss Potassium	1.13	8	39.35	19.50	59.19
Northern Piedmont	Diss Potassium	1.15	9	41.16	21.24	61.07
Northern Piedmont	Diss Potassium	1.17	10	42.18	22.24	62.12
Northern Piedmont	Diss Potassium	1.26	12	45.70	25.14	66.26
Northern Piedmont	Diss Potassium	1.31	13	47.51	27.05	67.97
Northern Piedmont	Diss Potassium	1.36	14	50.00	29.55	70.46
Northern Piedmont	Diss Potassium	1.37	16	52.06	31.62	72.49
Northern Piedmont	Diss Potassium	1.46	17	62.59	43.09	82.08
Northern Piedmont	Diss Potassium	1.48	18	64.40	45.41	83.39
Northern Piedmont	Diss Potassium	1.49	19	66.89	48.21	85.57
Northern Piedmont	Diss Potassium	1.52	21	69.73	51.41	88.05
Northern Piedmont	Diss Potassium	1.53	22	80.26	65.31	95.21
Northern Piedmont	Diss Potassium	1.74	23	82.75	67.24	98.27
Northern Piedmont	Diss Potassium	1.85	24	83.36	67.89	98.83
Northern Piedmont	Diss Potassium	1.87	25	84.39	68.37	100.00
Northern Piedmont	Diss Potassium	1.90	26	85.41	69.34	100.00
Northern Piedmont	Diss Potassium	2.16	27	95.95	91.94	99.95
Northern Piedmont	Diss Potassium	2.65	28	96.55	92.69	100.00
Northern Piedmont	Diss Potassium	5.41	29	97.58	94.09	100.00
Northern Piedmont	Diss Potassium	6.43	30	99.39	98.33	100.00
Northern Piedmont	Diss Potassium	7.44	31	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Diss Potassium	0.33	1	0.94	0.00	2.50
Central Appalachian Ridges and Valleys	Diss Potassium	0.47	2	6.40	0.00	15.09
Central Appalachian Ridges and Valleys	Diss Potassium	0.50	4	8.99	0.35	17.63
Central Appalachian Ridges and Valleys	Diss Potassium	0.54	5	14.45	3.72	25.18
Central Appalachian Ridges and Valleys	Diss Potassium	0.56	6	15.74	5.25	26.23

Central Appalachian Ridges and Valleys	Diss Potassium	0.62	7	16.68	6.12	27.24
Central Appalachian Ridges and Valleys	Diss Potassium	0.63	9	18.51	8.05	28.96
Central Appalachian Ridges and Valleys	Diss Potassium	0.68	11	20.74	10.17	31.31
Central Appalachian Ridges and Valleys	Diss Potassium	0.69	12	22.03	11.36	32.70
Central Appalachian Ridges and Valleys	Diss Potassium	0.71	14	24.26	13.41	35.12
Central Appalachian Ridges and Valleys	Diss Potassium	0.72	16	25.33	14.39	36.26
Central Appalachian Ridges and Valleys	Diss Potassium	0.78	17	26.27	15.28	37.25
Central Appalachian Ridges and Valleys	Diss Potassium	0.80	20	28.62	17.50	39.75
Central Appalachian Ridges and Valleys	Diss Potassium	0.83	21	29.56	18.47	40.66
Central Appalachian Ridges and Valleys	Diss Potassium	0.84	22	30.85	19.51	42.20
Central Appalachian Ridges and Valleys	Diss Potassium	0.85	23	36.32	23.42	49.21
Central Appalachian Ridges and Valleys	Diss Potassium	0.89	25	42.72	29.48	55.96
Central Appalachian Ridges and Valleys	Diss Potassium	0.91	26	43.66	30.50	56.82
Central Appalachian Ridges and Valleys	Diss Potassium	0.93	27	44.95	31.69	58.21
Central Appalachian Ridges and Valleys	Diss Potassium	0.94	28	46.24	33.14	59.35
Central Appalachian Ridges and Valleys	Diss Potassium	0.96	30	47.31	34.19	60.43
Central Appalachian Ridges and Valleys	Diss Potassium	0.98	31	48.25	35.28	61.21
Central Appalachian Ridges and Valleys	Diss Potassium	0.99	32	49.54	36.65	62.44
Central Appalachian Ridges and Valleys	Diss Potassium	1.03	33	50.48	37.58	63.38
Central Appalachian Ridges and Valleys	Diss Potassium	1.06	34	51.01	38.09	63.93
Central Appalachian Ridges and Valleys	Diss Potassium	1.09	37	54.18	41.63	66.74
Central Appalachian Ridges and Valleys	Diss Potassium	1.12	38	54.50	41.85	67.15
Central Appalachian Ridges and Valleys	Diss Potassium	1.13	40	55.97	43.22	68.72
Central Appalachian Ridges and Valleys	Diss Potassium	1.14	42	57.79	45.16	70.43
Central Appalachian Ridges and Valleys	Diss Potassium	1.20	43	59.09	46.65	71.53
Central Appalachian Ridges and Valleys	Diss Potassium	1.22	44	60.38	48.05	72.71
Central Appalachian Ridges and Valleys	Diss Potassium	1.23	45	60.91	48.57	73.25
Central Appalachian Ridges and Valleys	Diss Potassium	1.24	46	62.20	49.84	74.57
Central Appalachian Ridges and Valleys	Diss Potassium	1.29	47	63.14	50.63	75.65
Central Appalachian Ridges and Valleys	Diss Potassium	1.39	48	63.46	50.90	76.02
Central Appalachian Ridges and Valleys	Diss Potassium	1.40	49	64.75	52.21	77.29
Central Appalachian Ridges and Valleys	Diss Potassium	1.43	50	65.07	52.51	77.62
Central Appalachian Ridges and Valleys	Diss Potassium	1.47	51	65.38	52.81	77.96
Central Appalachian Ridges and Valleys	Diss Potassium	1.51	52	65.91	53.34	78.49
Central Appalachian Ridges and Valleys	Diss Potassium	1.53	53	66.23	53.63	78.83
Central Appalachian Ridges and Valleys	Diss Potassium	1.54	54	67.17	54.49	79.85
Central Appalachian Ridges and Valleys	Diss Potassium	1.66	55	67.70	54.97	80.43
Central Appalachian Ridges and Valleys	Diss Potassium	1.71	56	68.99	56.12	81.87
Central Appalachian Ridges and Valleys	Diss Potassium	1.74	58	75.40	63.37	87.42
Central Appalachian Ridges and Valleys	Diss Potassium	1.75	59	75.93	63.87	87.99
Central Appalachian Ridges and Valleys	Diss Potassium	1.80	60	76.46	64.37	88.56
Central Appalachian Ridges and Valleys	Diss Potassium	1.84	61	77.75	65.76	89.74
Central Appalachian Ridges and Valleys	Diss Potassium	1.96	62	78.29	66.28	90.30
Central Appalachian Ridges and Valleys	Diss Potassium	1.99	63	79.23	67.27	91.18
Central Appalachian Ridges and Valleys	Diss Potassium	2.03	64	84.69	75.41	93.97
Central Appalachian Ridges and Valleys	Diss Potassium	2.18	65	85.98	76.73	95.23
Central Appalachian Ridges and Valleys	Diss Potassium	2.32	66	87.27	78.20	96.35
Central Appalachian Ridges and Valleys	Diss Potassium	2.36	67	87.81	78.76	96.85
Central Appalachian Ridges and Valleys	Diss Potassium	2.51	68	93.27	88.73	97.81
Central Appalachian Ridges and Valleys	Diss Potassium	2.68	69	94.21	89.95	98.47
Central Appalachian Ridges and Valleys	Diss Potassium	2.94	70	94.74	90.63	98.85
Central Appalachian Ridges and Valleys	Diss Potassium	2.96	71	96.03	92.57	99.50
Central Appalachian Ridges and Valleys	Diss Potassium	3.21	72	96.57	93.26	99.88

Central Appalachian Ridges and Valleys	Diss Potassium	3.32	73	97.10	93.95	100.00
Central Appalachian Ridges and Valleys	Diss Potassium	3.98	74	97.42	94.34	100.00
Central Appalachian Ridges and Valleys	Diss Potassium	4.34	75	98.71	96.68	100.00
Central Appalachian Ridges and Valleys	Diss Potassium	9.17	76	100.00	100.00	100.00
Southeastern Plains	Diss Potassium	0.76	1	4.02	0.00	11.01
Southeastern Plains	Diss Potassium	1.13	2	6.94	0.00	14.79
Southeastern Plains	Diss Potassium	1.22	3	23.93	0.00	48.21
Southeastern Plains	Diss Potassium	1.34	4	26.85	2.96	50.75
Southeastern Plains	Diss Potassium	1.43	5	28.51	4.61	52.41
Southeastern Plains	Diss Potassium	1.49	6	32.53	9.17	55.89
Southeastern Plains	Diss Potassium	1.50	7	36.55	12.49	60.61
Southeastern Plains	Diss Potassium	1.55	8	37.02	12.85	61.19
Southeastern Plains	Diss Potassium	1.58	9	38.00	13.56	62.44
Southeastern Plains	Diss Potassium	1.60	10	42.02	17.07	66.97
Southeastern Plains	Diss Potassium	1.63	11	43.68	18.32	69.03
Southeastern Plains	Diss Potassium	1.67	12	60.67	36.08	85.26
Southeastern Plains	Diss Potassium	1.68	13	64.69	40.66	88.71
Southeastern Plains	Diss Potassium	1.72	14	68.71	45.74	91.68
Southeastern Plains	Diss Potassium	2.02	15	69.69	46.70	92.68
Southeastern Plains	Diss Potassium	2.12	16	70.67	47.69	93.65
Southeastern Plains	Diss Potassium	2.42	17	71.65	48.14	95.17
Southeastern Plains	Diss Potassium	2.62	18	73.31	49.87	96.76
Southeastern Plains	Diss Potassium	2.66	19	74.97	51.74	98.19
Southeastern Plains	Diss Potassium	3.20	20	78.99	56.77	100.00
Southeastern Plains	Diss Potassium	3.85	21	95.98	89.15	100.00
Southeastern Plains	Diss Potassium	4.16	22	100.00	100.00	100.00
Blue Ridge Mountains	Diss Potassium	0.35	1	9.12	0.00	23.29
Blue Ridge Mountains	Diss Potassium	0.44	2	18.24	0.00	38.91
Blue Ridge Mountains	Diss Potassium	0.50	5	38.63	17.08	60.18
Blue Ridge Mountains	Diss Potassium	0.58	6	47.75	25.53	69.96
Blue Ridge Mountains	Diss Potassium	0.59	7	49.90	27.60	72.20
Blue Ridge Mountains	Diss Potassium	0.62	8	59.02	36.85	81.19
Blue Ridge Mountains	Diss Potassium	0.66	9	61.18	39.99	82.37
Blue Ridge Mountains	Diss Potassium	0.80	10	62.74	41.55	83.94
Blue Ridge Mountains	Diss Potassium	0.82	12	73.43	55.13	91.73
Blue Ridge Mountains	Diss Potassium	0.88	13	82.55	67.48	97.61
Blue Ridge Mountains	Diss Potassium	0.92	14	84.70	70.07	99.33
Blue Ridge Mountains	Diss Potassium	0.96	15	86.27	72.22	100.00
Blue Ridge Mountains	Diss Potassium	1.09	16	87.84	74.09	100.00
Blue Ridge Mountains	Diss Potassium	1.10	17	89.99	76.20	100.00
Blue Ridge Mountains	Diss Potassium	1.31	18	99.11	97.49	100.00
Blue Ridge Mountains	Diss Potassium	1.39	19	100.00	100.00	100.00
Central Appalachians	Diss Potassium	0.41	1	5.10	0.00	13.68
Central Appalachians	Diss Potassium	0.89	2	8.81	0.00	17.98
Central Appalachians	Diss Potassium	0.91	3	30.38	1.11	59.64
Central Appalachians	Diss Potassium	0.96	4	34.08	5.89	62.27
Central Appalachians	Diss Potassium	1.16	5	55.65	28.06	83.25
Central Appalachians	Diss Potassium	1.22	6	60.75	36.70	84.81
Central Appalachians	Diss Potassium	1.30	7	64.46	43.49	85.43
Central Appalachians	Diss Potassium	1.45	8	66.56	45.78	87.35
Central Appalachians	Diss Potassium	1.46	9	71.66	53.13	90.20
Central Appalachians	Diss Potassium	1.49	10	76.77	59.68	93.85
Central Appalachians	Diss Potassium	1.70	11	78.87	63.27	94.47

Central Appalachians	Diss Potassium	1.72	12	82.58	68.92	96.23
Central Appalachians	Diss Potassium	1.76	13	86.28	75.08	97.48
Central Appalachians	Diss Potassium	2.24	14	88.38	77.23	99.53
Central Appalachians	Diss Potassium	2.32	15	92.09	84.32	99.86
Central Appalachians	Diss Potassium	3.28	16	94.19	86.70	100.00
Central Appalachians	Diss Potassium	3.96	17	96.29	89.84	100.00
Central Appalachians	Diss Potassium	4.43	18	100.00	100.00	100.00

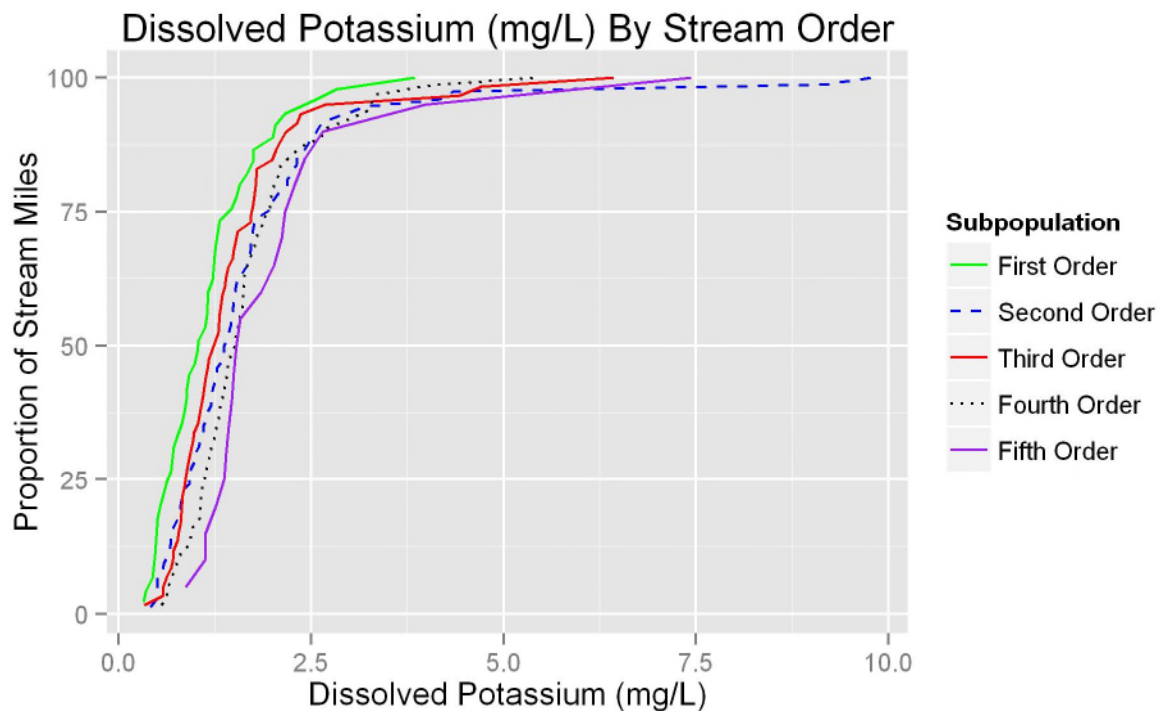


Figure 70. Dissolved Potassium by Stream Order CDF graph.

Dissolved potassium by stream order CDFs are shown in Figure 70. Table 45 contains the values and percentile estimates that correspond to Figure 70. Eighty-eight percent of first order stream miles have 2 mg/L or less dissolved potassium. Similarly, the 86<sup>th</sup> percentile of third order streams is 2.04 mg/L. Seventy-seven percent of second order stream miles and 80% of fourth order stream miles are less than 2 mg/L dissolved potassium. Sixty-five percent of fifth order stream miles have dissolved potassium concentrations less than 2.02 mg/L.

Table 45. Dissolved Potassium Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Diss Potassium	0.32	1	2.22	0.00	6.04
First Order	Diss Potassium	0.35	2	4.44	0.00	9.80



First Order	Diss Potassium	0.44	3	6.67	0.18	13.16
First Order	Diss Potassium	0.47	5	11.11	3.11	19.11
First Order	Diss Potassium	0.50	8	17.78	8.00	27.55
First Order	Diss Potassium	0.54	9	20.00	9.71	30.29
First Order	Diss Potassium	0.58	10	22.22	11.85	32.60
First Order	Diss Potassium	0.62	11	24.44	13.67	35.22
First Order	Diss Potassium	0.68	12	26.67	15.41	37.93
First Order	Diss Potassium	0.71	14	31.11	18.75	43.47
First Order	Diss Potassium	0.76	15	33.33	20.51	46.15
First Order	Diss Potassium	0.82	16	35.56	22.81	48.30
First Order	Diss Potassium	0.85	17	37.78	25.09	50.46
First Order	Diss Potassium	0.88	18	40.00	27.36	52.64
First Order	Diss Potassium	0.89	19	42.22	30.05	54.40
First Order	Diss Potassium	0.91	20	44.44	32.30	56.59
First Order	Diss Potassium	0.99	21	46.67	34.14	59.19
First Order	Diss Potassium	1.02	22	48.89	36.48	61.30
First Order	Diss Potassium	1.04	23	51.11	39.14	63.09
First Order	Diss Potassium	1.12	24	53.33	41.85	64.82
First Order	Diss Potassium	1.14	25	55.56	44.15	66.96
First Order	Diss Potassium	1.16	27	60.00	49.47	70.53
First Order	Diss Potassium	1.22	28	62.22	51.41	73.04
First Order	Diss Potassium	1.24	30	66.67	56.13	77.20
First Order	Diss Potassium	1.26	31	68.89	58.45	79.33
First Order	Diss Potassium	1.31	33	73.33	63.15	83.52
First Order	Diss Potassium	1.46	34	75.56	65.26	85.85
First Order	Diss Potassium	1.53	35	77.78	67.67	87.89
First Order	Diss Potassium	1.57	36	80.00	70.17	89.83
First Order	Diss Potassium	1.67	37	82.22	72.66	91.79
First Order	Diss Potassium	1.74	38	84.44	75.48	93.41
First Order	Diss Potassium	1.75	39	86.67	77.92	95.41
First Order	Diss Potassium	2.00	40	88.89	80.88	96.89
First Order	Diss Potassium	2.03	41	91.11	84.10	98.13
First Order	Diss Potassium	2.16	42	93.33	87.34	99.32
First Order	Diss Potassium	2.51	43	95.56	90.85	100.00
First Order	Diss Potassium	2.83	44	97.78	94.01	100.00
First Order	Diss Potassium	3.85	45	100.00	100.00	100.00
Second Order	Diss Potassium	0.41	1	1.35	0.00	3.53
Second Order	Diss Potassium	0.49	2	2.70	0.00	5.92
Second Order	Diss Potassium	0.50	5	6.76	1.84	11.67
Second Order	Diss Potassium	0.56	6	8.11	2.99	13.22
Second Order	Diss Potassium	0.59	7	9.46	3.97	14.95
Second Order	Diss Potassium	0.63	8	10.81	4.89	16.73
Second Order	Diss Potassium	0.66	9	12.16	5.80	18.53
Second Order	Diss Potassium	0.68	10	13.51	6.78	20.24
Second Order	Diss Potassium	0.69	11	14.86	7.93	21.80
Second Order	Diss Potassium	0.71	12	16.22	8.93	23.50
Second Order	Diss Potassium	0.76	13	17.57	9.92	25.21
Second Order	Diss Potassium	0.79	14	18.92	10.98	26.86
Second Order	Diss Potassium	0.80	15	20.27	12.23	28.31
Second Order	Diss Potassium	0.84	17	22.97	14.61	31.33
Second Order	Diss Potassium	0.92	18	24.32	16.06	32.59
Second Order	Diss Potassium	0.93	19	25.68	17.35	34.00
Second Order	Diss Potassium	0.94	20	27.03	18.85	35.20



Second Order	Diss Potassium	0.98	21	28.38	19.99	36.77
Second Order	Diss Potassium	0.99	22	29.73	21.15	38.31
Second Order	Diss Potassium	1.04	23	31.08	22.46	39.70
Second Order	Diss Potassium	1.06	24	32.43	23.61	41.25
Second Order	Diss Potassium	1.09	25	33.78	24.98	42.59
Second Order	Diss Potassium	1.10	26	35.14	26.52	43.75
Second Order	Diss Potassium	1.14	27	36.49	27.98	44.99
Second Order	Diss Potassium	1.16	28	37.84	29.03	46.65
Second Order	Diss Potassium	1.20	29	39.19	30.61	47.76
Second Order	Diss Potassium	1.22	31	41.89	33.29	50.50
Second Order	Diss Potassium	1.24	32	43.24	34.52	51.96
Second Order	Diss Potassium	1.26	33	44.59	35.76	53.43
Second Order	Diss Potassium	1.28	34	45.95	37.06	54.83
Second Order	Diss Potassium	1.34	35	47.30	38.27	56.32
Second Order	Diss Potassium	1.36	36	48.65	39.66	57.63
Second Order	Diss Potassium	1.37	37	50.00	40.98	59.02
Second Order	Diss Potassium	1.40	38	51.35	42.39	60.31
Second Order	Diss Potassium	1.46	40	54.05	45.32	62.78
Second Order	Diss Potassium	1.49	43	58.11	49.63	66.59
Second Order	Diss Potassium	1.50	44	59.46	50.75	68.17
Second Order	Diss Potassium	1.52	45	60.81	52.00	69.62
Second Order	Diss Potassium	1.54	46	62.16	53.15	71.17
Second Order	Diss Potassium	1.60	47	63.51	54.35	72.68
Second Order	Diss Potassium	1.67	48	64.86	55.91	73.82
Second Order	Diss Potassium	1.68	49	66.22	57.19	75.24
Second Order	Diss Potassium	1.71	50	67.57	58.63	76.51
Second Order	Diss Potassium	1.72	51	68.92	60.04	77.80
Second Order	Diss Potassium	1.73	52	70.27	61.37	79.17
Second Order	Diss Potassium	1.74	53	71.62	62.84	80.40
Second Order	Diss Potassium	1.77	54	72.97	64.21	81.73
Second Order	Diss Potassium	1.84	55	74.32	65.85	82.79
Second Order	Diss Potassium	1.99	56	75.68	67.12	84.23
Second Order	Diss Potassium	2.00	57	77.03	68.70	85.35
Second Order	Diss Potassium	2.07	58	78.38	70.07	86.69
Second Order	Diss Potassium	2.18	59	79.73	71.54	87.92
Second Order	Diss Potassium	2.19	60	81.08	72.91	89.25
Second Order	Diss Potassium	2.25	61	82.43	74.50	90.36
Second Order	Diss Potassium	2.31	62	83.78	76.10	91.46
Second Order	Diss Potassium	2.32	63	85.14	77.80	92.48
Second Order	Diss Potassium	2.41	64	86.49	79.48	93.49
Second Order	Diss Potassium	2.47	65	87.84	81.16	94.51
Second Order	Diss Potassium	2.55	66	89.19	82.83	95.55
Second Order	Diss Potassium	2.59	67	90.54	84.61	96.47
Second Order	Diss Potassium	2.66	68	91.89	86.35	97.43
Second Order	Diss Potassium	2.96	69	93.24	88.16	98.33
Second Order	Diss Potassium	3.20	70	94.59	90.07	99.12
Second Order	Diss Potassium	4.16	71	95.95	91.98	99.92
Second Order	Diss Potassium	4.34	72	97.30	94.15	100.00
Second Order	Diss Potassium	9.17	73	98.65	96.42	100.00
Second Order	Diss Potassium	9.78	74	100.00	100.00	100.00
Third Order	Diss Potassium	0.33	1	1.69	0.00	4.47
Third Order	Diss Potassium	0.57	2	3.39	0.00	7.40
Third Order	Diss Potassium	0.58	3	5.08	0.66	9.51

Third Order	Diss Potassium	0.62	4	6.78	1.56	11.99
Third Order	Diss Potassium	0.68	5	8.47	2.98	13.97
Third Order	Diss Potassium	0.70	6	10.17	4.05	16.29
Third Order	Diss Potassium	0.71	7	11.86	5.51	18.22
Third Order	Diss Potassium	0.76	8	13.56	6.60	20.52
Third Order	Diss Potassium	0.78	9	15.25	7.69	22.81
Third Order	Diss Potassium	0.80	10	16.95	9.05	24.85
Third Order	Diss Potassium	0.82	12	20.34	12.06	28.62
Third Order	Diss Potassium	0.83	13	22.03	13.55	30.52
Third Order	Diss Potassium	0.85	14	23.73	15.20	32.25
Third Order	Diss Potassium	0.89	16	27.12	17.87	36.37
Third Order	Diss Potassium	0.91	17	28.81	19.74	37.89
Third Order	Diss Potassium	0.96	19	32.20	22.93	41.47
Third Order	Diss Potassium	0.98	20	33.90	24.93	42.86
Third Order	Diss Potassium	1.03	21	35.59	26.64	44.55
Third Order	Diss Potassium	1.09	24	40.68	32.67	48.69
Third Order	Diss Potassium	1.13	26	44.07	35.40	52.73
Third Order	Diss Potassium	1.15	27	45.76	36.68	54.85
Third Order	Diss Potassium	1.17	28	47.46	38.26	56.66
Third Order	Diss Potassium	1.21	29	49.15	39.74	58.57
Third Order	Diss Potassium	1.25	30	50.85	41.16	60.54
Third Order	Diss Potassium	1.29	31	52.54	43.19	61.90
Third Order	Diss Potassium	1.30	32	54.24	45.16	63.32
Third Order	Diss Potassium	1.31	33	55.93	46.85	65.02
Third Order	Diss Potassium	1.34	35	59.32	50.43	68.22
Third Order	Diss Potassium	1.38	36	61.02	52.16	69.87
Third Order	Diss Potassium	1.39	37	62.71	53.81	71.61
Third Order	Diss Potassium	1.42	38	64.41	55.73	73.08
Third Order	Diss Potassium	1.48	39	66.10	57.60	74.61
Third Order	Diss Potassium	1.49	40	67.80	59.31	76.29
Third Order	Diss Potassium	1.52	41	69.49	60.87	78.11
Third Order	Diss Potassium	1.54	42	71.19	62.67	79.71
Third Order	Diss Potassium	1.71	43	72.88	64.83	80.93
Third Order	Diss Potassium	1.72	44	74.58	66.13	83.02
Third Order	Diss Potassium	1.74	45	76.27	67.84	84.71
Third Order	Diss Potassium	1.76	46	77.97	69.62	86.31
Third Order	Diss Potassium	1.78	47	79.66	71.03	88.30
Third Order	Diss Potassium	1.79	49	83.05	74.83	91.27
Third Order	Diss Potassium	1.99	50	84.75	77.06	92.43
Third Order	Diss Potassium	2.04	51	86.44	79.09	93.80
Third Order	Diss Potassium	2.10	52	88.14	80.83	95.44
Third Order	Diss Potassium	2.17	53	89.83	83.08	96.58
Third Order	Diss Potassium	2.32	54	91.53	85.11	97.94
Third Order	Diss Potassium	2.36	55	93.22	87.54	98.90
Third Order	Diss Potassium	2.68	56	94.92	89.91	99.92
Third Order	Diss Potassium	4.43	57	96.61	92.54	100.00
Third Order	Diss Potassium	4.71	58	98.31	95.26	100.00
Third Order	Diss Potassium	6.43	59	100.00	100.00	100.00
Fourth Order	Diss Potassium	0.55	1	1.61	0.00	4.22
Fourth Order	Diss Potassium	0.63	2	3.23	0.00	6.91
Fourth Order	Diss Potassium	0.64	3	4.84	0.65	9.03
Fourth Order	Diss Potassium	0.72	5	8.06	3.17	12.95
Fourth Order	Diss Potassium	0.80	7	11.29	6.24	16.34

Fourth Order	Diss Potassium	0.92	8	12.90	7.19	18.61
Fourth Order	Diss Potassium	0.96	10	16.13	9.33	22.93
Fourth Order	Diss Potassium	1.05	11	17.74	10.81	24.67
Fourth Order	Diss Potassium	1.06	12	19.35	12.12	26.59
Fourth Order	Diss Potassium	1.07	13	20.97	14.03	27.91
Fourth Order	Diss Potassium	1.08	14	22.58	15.09	30.07
Fourth Order	Diss Potassium	1.09	15	24.19	16.47	31.92
Fourth Order	Diss Potassium	1.13	16	25.81	17.99	33.62
Fourth Order	Diss Potassium	1.14	17	27.42	19.64	35.20
Fourth Order	Diss Potassium	1.17	18	29.03	20.85	37.21
Fourth Order	Diss Potassium	1.19	19	30.65	22.04	39.26
Fourth Order	Diss Potassium	1.23	20	32.26	23.74	40.78
Fourth Order	Diss Potassium	1.26	21	33.87	24.89	42.85
Fourth Order	Diss Potassium	1.27	22	35.48	26.23	44.74
Fourth Order	Diss Potassium	1.31	23	37.10	27.56	46.63
Fourth Order	Diss Potassium	1.32	24	38.71	28.98	48.44
Fourth Order	Diss Potassium	1.37	26	41.94	32.04	51.83
Fourth Order	Diss Potassium	1.39	27	43.55	34.00	53.10
Fourth Order	Diss Potassium	1.43	29	46.77	36.92	56.63
Fourth Order	Diss Potassium	1.45	30	48.39	38.27	58.50
Fourth Order	Diss Potassium	1.51	31	50.00	40.25	59.75
Fourth Order	Diss Potassium	1.52	32	51.61	41.84	61.39
Fourth Order	Diss Potassium	1.55	33	53.23	43.35	63.11
Fourth Order	Diss Potassium	1.56	34	54.84	45.07	64.61
Fourth Order	Diss Potassium	1.60	35	56.45	46.84	66.07
Fourth Order	Diss Potassium	1.62	37	59.68	50.22	69.14
Fourth Order	Diss Potassium	1.63	39	62.90	53.70	72.11
Fourth Order	Diss Potassium	1.66	40	64.52	55.24	73.79
Fourth Order	Diss Potassium	1.70	41	66.13	57.12	75.13
Fourth Order	Diss Potassium	1.75	42	67.74	58.87	76.61
Fourth Order	Diss Potassium	1.78	43	69.35	60.37	78.34
Fourth Order	Diss Potassium	1.80	44	70.97	62.17	79.77
Fourth Order	Diss Potassium	1.87	45	72.58	63.63	81.53
Fourth Order	Diss Potassium	1.90	46	74.19	65.28	83.11
Fourth Order	Diss Potassium	1.96	47	75.81	67.27	84.35
Fourth Order	Diss Potassium	1.99	49	79.03	71.12	86.95
Fourth Order	Diss Potassium	2.03	50	80.65	73.24	88.05
Fourth Order	Diss Potassium	2.08	51	82.26	74.97	89.55
Fourth Order	Diss Potassium	2.10	52	83.87	77.10	90.64
Fourth Order	Diss Potassium	2.24	53	85.48	78.52	92.45
Fourth Order	Diss Potassium	2.36	54	87.10	80.22	93.98
Fourth Order	Diss Potassium	2.62	55	88.71	82.18	95.24
Fourth Order	Diss Potassium	2.66	56	90.32	84.38	96.27
Fourth Order	Diss Potassium	2.94	57	91.94	86.60	97.27
Fourth Order	Diss Potassium	3.21	58	93.55	88.29	98.81
Fourth Order	Diss Potassium	3.28	59	95.16	90.39	99.93
Fourth Order	Diss Potassium	3.32	60	96.77	92.94	100.00
Fourth Order	Diss Potassium	3.96	61	98.39	95.77	100.00
Fourth Order	Diss Potassium	5.41	62	100.00	100.00	100.00
Fifth Order	Diss Potassium	0.87	1	5.00	0.00	13.55
Fifth Order	Diss Potassium	1.12	2	10.00	0.00	22.04
Fifth Order	Diss Potassium	1.13	3	15.00	0.49	29.51
Fifth Order	Diss Potassium	1.26	4	20.00	4.17	35.83

Fifth Order	Diss Potassium	1.37	5	25.00	8.46	41.54
Fifth Order	Diss Potassium	1.39	6	30.00	12.07	47.93
Fifth Order	Diss Potassium	1.43	7	35.00	17.54	52.46
Fifth Order	Diss Potassium	1.47	8	40.00	21.96	58.04
Fifth Order	Diss Potassium	1.49	9	45.00	27.67	62.33
Fifth Order	Diss Potassium	1.53	10	50.00	34.29	65.71
Fifth Order	Diss Potassium	1.58	11	55.00	38.72	71.28
Fifth Order	Diss Potassium	1.85	12	60.00	43.26	76.74
Fifth Order	Diss Potassium	2.02	13	65.00	47.17	82.83
Fifth Order	Diss Potassium	2.12	14	70.00	52.23	87.77
Fifth Order	Diss Potassium	2.16	15	75.00	58.32	91.68
Fifth Order	Diss Potassium	2.28	16	80.00	65.28	94.72
Fifth Order	Diss Potassium	2.42	17	85.00	72.68	97.32
Fifth Order	Diss Potassium	2.65	18	90.00	78.31	100.00
Fifth Order	Diss Potassium	3.98	19	95.00	86.90	100.00
Fifth Order	Diss Potassium	7.44	20	100.00	100.00	100.00

## Appendix I. Total Dissolved Sodium Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by dissolved sodium in this appendix) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Dissolved sodium over 20 mg/L increases the likelihood of having a low VSCI score. Figure 71 shows declining VSCI scores as total dissolved sodium increases. The case for this increased probability of stress to aquatic communities is presented in this appendix.

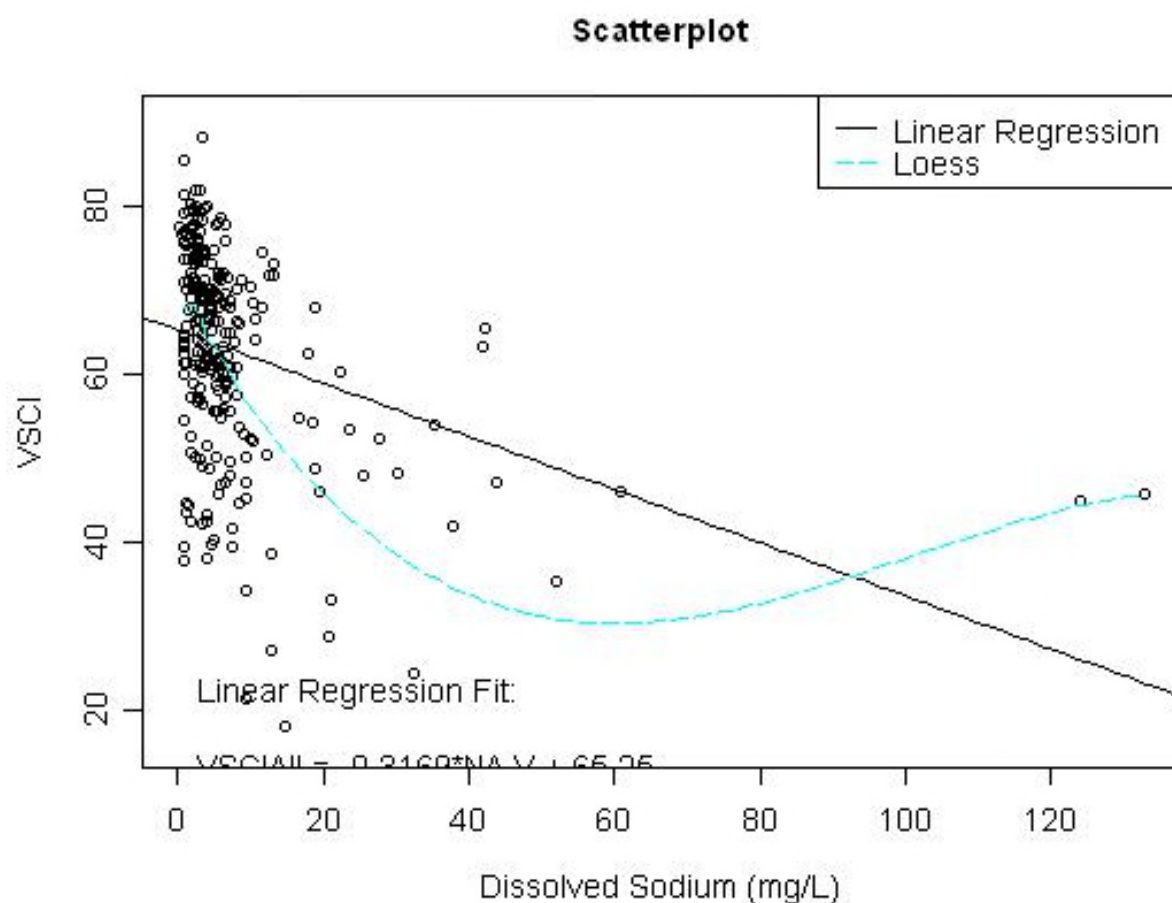


Figure 71. Total Dissolved Sodium Stressor Gradient Scatterplot.

### *Total Dissolved Sodium Relative Risk Results*

An optimal level of less than 7 mg/L was selected based on the low risk to aquatic life. VDEQ estimates 76% of Virginia streams have dissolved sodium less than 7 mg/L (Table 41). Dissolved sodium above 20 mg/L is considered suboptimal based on declining VSCI scores observed in

categorical boxplots (Figure 72) and scatter plot graphs. An estimated 4.5% of Virginia streams have a dissolved sodium concentration above 20 mg/L (Figure 76, Table 41). VDEQ relative risk calculations found that a VSCI score is 7 times more likely to be below 50 when dissolved sodium are above 20 mg/L than when the dissolved sodium concentrations are below 7 mg/L (Figure 73).

Table 41. Total Dissolved Sodium Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Dissolved Sodium (mg/L)	<7	>20

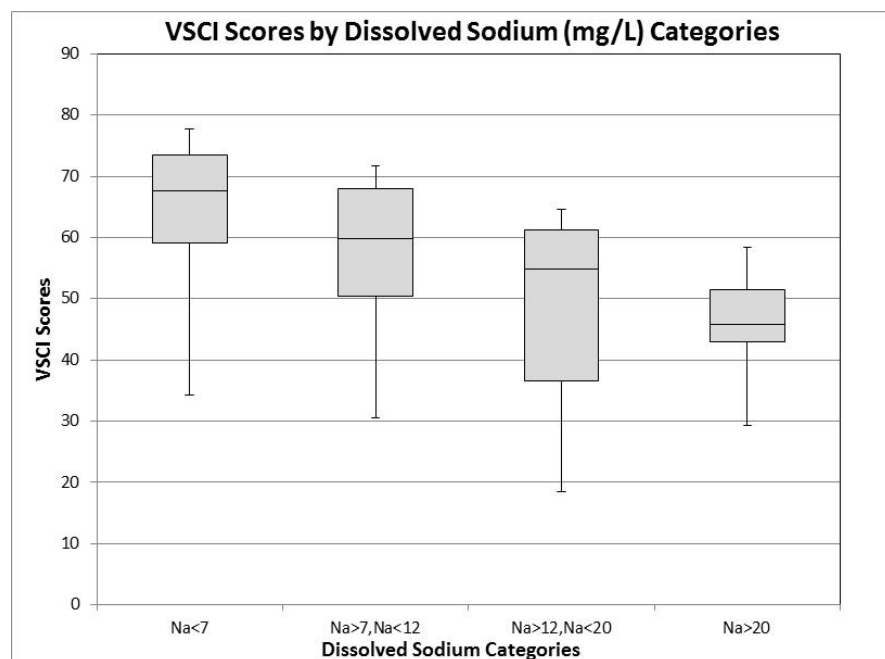


Figure 72. VSCI Scores by Dissolved Sodium Categories.

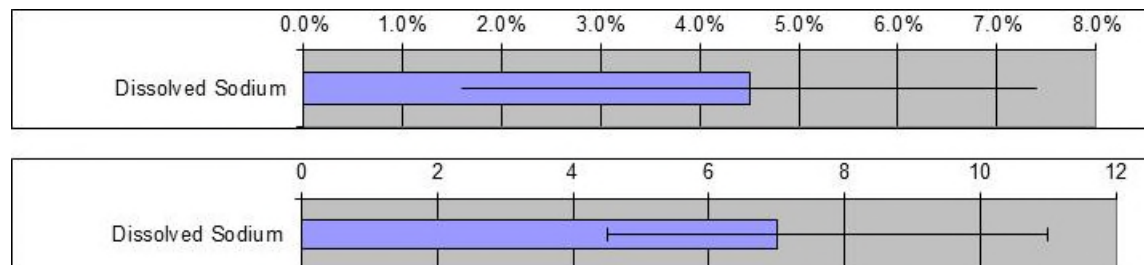


Figure 73. Dissolved Sodium Relative Extent (Dissolved Sodium > 20 mg/L) and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 17 sites with dissolved sodium over 20 mg/L. Three sites out of seventeen have a VSCI over 60. The probability of having VSCI score less than 60 when dissolved sodium are over 20 mg/L is 90% and the probability of having VSCI score less than 60 when dissolved sodium is over 50 mg/L is 100% (Figure 74).

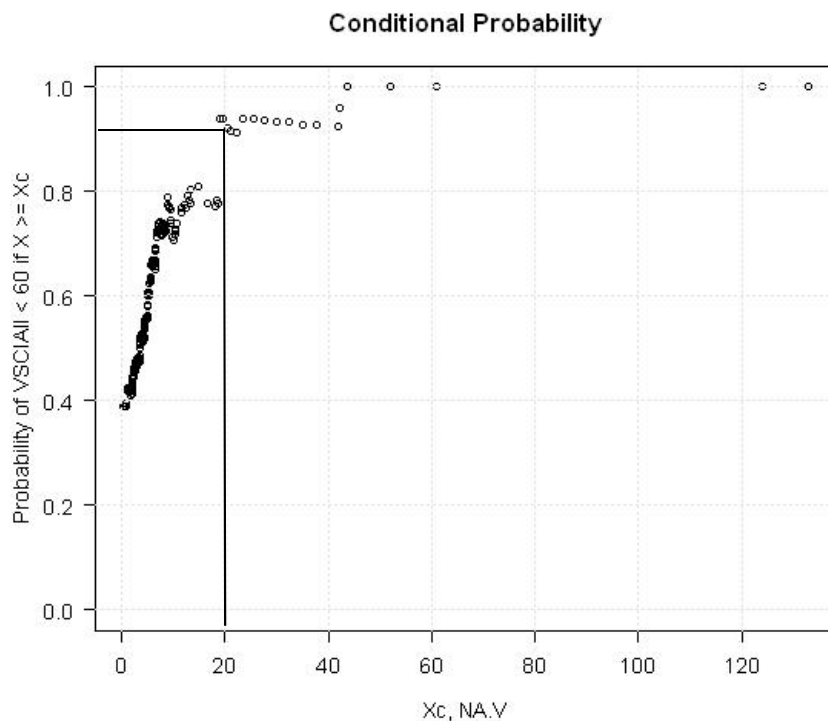


Figure 74. Probability of VSCI less than 60 if Dissolved Sodium > 20 mg/L.

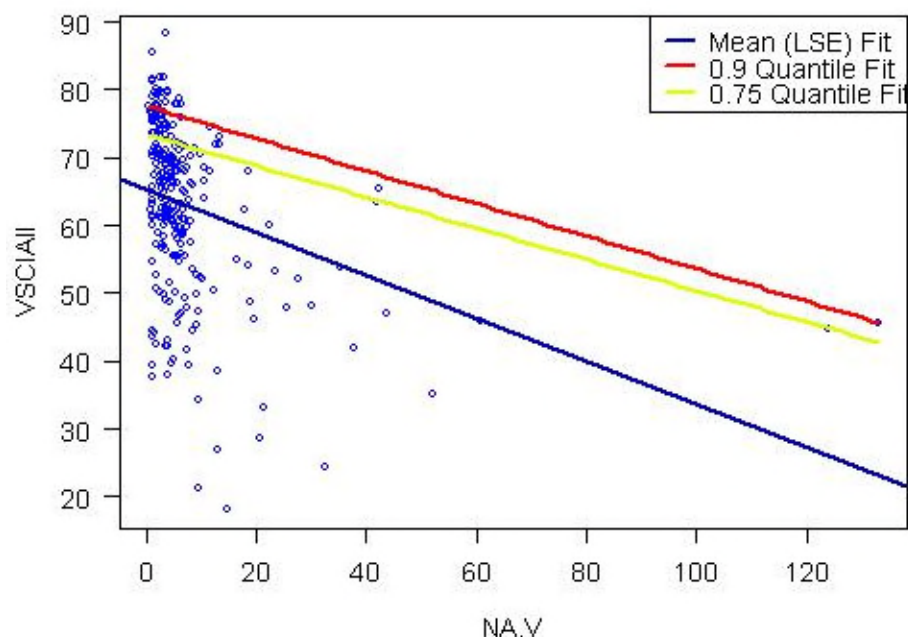


Figure 75. Quantile Regression VSCI versus Dissolved Sodium (mg/L).

Quantile regression for dissolved sodium is shown in Figure 75. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to dissolved sodium mg/L values. The 50<sup>th</sup> percentile of percentile of reference crosses at 23 mg/L, 25<sup>th</sup> percentile intersects at 48 mg/L, and the 10<sup>th</sup> percentile is equal to 73 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed (Figure 75).

### *Dissolved Sodium and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from dissolved sodium concentrations below 7 mg/L (Table 42). Streams with dissolved sodium above 20 mg/L do not support healthy benthic communities and are associated with VSCI scores less than 60.



Table 42. Total Dissolved Sodium (mg/L) concentrations and associated probability of stress to aquatic life (based on VSCI Scores).

Dissolved Sodium	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 20
Medium	> 10, < 20
Low	> 7, < 10
None	< 7

### *Dissolved Sodium Cumulative Distribution Function curves*

Dissolved Sodium cumulative distribution function (CDF) curves are shown statewide, by major basin, major ecoregion (level III), and by stream order in Figures 76-79. Percentiles and values corresponding to CDF curves are shown in Tables 43-46.

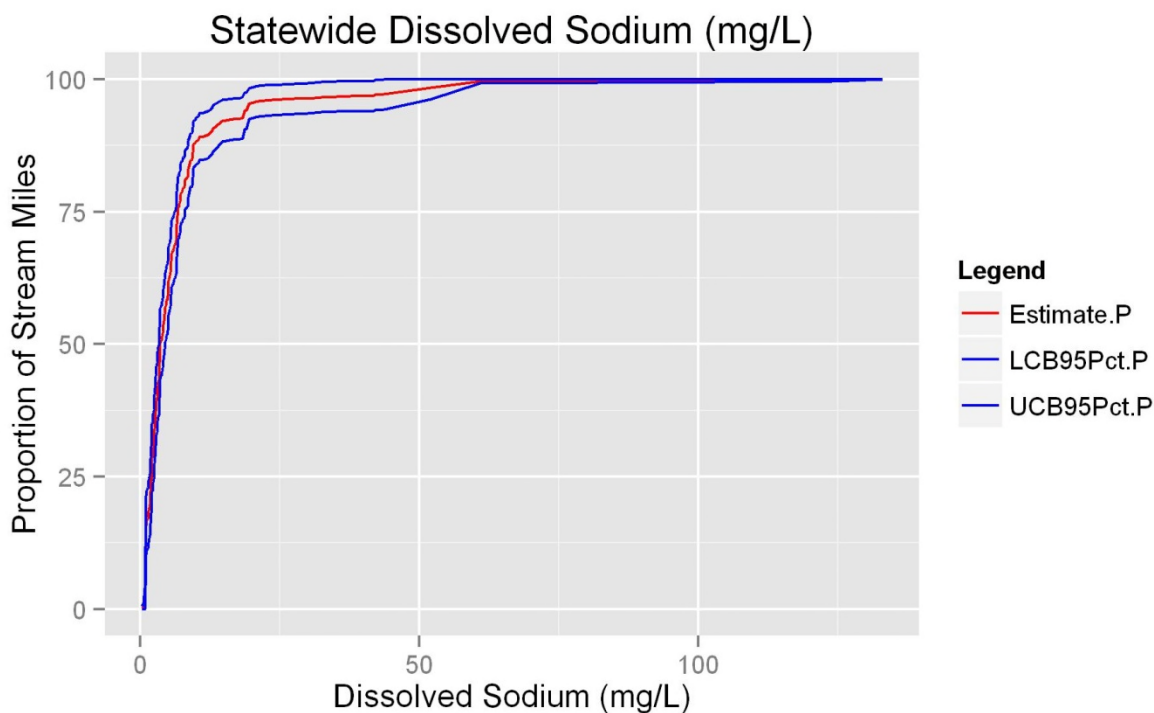


Figure 76. Dissolved Sodium Statewide CDF graph.

Statewide dissolved sodium distributions are depicted in Figure 76. Ninety-five percent of Virginia stream miles have dissolved sodium less than 20 mg/L.

Table 43. Dissolved Sodium Statewide Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Dissolved Sodium	0.32	1	0.22	0.00	0.57
Virginia	Dissolved Sodium	0.62	2	0.51	0.00	1.15
Virginia	Dissolved Sodium	0.76	3	1.76	0.00	3.94
Virginia	Dissolved Sodium	1.00	21	14.39	8.96	19.82
Virginia	Dissolved Sodium	1.03	22	14.60	9.18	20.03
Virginia	Dissolved Sodium	1.04	23	15.85	10.21	21.50
Virginia	Dissolved Sodium	1.09	24	16.15	10.50	21.80
Virginia	Dissolved Sodium	1.12	25	16.45	10.80	22.10
Virginia	Dissolved Sodium	1.17	26	16.74	11.09	22.40
Virginia	Dissolved Sodium	1.21	27	16.87	11.21	22.52
Virginia	Dissolved Sodium	1.24	28	16.99	11.33	22.64
Virginia	Dissolved Sodium	1.45	29	17.28	11.65	22.92
Virginia	Dissolved Sodium	1.49	30	18.53	12.69	24.38
Virginia	Dissolved Sodium	1.55	31	18.83	13.01	24.65
Virginia	Dissolved Sodium	1.57	32	19.05	13.24	24.85
Virginia	Dissolved Sodium	1.58	33	19.17	13.37	24.96
Virginia	Dissolved Sodium	1.70	34	19.38	13.58	25.19
Virginia	Dissolved Sodium	1.71	35	19.60	13.79	25.41
Virginia	Dissolved Sodium	1.76	36	19.81	14.01	25.61
Virginia	Dissolved Sodium	1.78	37	20.11	14.29	25.92
Virginia	Dissolved Sodium	1.80	38	20.32	14.51	26.14
Virginia	Dissolved Sodium	1.81	39	20.54	14.70	26.38
Virginia	Dissolved Sodium	1.84	40	20.84	14.98	26.69
Virginia	Dissolved Sodium	1.86	41	21.13	15.27	26.99
Virginia	Dissolved Sodium	1.88	42	22.38	16.32	28.45
Virginia	Dissolved Sodium	1.89	43	22.68	16.61	28.75
Virginia	Dissolved Sodium	1.95	44	22.89	16.82	28.97
Virginia	Dissolved Sodium	1.99	46	24.44	18.22	30.67
Virginia	Dissolved Sodium	2.00	47	25.69	19.34	32.05
Virginia	Dissolved Sodium	2.04	48	25.99	19.62	32.36
Virginia	Dissolved Sodium	2.05	49	26.06	19.70	32.42
Virginia	Dissolved Sodium	2.06	50	27.31	20.80	33.82
Virginia	Dissolved Sodium	2.07	51	28.57	22.13	35.00
Virginia	Dissolved Sodium	2.19	52	28.78	22.38	35.19
Virginia	Dissolved Sodium	2.24	53	28.90	22.49	35.31
Virginia	Dissolved Sodium	2.25	54	30.15	23.62	36.69
Virginia	Dissolved Sodium	2.29	55	30.23	23.70	36.75
Virginia	Dissolved Sodium	2.33	56	30.44	23.94	36.94
Virginia	Dissolved Sodium	2.35	57	30.66	24.16	37.15
Virginia	Dissolved Sodium	2.44	58	30.95	24.45	37.45
Virginia	Dissolved Sodium	2.47	59	31.25	24.78	37.72
Virginia	Dissolved Sodium	2.49	60	31.46	24.99	37.93
Virginia	Dissolved Sodium	2.50	61	31.76	25.28	38.24
Virginia	Dissolved Sodium	2.51	62	33.01	26.42	39.61
Virginia	Dissolved Sodium	2.53	63	33.31	26.75	39.86
Virginia	Dissolved Sodium	2.54	65	33.82	27.30	40.33
Virginia	Dissolved Sodium	2.55	66	33.94	27.43	40.45
Virginia	Dissolved Sodium	2.56	67	34.06	27.55	40.57
Virginia	Dissolved Sodium	2.59	68	34.28	27.79	40.77
Virginia	Dissolved Sodium	2.61	69	34.49	28.01	40.98

Virginia	Dissolved Sodium	2.63	70	34.71	28.23	41.19
Virginia	Dissolved Sodium	2.64	71	35.00	28.52	41.49
Virginia	Dissolved Sodium	2.67	72	35.30	28.82	41.78
Virginia	Dissolved Sodium	2.71	74	35.72	29.28	42.15
Virginia	Dissolved Sodium	2.74	77	37.26	30.74	43.78
Virginia	Dissolved Sodium	2.80	78	37.47	30.97	43.97
Virginia	Dissolved Sodium	2.83	79	37.77	31.28	44.26
Virginia	Dissolved Sodium	2.87	80	37.84	31.34	44.34
Virginia	Dissolved Sodium	2.88	81	39.09	32.56	45.62
Virginia	Dissolved Sodium	2.90	83	39.43	32.93	45.93
Virginia	Dissolved Sodium	2.93	84	39.55	33.04	46.06
Virginia	Dissolved Sodium	3.02	85	39.85	33.33	46.36
Virginia	Dissolved Sodium	3.04	86	40.06	33.54	46.58
Virginia	Dissolved Sodium	3.09	87	41.31	34.68	47.95
Virginia	Dissolved Sodium	3.11	88	41.53	34.90	48.16
Virginia	Dissolved Sodium	3.12	89	41.74	35.09	48.39
Virginia	Dissolved Sodium	3.13	90	41.87	35.24	48.49
Virginia	Dissolved Sodium	3.14	92	42.11	35.49	48.73
Virginia	Dissolved Sodium	3.21	93	42.32	35.70	48.95
Virginia	Dissolved Sodium	3.22	94	42.62	36.02	49.22
Virginia	Dissolved Sodium	3.26	95	42.92	36.31	49.53
Virginia	Dissolved Sodium	3.32	96	43.13	36.51	49.75
Virginia	Dissolved Sodium	3.40	99	44.80	38.14	51.47
Virginia	Dissolved Sodium	3.41	100	44.87	38.20	51.54
Virginia	Dissolved Sodium	3.42	101	46.13	39.47	52.78
Virginia	Dissolved Sodium	3.43	103	46.27	39.61	52.93
Virginia	Dissolved Sodium	3.44	104	46.39	39.74	53.04
Virginia	Dissolved Sodium	3.47	105	46.51	39.88	53.15
Virginia	Dissolved Sodium	3.49	107	47.98	41.32	54.64
Virginia	Dissolved Sodium	3.51	109	48.49	41.83	55.15
Virginia	Dissolved Sodium	3.55	112	49.13	42.49	55.76
Virginia	Dissolved Sodium	3.57	113	49.34	42.71	55.97
Virginia	Dissolved Sodium	3.59	114	49.56	42.92	56.19
Virginia	Dissolved Sodium	3.60	116	50.15	43.54	56.76
Virginia	Dissolved Sodium	3.61	117	50.44	43.87	57.01
Virginia	Dissolved Sodium	3.67	119	50.64	44.07	57.21
Virginia	Dissolved Sodium	3.75	120	50.71	44.15	57.27
Virginia	Dissolved Sodium	3.84	121	50.83	44.27	57.39
Virginia	Dissolved Sodium	3.85	122	51.05	44.47	57.62
Virginia	Dissolved Sodium	3.90	123	51.34	44.75	57.94
Virginia	Dissolved Sodium	3.94	124	51.56	44.97	58.15
Virginia	Dissolved Sodium	3.98	125	51.68	45.09	58.27
Virginia	Dissolved Sodium	4.04	127	52.11	45.51	58.71
Virginia	Dissolved Sodium	4.12	128	52.33	45.74	58.92
Virginia	Dissolved Sodium	4.13	129	52.54	45.92	59.17
Virginia	Dissolved Sodium	4.16	130	53.79	47.16	60.43
Virginia	Dissolved Sodium	4.19	131	54.09	47.47	60.71
Virginia	Dissolved Sodium	4.26	132	54.21	47.59	60.83
Virginia	Dissolved Sodium	4.28	133	54.43	47.82	61.03
Virginia	Dissolved Sodium	4.33	134	55.68	49.08	62.27
Virginia	Dissolved Sodium	4.41	135	55.89	49.30	62.49
Virginia	Dissolved Sodium	4.42	136	56.19	49.57	62.81
Virginia	Dissolved Sodium	4.43	137	56.40	49.78	63.03

Virginia	Dissolved Sodium	4.45	138	56.62	50.00	63.23
Virginia	Dissolved Sodium	4.51	140	57.04	50.45	63.62
Virginia	Dissolved Sodium	4.57	141	57.33	50.77	63.90
Virginia	Dissolved Sodium	4.58	142	57.45	50.89	64.02
Virginia	Dissolved Sodium	4.64	143	57.75	51.17	64.33
Virginia	Dissolved Sodium	4.65	144	58.05	51.49	64.60
Virginia	Dissolved Sodium	4.68	145	58.08	51.53	64.63
Virginia	Dissolved Sodium	4.74	146	58.20	51.65	64.76
Virginia	Dissolved Sodium	4.81	147	58.42	51.86	64.97
Virginia	Dissolved Sodium	4.88	148	58.71	52.15	65.28
Virginia	Dissolved Sodium	4.90	149	59.01	52.46	65.56
Virginia	Dissolved Sodium	4.98	150	59.08	52.53	65.63
Virginia	Dissolved Sodium	5.00	152	60.63	54.16	67.10
Virginia	Dissolved Sodium	5.03	153	60.75	54.29	67.22
Virginia	Dissolved Sodium	5.06	154	62.00	55.61	68.39
Virginia	Dissolved Sodium	5.11	155	62.30	55.92	68.68
Virginia	Dissolved Sodium	5.13	156	62.42	56.04	68.80
Virginia	Dissolved Sodium	5.19	157	62.49	56.12	68.87
Virginia	Dissolved Sodium	5.26	158	62.79	56.41	69.17
Virginia	Dissolved Sodium	5.29	159	62.91	56.54	69.28
Virginia	Dissolved Sodium	5.38	160	63.21	56.85	69.57
Virginia	Dissolved Sodium	5.39	161	63.33	56.97	69.69
Virginia	Dissolved Sodium	5.43	162	63.55	57.18	69.91
Virginia	Dissolved Sodium	5.44	163	63.84	57.46	70.23
Virginia	Dissolved Sodium	5.45	165	65.22	58.90	71.53
Virginia	Dissolved Sodium	5.46	166	65.43	59.13	71.73
Virginia	Dissolved Sodium	5.47	167	65.65	59.32	71.97
Virginia	Dissolved Sodium	5.53	168	65.72	59.38	72.05
Virginia	Dissolved Sodium	5.54	169	65.79	59.46	72.12
Virginia	Dissolved Sodium	5.57	170	65.91	59.58	72.25
Virginia	Dissolved Sodium	5.62	171	67.16	60.90	73.42
Virginia	Dissolved Sodium	5.65	172	67.24	60.97	73.50
Virginia	Dissolved Sodium	5.67	173	67.36	61.07	73.65
Virginia	Dissolved Sodium	5.70	174	67.48	61.19	73.77
Virginia	Dissolved Sodium	5.86	175	67.60	61.31	73.89
Virginia	Dissolved Sodium	5.90	176	67.64	61.35	73.93
Virginia	Dissolved Sodium	5.96	177	67.93	61.65	74.22
Virginia	Dissolved Sodium	6.00	178	68.05	61.76	74.35
Virginia	Dissolved Sodium	6.04	179	68.35	62.09	74.61
Virginia	Dissolved Sodium	6.05	180	68.47	62.22	74.73
Virginia	Dissolved Sodium	6.10	181	68.54	62.29	74.80
Virginia	Dissolved Sodium	6.23	182	68.76	62.50	75.02
Virginia	Dissolved Sodium	6.25	183	68.88	62.62	75.15
Virginia	Dissolved Sodium	6.29	184	69.10	62.84	75.36
Virginia	Dissolved Sodium	6.37	185	69.39	63.14	75.65
Virginia	Dissolved Sodium	6.47	186	69.52	63.26	75.77
Virginia	Dissolved Sodium	6.48	187	70.77	64.45	77.08
Virginia	Dissolved Sodium	6.49	188	70.98	64.67	77.29
Virginia	Dissolved Sodium	6.51	189	72.23	66.06	78.41
Virginia	Dissolved Sodium	6.54	190	72.53	66.35	78.71
Virginia	Dissolved Sodium	6.56	191	72.74	66.55	78.94
Virginia	Dissolved Sodium	6.61	192	72.87	66.68	79.06
Virginia	Dissolved Sodium	6.63	193	72.99	66.79	79.19

Virginia	Dissolved Sodium	6.64	194	74.24	68.23	80.25
Virginia	Dissolved Sodium	6.78	195	75.49	69.55	81.43
Virginia	Dissolved Sodium	6.79	196	75.79	69.88	81.69
Virginia	Dissolved Sodium	6.84	197	75.91	70.01	81.81
Virginia	Dissolved Sodium	6.99	198	75.98	70.08	81.88
Virginia	Dissolved Sodium	7.02	200	76.23	70.32	82.14
Virginia	Dissolved Sodium	7.03	201	76.52	70.62	82.42
Virginia	Dissolved Sodium	7.08	202	76.82	70.93	82.70
Virginia	Dissolved Sodium	7.11	203	76.94	71.05	82.83
Virginia	Dissolved Sodium	7.25	204	77.06	71.16	82.96
Virginia	Dissolved Sodium	7.27	205	78.31	72.54	84.09
Virginia	Dissolved Sodium	7.35	206	78.61	72.85	84.37
Virginia	Dissolved Sodium	7.55	207	78.91	73.14	84.68
Virginia	Dissolved Sodium	7.60	208	79.12	73.33	84.91
Virginia	Dissolved Sodium	7.72	209	79.42	73.64	85.20
Virginia	Dissolved Sodium	7.95	210	79.63	73.87	85.40
Virginia	Dissolved Sodium	7.96	211	79.75	73.99	85.52
Virginia	Dissolved Sodium	8.05	212	81.01	75.40	86.61
Virginia	Dissolved Sodium	8.20	213	81.22	75.62	86.83
Virginia	Dissolved Sodium	8.33	214	81.34	75.74	86.94
Virginia	Dissolved Sodium	8.43	215	81.64	76.05	87.23
Virginia	Dissolved Sodium	8.57	216	81.94	76.37	87.50
Virginia	Dissolved Sodium	8.62	217	83.19	77.88	88.50
Virginia	Dissolved Sodium	8.97	218	84.44	79.41	89.46
Virginia	Dissolved Sodium	8.99	219	84.65	79.64	89.66
Virginia	Dissolved Sodium	9.23	220	84.87	79.83	89.91
Virginia	Dissolved Sodium	9.30	221	84.99	79.96	90.02
Virginia	Dissolved Sodium	9.39	222	86.24	81.52	90.96
Virginia	Dissolved Sodium	9.50	223	86.46	81.75	91.16
Virginia	Dissolved Sodium	9.51	224	87.71	83.29	92.13
Virginia	Dissolved Sodium	9.86	225	88.00	83.61	92.40
Virginia	Dissolved Sodium	10.00	226	88.30	83.89	92.72
Virginia	Dissolved Sodium	10.30	227	88.52	84.10	92.93
Virginia	Dissolved Sodium	10.40	228	88.64	84.20	93.08
Virginia	Dissolved Sodium	10.50	229	88.85	84.44	93.27
Virginia	Dissolved Sodium	10.60	230	89.15	84.72	93.58
Virginia	Dissolved Sodium	11.50	231	89.27	84.84	93.70
Virginia	Dissolved Sodium	11.70	232	89.34	84.92	93.77
Virginia	Dissolved Sodium	12.30	233	89.64	85.21	94.07
Virginia	Dissolved Sodium	12.60	234	89.94	85.54	94.33
Virginia	Dissolved Sodium	12.80	235	90.23	85.87	94.60
Virginia	Dissolved Sodium	13.00	236	90.53	86.17	94.89
Virginia	Dissolved Sodium	13.20	237	90.82	86.48	95.17
Virginia	Dissolved Sodium	13.30	238	90.90	86.56	95.24
Virginia	Dissolved Sodium	14.70	239	92.15	88.24	96.05
Virginia	Dissolved Sodium	16.60	240	92.44	88.55	96.33
Virginia	Dissolved Sodium	18.00	241	92.57	88.68	96.45
Virginia	Dissolved Sodium	18.40	242	92.78	88.90	96.67
Virginia	Dissolved Sodium	18.70	243	94.03	90.58	97.48
Virginia	Dissolved Sodium	19.00	244	94.15	90.71	97.59
Virginia	Dissolved Sodium	19.50	245	95.41	92.48	98.34
Virginia	Dissolved Sodium	20.60	246	95.70	92.81	98.60
Virginia	Dissolved Sodium	21.20	247	95.82	92.93	98.72

Virginia	Dissolved Sodium	22.40	248	95.95	93.05	98.84
Virginia	Dissolved Sodium	23.60	249	96.07	93.19	98.95
Virginia	Dissolved Sodium	25.40	250	96.19	93.31	99.07
Virginia	Dissolved Sodium	27.60	251	96.31	93.44	99.19
Virginia	Dissolved Sodium	30.10	252	96.38	93.51	99.25
Virginia	Dissolved Sodium	32.40	253	96.60	93.75	99.44
Virginia	Dissolved Sodium	35.20	254	96.72	93.88	99.56
Virginia	Dissolved Sodium	37.70	255	96.79	93.95	99.63
Virginia	Dissolved Sodium	42.00	256	96.92	94.08	99.75
Virginia	Dissolved Sodium	42.10	257	97.04	94.21	99.86
Virginia	Dissolved Sodium	43.70	258	97.16	94.34	99.98
Virginia	Dissolved Sodium	52.10	259	98.41	96.23	100.00
Virginia	Dissolved Sodium	60.90	260	99.66	99.23	100.00
Virginia	Dissolved Sodium	124.00	261	99.88	99.67	100.00
Virginia	Dissolved Sodium	133.00	262	100.00	100.00	100.00

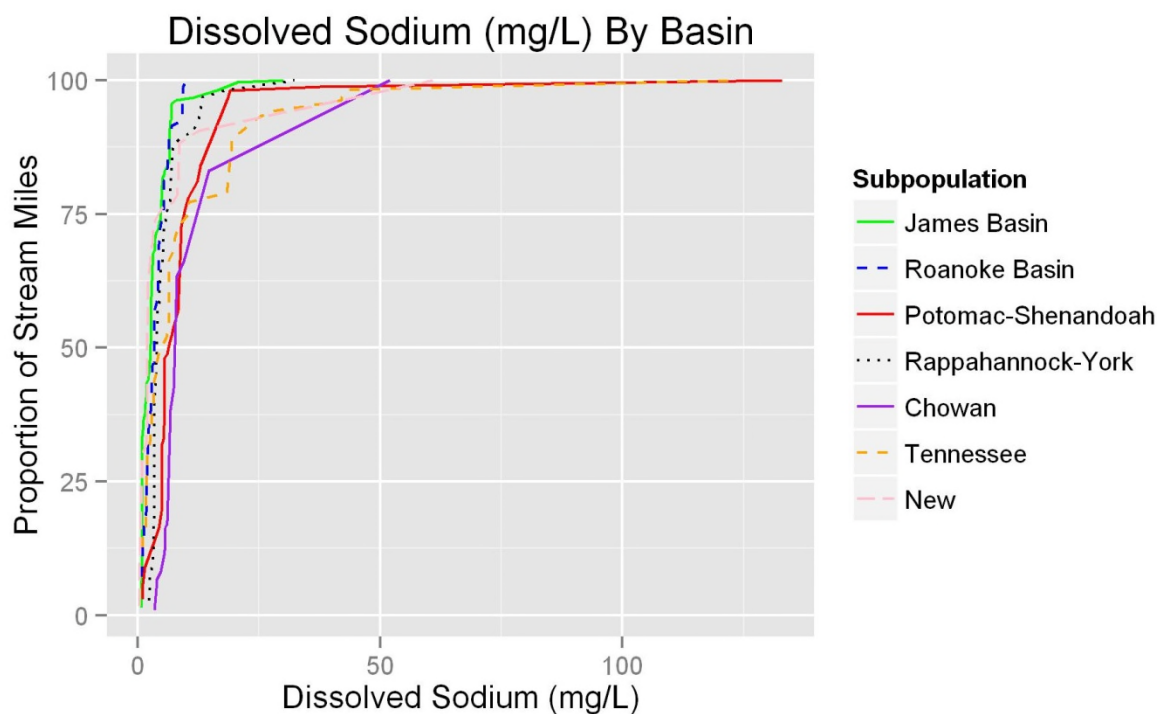


Figure 77. Dissolved Sodium by Major Basin CDF graph.

Figure 77 and Table 44 show dissolved sodium by major river basin. Ninety-nine percent of James Basin stream miles have dissolved sodium less than 20 mg/L. One hundred percent of Roanoke Basin streams have dissolved sodium concentrations below 10 mg/L. Ninety-eight percent of Potomac-Shenandoah stream miles are less than 19 mg/L dissolved sodium. Ninety

percent of Tennessee basin stream miles have dissolved sodium concentrations below 21.2 mg/L.

Table 44. Dissolved Sodium Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	Dissolved Sodium	0.62	1	1.43	0.00	4.00
James Basin	Dissolved Sodium	0.76	2	7.45	0.00	17.47
James Basin	Dissolved Sodium	1.00	8	33.56	17.52	49.59
James Basin	Dissolved Sodium	1.03	9	34.59	18.64	50.55
James Basin	Dissolved Sodium	1.17	10	36.02	20.17	51.87
James Basin	Dissolved Sodium	1.24	11	36.61	20.82	52.39
James Basin	Dissolved Sodium	1.55	12	38.03	22.52	53.54
James Basin	Dissolved Sodium	1.57	13	39.07	23.73	54.40
James Basin	Dissolved Sodium	1.58	14	39.65	24.41	54.90
James Basin	Dissolved Sodium	1.76	15	40.69	25.60	55.78
James Basin	Dissolved Sodium	1.84	16	42.11	27.13	57.10
James Basin	Dissolved Sodium	1.89	17	43.54	28.71	58.37
James Basin	Dissolved Sodium	2.24	18	44.13	29.29	58.96
James Basin	Dissolved Sodium	2.33	19	45.16	30.59	59.73
James Basin	Dissolved Sodium	2.35	20	46.20	31.71	60.68
James Basin	Dissolved Sodium	2.47	21	47.62	33.48	61.76
James Basin	Dissolved Sodium	2.61	22	48.66	34.61	62.70
James Basin	Dissolved Sodium	2.71	24	50.67	37.04	64.30
James Basin	Dissolved Sodium	2.74	26	57.04	43.38	70.70
James Basin	Dissolved Sodium	2.80	27	58.08	44.56	71.59
James Basin	Dissolved Sodium	2.83	28	59.50	46.07	72.93
James Basin	Dissolved Sodium	3.09	29	65.52	51.43	79.62
James Basin	Dissolved Sodium	3.13	30	66.11	52.19	80.03
James Basin	Dissolved Sodium	3.14	31	66.70	52.73	80.67
James Basin	Dissolved Sodium	3.21	32	67.73	53.74	81.73
James Basin	Dissolved Sodium	3.41	33	68.08	54.03	82.14
James Basin	Dissolved Sodium	3.59	34	69.12	55.24	83.00
James Basin	Dissolved Sodium	3.61	35	70.54	57.04	84.04
James Basin	Dissolved Sodium	3.85	36	71.58	57.88	85.28
James Basin	Dissolved Sodium	4.26	37	72.16	58.56	85.77
James Basin	Dissolved Sodium	4.57	38	73.59	59.81	87.37
James Basin	Dissolved Sodium	4.68	39	73.76	59.95	87.56
James Basin	Dissolved Sodium	5.00	40	79.78	68.79	90.77
James Basin	Dissolved Sodium	5.03	41	80.37	69.35	91.39
James Basin	Dissolved Sodium	5.11	42	81.79	70.84	92.74
James Basin	Dissolved Sodium	5.45	43	82.38	71.38	93.38
James Basin	Dissolved Sodium	5.57	44	82.97	71.98	93.96
James Basin	Dissolved Sodium	6.37	45	84.39	73.56	95.22
James Basin	Dissolved Sodium	6.47	46	84.98	74.11	95.85
James Basin	Dissolved Sodium	6.64	47	91.00	85.38	96.63
James Basin	Dissolved Sodium	6.79	48	92.43	87.58	97.28
James Basin	Dissolved Sodium	6.99	49	92.78	88.05	97.50
James Basin	Dissolved Sodium	7.03	50	94.20	90.23	98.18
James Basin	Dissolved Sodium	7.08	51	95.63	92.19	99.07
James Basin	Dissolved Sodium	7.96	52	96.21	92.85	99.58
James Basin	Dissolved Sodium	11.50	53	96.80	93.39	100.00

James Basin	Dissolved Sodium	16.60	54	98.23	95.64	100.00
James Basin	Dissolved Sodium	20.60	55	99.65	99.02	100.00
James Basin	Dissolved Sodium	30.10	56	100.00	100.00	100.00
Roanoke Basin	Dissolved Sodium	1.00	3	7.18	0.00	15.29
Roanoke Basin	Dissolved Sodium	1.04	4	12.56	1.75	23.37
Roanoke Basin	Dissolved Sodium	1.49	5	17.94	4.77	31.12
Roanoke Basin	Dissolved Sodium	1.78	6	19.22	5.95	32.48
Roanoke Basin	Dissolved Sodium	1.86	7	20.49	7.16	33.82
Roanoke Basin	Dissolved Sodium	1.88	8	25.87	11.26	40.49
Roanoke Basin	Dissolved Sodium	1.95	9	26.80	12.19	41.40
Roanoke Basin	Dissolved Sodium	1.99	10	28.07	13.50	42.63
Roanoke Basin	Dissolved Sodium	2.04	11	29.34	14.67	44.01
Roanoke Basin	Dissolved Sodium	2.25	12	34.72	19.30	50.15
Roanoke Basin	Dissolved Sodium	2.29	13	35.03	19.68	50.39
Roanoke Basin	Dissolved Sodium	2.53	14	36.31	20.91	51.70
Roanoke Basin	Dissolved Sodium	2.56	15	36.83	21.44	52.22
Roanoke Basin	Dissolved Sodium	2.59	16	37.76	22.55	52.96
Roanoke Basin	Dissolved Sodium	2.74	17	38.68	23.46	53.90
Roanoke Basin	Dissolved Sodium	2.88	18	44.06	28.91	59.21
Roanoke Basin	Dissolved Sodium	2.90	19	44.59	29.56	59.61
Roanoke Basin	Dissolved Sodium	3.02	20	45.86	30.89	60.83
Roanoke Basin	Dissolved Sodium	3.11	21	46.78	31.92	61.65
Roanoke Basin	Dissolved Sodium	3.40	22	47.31	32.53	62.09
Roanoke Basin	Dissolved Sodium	3.42	23	52.69	38.48	66.90
Roanoke Basin	Dissolved Sodium	3.43	24	53.00	38.85	67.15
Roanoke Basin	Dissolved Sodium	3.44	25	53.53	39.48	67.57
Roanoke Basin	Dissolved Sodium	3.47	26	54.05	40.15	67.96
Roanoke Basin	Dissolved Sodium	3.49	27	54.98	41.14	68.81
Roanoke Basin	Dissolved Sodium	3.55	28	56.25	42.81	69.69
Roanoke Basin	Dissolved Sodium	3.60	29	57.52	44.26	70.79
Roanoke Basin	Dissolved Sodium	3.75	30	57.83	44.62	71.04
Roanoke Basin	Dissolved Sodium	4.04	31	58.76	45.55	71.96
Roanoke Basin	Dissolved Sodium	4.12	32	59.68	46.57	72.80
Roanoke Basin	Dissolved Sodium	4.13	33	60.61	47.21	74.01
Roanoke Basin	Dissolved Sodium	4.19	34	61.88	48.65	75.11
Roanoke Basin	Dissolved Sodium	4.28	35	62.80	49.67	75.94
Roanoke Basin	Dissolved Sodium	4.33	36	68.19	55.78	80.59
Roanoke Basin	Dissolved Sodium	4.42	37	69.46	56.94	81.98
Roanoke Basin	Dissolved Sodium	4.51	38	69.98	57.55	82.42
Roanoke Basin	Dissolved Sodium	4.64	39	71.26	58.77	83.74
Roanoke Basin	Dissolved Sodium	4.65	40	72.53	60.31	84.75
Roanoke Basin	Dissolved Sodium	4.90	41	73.80	61.73	85.88
Roanoke Basin	Dissolved Sodium	4.98	42	74.11	62.03	86.19
Roanoke Basin	Dissolved Sodium	5.13	43	74.64	62.58	86.70
Roanoke Basin	Dissolved Sodium	5.38	44	75.91	63.92	87.90
Roanoke Basin	Dissolved Sodium	5.45	45	81.29	71.07	91.52
Roanoke Basin	Dissolved Sodium	5.86	46	81.82	71.67	91.96
Roanoke Basin	Dissolved Sodium	6.04	47	83.09	73.31	92.87
Roanoke Basin	Dissolved Sodium	6.05	48	83.62	73.82	93.41
Roanoke Basin	Dissolved Sodium	6.23	49	84.54	74.66	94.42
Roanoke Basin	Dissolved Sodium	6.48	50	89.92	81.61	98.24
Roanoke Basin	Dissolved Sodium	6.61	51	90.45	82.15	98.75
Roanoke Basin	Dissolved Sodium	6.84	52	90.97	82.73	99.22



Roanoke Basin	Dissolved Sodium	7.02	53	91.50	83.31	99.68
Roanoke Basin	Dissolved Sodium	8.99	54	92.42	84.41	100.00
Roanoke Basin	Dissolved Sodium	9.23	55	93.35	84.95	100.00
Roanoke Basin	Dissolved Sodium	9.39	56	98.73	96.63	100.00
Roanoke Basin	Dissolved Sodium	9.86	57	100.00	100.00	100.00
Potomac-Shenandoah	Dissolved Sodium	1.00	1	3.00	0.00	8.00
Potomac-Shenandoah	Dissolved Sodium	1.12	2	6.00	0.07	11.93
Potomac-Shenandoah	Dissolved Sodium	1.45	3	9.00	4.03	13.97
Potomac-Shenandoah	Dissolved Sodium	2.67	4	12.00	4.44	19.56
Potomac-Shenandoah	Dissolved Sodium	3.55	5	14.18	5.69	22.68
Potomac-Shenandoah	Dissolved Sodium	4.43	6	16.36	7.01	25.71
Potomac-Shenandoah	Dissolved Sodium	4.88	7	19.36	7.70	31.02
Potomac-Shenandoah	Dissolved Sodium	5.06	8	32.05	14.82	49.27
Potomac-Shenandoah	Dissolved Sodium	5.39	9	33.28	15.92	50.65
Potomac-Shenandoah	Dissolved Sodium	5.47	10	35.46	17.24	53.68
Potomac-Shenandoah	Dissolved Sodium	5.62	11	48.15	27.74	68.56
Potomac-Shenandoah	Dissolved Sodium	6.10	12	48.88	28.63	69.13
Potomac-Shenandoah	Dissolved Sodium	6.56	13	51.06	30.41	71.71
Potomac-Shenandoah	Dissolved Sodium	7.02	14	52.30	31.72	72.87
Potomac-Shenandoah	Dissolved Sodium	7.25	15	53.53	32.66	74.40
Potomac-Shenandoah	Dissolved Sodium	7.95	16	55.71	35.27	76.16
Potomac-Shenandoah	Dissolved Sodium	8.33	17	56.95	36.77	77.12
Potomac-Shenandoah	Dissolved Sodium	8.43	18	59.95	39.69	80.21
Potomac-Shenandoah	Dissolved Sodium	8.97	19	72.63	57.02	88.25
Potomac-Shenandoah	Dissolved Sodium	9.30	20	73.87	58.42	89.32
Potomac-Shenandoah	Dissolved Sodium	10.00	21	76.87	60.20	93.54
Potomac-Shenandoah	Dissolved Sodium	10.40	22	78.11	60.87	95.34
Potomac-Shenandoah	Dissolved Sodium	12.30	23	81.11	63.56	98.65
Potomac-Shenandoah	Dissolved Sodium	13.00	24	84.11	100.00	100.00
Potomac-Shenandoah	Dissolved Sodium	18.70	25	96.79	93.39	100.00
Potomac-Shenandoah	Dissolved Sodium	19.00	26	98.03	95.73	100.00
Potomac-Shenandoah	Dissolved Sodium	37.70	27	98.76	96.63	100.00
Potomac-Shenandoah	Dissolved Sodium	133.00	28	100.00	100.00	100.00
Rappahannock-York	Dissolved Sodium	2.44	1	2.74	0.00	7.46
Rappahannock-York	Dissolved Sodium	2.49	2	4.72	0.00	10.22
Rappahannock-York	Dissolved Sodium	2.50	3	7.46	0.20	14.72
Rappahannock-York	Dissolved Sodium	3.12	4	9.45	1.05	17.84
Rappahannock-York	Dissolved Sodium	3.32	5	11.43	2.02	20.85
Rappahannock-York	Dissolved Sodium	3.40	6	23.00	9.84	36.16
Rappahannock-York	Dissolved Sodium	3.49	7	34.56	18.15	50.98
Rappahannock-York	Dissolved Sodium	3.51	9	39.29	22.66	55.91
Rappahannock-York	Dissolved Sodium	3.55	10	40.41	24.19	56.64
Rappahannock-York	Dissolved Sodium	3.57	11	42.40	26.09	58.71
Rappahannock-York	Dissolved Sodium	3.67	13	44.20	28.15	60.24
Rappahannock-York	Dissolved Sodium	3.84	14	45.32	28.98	61.66
Rappahannock-York	Dissolved Sodium	4.16	15	56.89	38.35	75.43
Rappahannock-York	Dissolved Sodium	4.45	16	58.88	40.91	76.84
Rappahannock-York	Dissolved Sodium	4.51	17	61.61	43.86	79.37
Rappahannock-York	Dissolved Sodium	4.58	18	62.74	45.10	80.38
Rappahannock-York	Dissolved Sodium	4.81	19	64.73	47.37	82.09
Rappahannock-York	Dissolved Sodium	5.19	20	65.39	48.20	82.59
Rappahannock-York	Dissolved Sodium	5.26	21	68.13	51.01	85.25
Rappahannock-York	Dissolved Sodium	5.29	22	69.26	52.56	85.95

Rappahannock-York	Dissolved Sodium	5.44	23	71.99	55.91	88.07
Rappahannock-York	Dissolved Sodium	5.54	24	72.66	56.71	88.62
Rappahannock-York	Dissolved Sodium	5.96	25	75.40	59.80	91.00
Rappahannock-York	Dissolved Sodium	6.63	26	76.52	60.56	92.49
Rappahannock-York	Dissolved Sodium	7.27	27	88.09	78.94	97.24
Rappahannock-York	Dissolved Sodium	10.50	28	90.08	81.76	98.39
Rappahannock-York	Dissolved Sodium	11.70	29	90.75	82.60	98.89
Rappahannock-York	Dissolved Sodium	12.80	30	93.48	87.19	99.78
Rappahannock-York	Dissolved Sodium	13.20	31	96.22	91.80	100.00
Rappahannock-York	Dissolved Sodium	13.30	32	96.89	92.71	100.00
Rappahannock-York	Dissolved Sodium	18.00	33	98.01	94.44	100.00
Rappahannock-York	Dissolved Sodium	32.40	34	100.00	100.00	100.00
Chowan	Dissolved Sodium	3.43	1	0.98	0.00	2.78
Chowan	Dissolved Sodium	3.90	2	4.98	0.00	12.45
Chowan	Dissolved Sodium	3.98	3	6.63	0.00	14.83
Chowan	Dissolved Sodium	4.74	4	8.27	0.00	17.11
Chowan	Dissolved Sodium	5.43	5	11.18	0.13	22.23
Chowan	Dissolved Sodium	5.53	6	12.16	0.73	23.59
Chowan	Dissolved Sodium	5.65	7	13.13	1.29	24.97
Chowan	Dissolved Sodium	5.67	8	14.78	1.95	27.62
Chowan	Dissolved Sodium	5.70	9	16.43	3.03	29.83
Chowan	Dissolved Sodium	5.90	10	16.90	3.36	30.44
Chowan	Dissolved Sodium	6.25	11	18.55	4.35	32.75
Chowan	Dissolved Sodium	6.29	12	21.45	6.29	36.61
Chowan	Dissolved Sodium	6.78	13	38.36	10.36	66.37
Chowan	Dissolved Sodium	7.35	14	42.36	14.46	70.27
Chowan	Dissolved Sodium	7.55	15	46.36	17.38	75.34
Chowan	Dissolved Sodium	8.05	16	63.27	33.51	93.04
Chowan	Dissolved Sodium	9.50	17	66.18	36.70	95.66
Chowan	Dissolved Sodium	14.70	18	83.09	61.16	100.00
Chowan	Dissolved Sodium	52.10	19	100.00	100.00	100.00
Tennessee	Dissolved Sodium	1.00	2	12.67	0.00	26.61
Tennessee	Dissolved Sodium	1.09	3	15.09	0.91	29.27
Tennessee	Dissolved Sodium	1.70	4	16.85	2.42	31.28
Tennessee	Dissolved Sodium	1.71	5	18.61	4.00	33.22
Tennessee	Dissolved Sodium	1.80	6	20.37	5.67	35.07
Tennessee	Dissolved Sodium	2.06	7	30.61	12.02	49.21
Tennessee	Dissolved Sodium	2.54	8	32.37	13.96	50.79
Tennessee	Dissolved Sodium	2.64	9	34.80	16.42	53.18
Tennessee	Dissolved Sodium	2.87	10	35.39	16.90	53.88
Tennessee	Dissolved Sodium	2.90	11	37.15	18.76	55.54
Tennessee	Dissolved Sodium	2.93	12	38.15	19.56	56.73
Tennessee	Dissolved Sodium	3.14	13	39.15	20.83	57.47
Tennessee	Dissolved Sodium	3.26	14	41.57	23.12	60.02
Tennessee	Dissolved Sodium	3.40	15	43.99	25.06	62.93
Tennessee	Dissolved Sodium	3.94	16	45.75	26.99	64.51
Tennessee	Dissolved Sodium	4.04	17	47.51	28.92	66.10
Tennessee	Dissolved Sodium	4.41	18	49.27	30.74	67.81
Tennessee	Dissolved Sodium	5.46	19	51.03	33.01	69.06
Tennessee	Dissolved Sodium	6.00	20	52.03	33.89	70.18
Tennessee	Dissolved Sodium	6.49	21	53.79	35.94	71.65
Tennessee	Dissolved Sodium	6.51	22	64.04	47.95	80.12
Tennessee	Dissolved Sodium	6.54	23	66.46	50.57	82.35

Tennessee	Dissolved Sodium	7.60	24	68.22	52.08	84.36
Tennessee	Dissolved Sodium	7.72	25	70.64	54.88	86.41
Tennessee	Dissolved Sodium	8.57	26	73.07	57.87	88.27
Tennessee	Dissolved Sodium	10.30	27	74.83	59.76	89.89
Tennessee	Dissolved Sodium	10.60	28	77.25	61.92	92.58
Tennessee	Dissolved Sodium	18.40	29	79.01	63.69	94.33
Tennessee	Dissolved Sodium	19.50	30	89.25	82.45	96.06
Tennessee	Dissolved Sodium	21.20	31	90.25	83.71	96.79
Tennessee	Dissolved Sodium	22.40	32	91.25	84.96	97.54
Tennessee	Dissolved Sodium	23.60	33	92.25	86.44	98.06
Tennessee	Dissolved Sodium	25.40	34	93.25	87.85	98.65
Tennessee	Dissolved Sodium	27.60	35	94.25	89.16	99.33
Tennessee	Dissolved Sodium	35.20	36	95.24	90.55	99.94
Tennessee	Dissolved Sodium	42.00	37	96.24	92.00	100.00
Tennessee	Dissolved Sodium	42.10	38	97.24	93.56	100.00
Tennessee	Dissolved Sodium	43.70	39	98.24	95.07	100.00
Tennessee	Dissolved Sodium	124.00	40	100.00	100.00	100.00
New	Dissolved Sodium	0.32	1	1.63	0.00	4.39
New	Dissolved Sodium	1.00	7	29.67	11.24	48.09
New	Dissolved Sodium	1.21	8	30.59	12.01	49.18
New	Dissolved Sodium	1.81	9	32.23	13.01	51.45
New	Dissolved Sodium	1.99	10	41.74	20.90	62.59
New	Dissolved Sodium	2.00	11	51.26	29.51	73.01
New	Dissolved Sodium	2.05	12	51.81	30.02	73.59
New	Dissolved Sodium	2.07	13	61.32	41.54	81.11
New	Dissolved Sodium	2.19	14	62.96	43.50	82.42
New	Dissolved Sodium	2.54	15	65.21	46.11	84.31
New	Dissolved Sodium	2.55	16	66.14	46.97	85.30
New	Dissolved Sodium	2.63	17	67.77	48.63	86.91
New	Dissolved Sodium	3.04	18	69.41	49.81	89.00
New	Dissolved Sodium	3.22	19	71.66	52.15	91.16
New	Dissolved Sodium	3.60	20	73.91	54.34	93.47
New	Dissolved Sodium	5.00	21	76.16	56.57	95.74
New	Dissolved Sodium	7.11	22	77.09	57.37	96.80
New	Dissolved Sodium	8.20	23	78.72	58.94	98.50
New	Dissolved Sodium	8.62	24	88.23	72.77	100.00
New	Dissolved Sodium	12.60	25	90.49	75.26	100.00
New	Dissolved Sodium	60.90	26	100.00	100.00	100.00

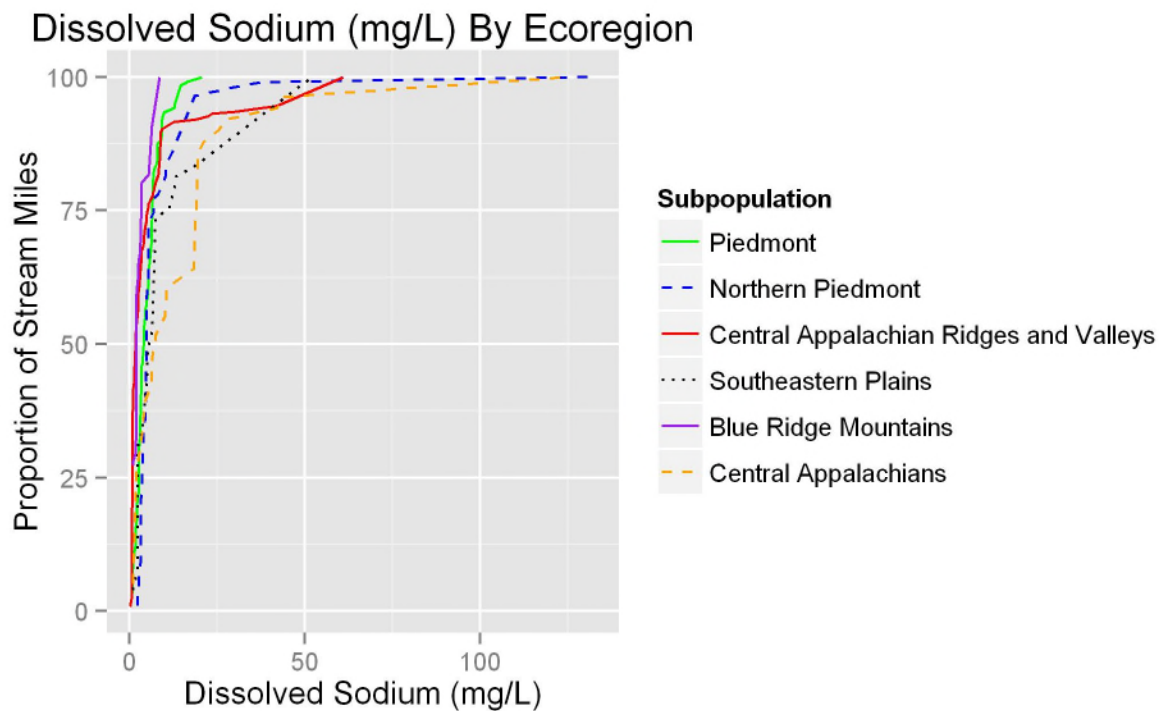


Figure 78. Dissolved Sodium by Major Ecoregion (Level III) CDF graph.

Ecoregion CDF curves are shown in Figure 78 and the corresponding data is contained in Table 45. One hundred percent of Piedmont stream miles have dissolved sodium concentrations less than 20.6 mg/L. Two percent of Northern Piedmont streams have dissolved sodium concentrations greater than 32 mg/L which is considered high probability of stress to aquatic life (Table 47). The 92<sup>nd</sup> percentile of Central Appalachian Ridges and Valley stream miles is 19 mg/L.

Table 45. Dissolved Sodium Population Estimates by Major Ecoregion.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Dissolved Sodium	0.76	1	3.38	0.00	8.93
Piedmont	Dissolved Sodium	1.00	3	4.51	0.00	10.25
Piedmont	Dissolved Sodium	1.04	4	7.88	0.47	15.30
Piedmont	Dissolved Sodium	1.49	5	11.26	2.55	19.97
Piedmont	Dissolved Sodium	1.78	6	12.06	3.28	20.83
Piedmont	Dissolved Sodium	1.88	7	15.44	5.50	25.37
Piedmont	Dissolved Sodium	1.95	8	16.02	6.08	25.95
Piedmont	Dissolved Sodium	2.04	9	16.81	6.82	26.81
Piedmont	Dissolved Sodium	2.25	10	20.19	9.36	31.03
Piedmont	Dissolved Sodium	2.29	11	20.39	9.60	31.17
Piedmont	Dissolved Sodium	2.50	12	21.19	10.35	32.02
Piedmont	Dissolved Sodium	2.56	13	21.51	10.68	32.35
Piedmont	Dissolved Sodium	2.59	14	22.09	11.37	32.82

Piedmont	Dissolved Sodium	2.71	15	22.89	12.29	33.50
Piedmont	Dissolved Sodium	2.74	18	27.05	15.94	38.16
Piedmont	Dissolved Sodium	2.80	19	27.63	16.63	38.62
Piedmont	Dissolved Sodium	2.88	20	31.00	19.75	42.26
Piedmont	Dissolved Sodium	2.90	21	31.33	20.15	42.52
Piedmont	Dissolved Sodium	3.02	22	32.13	20.97	43.29
Piedmont	Dissolved Sodium	3.09	23	35.51	24.19	46.83
Piedmont	Dissolved Sodium	3.13	24	35.84	24.62	47.05
Piedmont	Dissolved Sodium	3.14	25	36.17	24.96	47.37
Piedmont	Dissolved Sodium	3.21	26	36.75	25.54	47.95
Piedmont	Dissolved Sodium	3.40	27	37.08	25.92	48.23
Piedmont	Dissolved Sodium	3.41	28	37.27	26.11	48.43
Piedmont	Dissolved Sodium	3.42	29	40.65	29.53	51.77
Piedmont	Dissolved Sodium	3.44	30	40.98	29.92	52.04
Piedmont	Dissolved Sodium	3.47	31	41.31	30.32	52.29
Piedmont	Dissolved Sodium	3.49	32	41.89	31.00	52.77
Piedmont	Dissolved Sodium	3.51	34	43.27	32.44	54.09
Piedmont	Dissolved Sodium	3.55	36	44.65	34.03	55.26
Piedmont	Dissolved Sodium	3.57	37	45.23	34.64	55.81
Piedmont	Dissolved Sodium	3.60	38	46.02	35.50	56.55
Piedmont	Dissolved Sodium	3.67	39	46.22	35.70	56.73
Piedmont	Dissolved Sodium	3.85	40	46.80	36.24	57.36
Piedmont	Dissolved Sodium	3.90	41	47.60	36.96	58.23
Piedmont	Dissolved Sodium	3.98	42	47.93	37.29	58.57
Piedmont	Dissolved Sodium	4.04	43	48.51	37.83	59.18
Piedmont	Dissolved Sodium	4.12	44	49.09	38.44	59.73
Piedmont	Dissolved Sodium	4.13	45	49.67	38.88	60.45
Piedmont	Dissolved Sodium	4.28	46	50.25	39.54	60.95
Piedmont	Dissolved Sodium	4.33	47	53.63	42.93	64.32
Piedmont	Dissolved Sodium	4.42	48	54.42	43.63	65.22
Piedmont	Dissolved Sodium	4.51	49	54.75	44.01	65.50
Piedmont	Dissolved Sodium	4.58	50	55.08	44.39	65.77
Piedmont	Dissolved Sodium	4.64	51	55.88	45.15	66.61
Piedmont	Dissolved Sodium	4.65	52	56.68	46.06	67.30
Piedmont	Dissolved Sodium	4.68	53	56.77	46.15	67.40
Piedmont	Dissolved Sodium	4.74	54	57.10	46.47	67.74
Piedmont	Dissolved Sodium	4.90	55	57.90	47.33	68.48
Piedmont	Dissolved Sodium	5.03	56	58.23	47.67	68.79
Piedmont	Dissolved Sodium	5.26	57	59.03	48.46	69.60
Piedmont	Dissolved Sodium	5.38	58	59.83	49.31	70.35
Piedmont	Dissolved Sodium	5.43	59	60.41	49.86	70.96
Piedmont	Dissolved Sodium	5.45	61	64.12	53.86	74.37
Piedmont	Dissolved Sodium	5.53	62	64.31	54.02	74.60
Piedmont	Dissolved Sodium	5.67	63	64.64	54.27	75.01
Piedmont	Dissolved Sodium	5.70	64	64.97	54.57	75.36
Piedmont	Dissolved Sodium	5.86	65	65.30	54.93	75.66
Piedmont	Dissolved Sodium	5.96	66	66.10	55.79	76.40
Piedmont	Dissolved Sodium	6.04	67	66.90	56.75	77.04
Piedmont	Dissolved Sodium	6.05	68	67.23	57.10	77.35
Piedmont	Dissolved Sodium	6.23	69	67.81	57.67	77.95
Piedmont	Dissolved Sodium	6.25	70	68.13	57.97	78.30
Piedmont	Dissolved Sodium	6.29	71	68.71	58.57	78.86
Piedmont	Dissolved Sodium	6.37	72	69.51	59.41	79.62

Piedmont	Dissolved Sodium	6.47	73	69.84	59.70	79.98
Piedmont	Dissolved Sodium	6.48	74	73.22	62.83	83.61
Piedmont	Dissolved Sodium	6.61	75	73.55	63.17	83.93
Piedmont	Dissolved Sodium	6.64	76	76.93	67.41	86.44
Piedmont	Dissolved Sodium	6.78	77	80.30	71.27	89.34
Piedmont	Dissolved Sodium	6.79	78	81.10	72.21	89.99
Piedmont	Dissolved Sodium	6.99	79	81.30	72.43	90.17
Piedmont	Dissolved Sodium	7.02	80	81.63	72.71	90.55
Piedmont	Dissolved Sodium	7.08	81	82.43	73.58	91.27
Piedmont	Dissolved Sodium	7.35	82	83.22	74.47	91.97
Piedmont	Dissolved Sodium	7.95	83	83.80	75.02	92.59
Piedmont	Dissolved Sodium	7.96	84	84.13	75.36	92.91
Piedmont	Dissolved Sodium	8.05	85	87.51	79.71	95.31
Piedmont	Dissolved Sodium	8.99	86	88.09	80.36	95.83
Piedmont	Dissolved Sodium	9.23	87	88.67	80.80	96.54
Piedmont	Dissolved Sodium	9.39	88	92.05	85.94	98.16
Piedmont	Dissolved Sodium	9.50	89	92.63	86.62	98.64
Piedmont	Dissolved Sodium	9.86	90	93.43	87.57	99.29
Piedmont	Dissolved Sodium	12.80	91	94.23	88.47	99.99
Piedmont	Dissolved Sodium	13.00	92	95.03	89.40	100.00
Piedmont	Dissolved Sodium	14.70	93	98.40	96.71	100.00
Piedmont	Dissolved Sodium	16.60	94	99.20	97.92	100.00
Piedmont	Dissolved Sodium	20.60	95	100.00	100.00	100.00
Northern Piedmont	Dissolved Sodium	2.24	1	1.03	0.00	2.80
Northern Piedmont	Dissolved Sodium	2.35	2	2.84	0.00	5.79
Northern Piedmont	Dissolved Sodium	2.61	3	4.65	1.40	7.89
Northern Piedmont	Dissolved Sodium	2.83	4	7.14	2.90	11.38
Northern Piedmont	Dissolved Sodium	3.12	5	8.95	3.16	14.73
Northern Piedmont	Dissolved Sodium	3.32	6	10.76	3.80	17.72
Northern Piedmont	Dissolved Sodium	3.40	7	21.29	7.06	35.52
Northern Piedmont	Dissolved Sodium	3.55	8	22.32	8.00	36.64
Northern Piedmont	Dissolved Sodium	3.67	9	23.34	8.95	37.74
Northern Piedmont	Dissolved Sodium	4.16	10	33.88	15.01	52.74
Northern Piedmont	Dissolved Sodium	4.45	11	35.69	16.79	54.58
Northern Piedmont	Dissolved Sodium	4.57	12	38.18	19.15	57.20
Northern Piedmont	Dissolved Sodium	5.00	13	48.71	29.10	68.32
Northern Piedmont	Dissolved Sodium	5.06	14	59.24	40.52	77.97
Northern Piedmont	Dissolved Sodium	5.19	15	59.85	41.25	78.45
Northern Piedmont	Dissolved Sodium	5.29	16	60.88	42.65	79.11
Northern Piedmont	Dissolved Sodium	5.54	17	61.49	43.36	79.62
Northern Piedmont	Dissolved Sodium	5.57	18	62.52	44.44	80.59
Northern Piedmont	Dissolved Sodium	5.62	19	73.05	57.24	88.86
Northern Piedmont	Dissolved Sodium	6.10	20	73.66	57.99	89.32
Northern Piedmont	Dissolved Sodium	7.02	21	74.68	58.87	90.50
Northern Piedmont	Dissolved Sodium	7.03	22	77.18	61.89	92.46
Northern Piedmont	Dissolved Sodium	8.33	23	78.20	62.96	93.44
Northern Piedmont	Dissolved Sodium	10.00	24	80.69	64.84	96.55
Northern Piedmont	Dissolved Sodium	10.40	25	81.72	65.35	98.10
Northern Piedmont	Dissolved Sodium	10.50	26	83.53	67.57	99.49
Northern Piedmont	Dissolved Sodium	12.30	27	86.02	69.98	100.00
Northern Piedmont	Dissolved Sodium	18.70	28	96.55	92.69	100.00
Northern Piedmont	Dissolved Sodium	32.40	29	98.36	96.58	100.00
Northern Piedmont	Dissolved Sodium	37.70	30	98.97	97.22	100.00

Northern Piedmont	Dissolved Sodium	133.00	31	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	0.32	1	0.94	0.00	2.50
Central Appalachian Ridges and Valleys	Dissolved Sodium	0.62	2	2.23	0.00	5.07
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.00	13	36.54	22.28	50.80
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.03	14	37.48	23.29	51.68
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.09	15	38.78	24.57	52.98
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.12	16	40.07	25.95	54.19
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.17	17	41.36	27.29	55.43
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.24	18	41.89	27.87	55.91
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.45	19	43.19	29.39	56.98
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.55	20	44.48	30.95	58.01
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.57	21	45.42	32.03	58.81
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.58	22	45.95	32.64	59.26
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.70	23	46.89	33.61	60.17
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.71	24	47.83	34.57	61.08
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.76	25	48.77	35.64	61.89
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.80	26	49.70	36.67	62.74
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.84	27	51.00	37.96	64.03
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.89	28	52.29	39.28	65.29
Central Appalachian Ridges and Valleys	Dissolved Sodium	1.99	29	53.58	40.67	66.50
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.05	30	53.90	41.05	66.74
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.33	31	54.84	42.12	67.55
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.47	32	56.13	43.74	68.52
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.54	33	57.07	44.76	69.37
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.55	34	57.60	45.20	70.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.63	35	58.54	46.22	70.86
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.64	36	59.83	47.51	72.16
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.71	37	60.36	48.18	72.55
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.87	38	60.68	48.49	72.87
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.90	39	61.62	49.56	73.68
Central Appalachian Ridges and Valleys	Dissolved Sodium	2.93	40	62.15	50.09	74.21
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.11	41	63.09	51.09	75.09
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.14	42	63.62	51.62	75.63
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.26	43	64.91	52.87	76.96
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.43	44	65.23	53.19	77.27
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.59	45	66.17	54.16	78.18
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.61	46	67.46	55.79	79.14
Central Appalachian Ridges and Valleys	Dissolved Sodium	3.75	47	67.78	56.12	79.43
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.04	48	68.72	57.11	80.33
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.19	49	70.01	58.53	81.49
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.26	50	70.54	59.11	81.97
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.43	51	71.48	60.01	82.95
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.88	52	72.77	61.06	84.49
Central Appalachian Ridges and Valleys	Dissolved Sodium	4.98	53	73.09	61.37	84.81
Central Appalachian Ridges and Valleys	Dissolved Sodium	5.00	54	74.38	62.76	86.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	5.13	55	74.91	63.32	86.50
Central Appalachian Ridges and Valleys	Dissolved Sodium	5.39	56	75.45	63.82	87.07
Central Appalachian Ridges and Valleys	Dissolved Sodium	5.47	57	76.38	64.45	88.32
Central Appalachian Ridges and Valleys	Dissolved Sodium	6.00	58	76.92	64.98	88.85
Central Appalachian Ridges and Valleys	Dissolved Sodium	6.56	59	77.86	65.72	89.99
Central Appalachian Ridges and Valleys	Dissolved Sodium	6.84	60	78.39	66.28	90.50
Central Appalachian Ridges and Valleys	Dissolved Sodium	7.11	61	78.92	66.78	91.06
Central Appalachian Ridges and Valleys	Dissolved Sodium	7.25	62	79.45	67.19	91.71



Central Appalachian Ridges and Valleys	Dissolved Sodium	7.72	63	80.75	68.52	92.97
Central Appalachian Ridges and Valleys	Dissolved Sodium	8.20	64	81.68	69.34	94.03
Central Appalachian Ridges and Valleys	Dissolved Sodium	8.43	65	82.98	70.67	95.29
Central Appalachian Ridges and Valleys	Dissolved Sodium	8.57	66	84.27	72.05	96.48
Central Appalachian Ridges and Valleys	Dissolved Sodium	8.97	67	89.73	80.45	99.02
Central Appalachian Ridges and Valleys	Dissolved Sodium	9.30	68	90.27	81.02	99.51
Central Appalachian Ridges and Valleys	Dissolved Sodium	12.60	69	91.56	82.58	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	19.00	70	92.09	83.15	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	22.40	71	92.62	83.69	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	23.60	72	93.16	84.25	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	30.10	73	93.47	84.58	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	35.20	74	94.00	85.14	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	42.00	75	94.54	85.70	100.00
Central Appalachian Ridges and Valleys	Dissolved Sodium	60.90	76	100.00	100.00	100.00
Southeastern Plains	Dissolved Sodium	1.00	1	4.02	0.00	11.01
Southeastern Plains	Dissolved Sodium	2.44	2	8.04	0.00	17.72
Southeastern Plains	Dissolved Sodium	2.49	3	10.96	0.57	21.35
Southeastern Plains	Dissolved Sodium	2.51	4	27.95	3.41	52.49
Southeastern Plains	Dissolved Sodium	2.67	5	31.97	9.08	54.87
Southeastern Plains	Dissolved Sodium	3.43	6	32.95	9.78	56.12
Southeastern Plains	Dissolved Sodium	3.84	7	34.61	11.42	57.80
Southeastern Plains	Dissolved Sodium	4.51	8	38.63	17.22	60.04
Southeastern Plains	Dissolved Sodium	4.81	9	41.55	20.24	62.86
Southeastern Plains	Dissolved Sodium	5.11	10	45.57	24.14	67.00
Southeastern Plains	Dissolved Sodium	5.44	11	49.59	28.39	70.79
Southeastern Plains	Dissolved Sodium	5.65	12	50.57	28.88	72.26
Southeastern Plains	Dissolved Sodium	5.90	13	51.04	29.15	72.93
Southeastern Plains	Dissolved Sodium	6.63	14	52.70	29.92	75.48
Southeastern Plains	Dissolved Sodium	7.27	15	69.69	47.32	92.07
Southeastern Plains	Dissolved Sodium	7.55	16	73.71	50.62	96.80
Southeastern Plains	Dissolved Sodium	11.50	17	75.37	52.18	98.55
Southeastern Plains	Dissolved Sodium	11.70	18	76.35	53.12	99.58
Southeastern Plains	Dissolved Sodium	13.20	19	80.37	57.18	100.00
Southeastern Plains	Dissolved Sodium	13.30	20	81.35	58.11	100.00
Southeastern Plains	Dissolved Sodium	18.00	21	83.01	59.82	100.00
Southeastern Plains	Dissolved Sodium	52.10	22	100.00	100.00	100.00
Blue Ridge Mountains	Dissolved Sodium	1.00	3	27.35	4.22	50.49
Blue Ridge Mountains	Dissolved Sodium	1.21	4	28.24	4.96	51.52
Blue Ridge Mountains	Dissolved Sodium	1.81	5	29.81	6.17	53.45
Blue Ridge Mountains	Dissolved Sodium	1.86	6	31.97	8.32	55.62
Blue Ridge Mountains	Dissolved Sodium	1.99	7	41.08	15.87	66.30
Blue Ridge Mountains	Dissolved Sodium	2.00	8	50.20	24.31	76.09
Blue Ridge Mountains	Dissolved Sodium	2.07	9	59.32	35.35	83.29
Blue Ridge Mountains	Dissolved Sodium	2.19	10	60.89	37.23	84.54
Blue Ridge Mountains	Dissolved Sodium	2.53	11	63.04	39.96	86.13
Blue Ridge Mountains	Dissolved Sodium	2.54	12	65.20	42.34	88.06
Blue Ridge Mountains	Dissolved Sodium	3.04	13	66.77	43.69	89.84
Blue Ridge Mountains	Dissolved Sodium	3.22	14	68.92	46.04	91.80
Blue Ridge Mountains	Dissolved Sodium	3.49	15	78.04	59.11	96.97
Blue Ridge Mountains	Dissolved Sodium	3.60	16	80.20	61.40	98.99
Blue Ridge Mountains	Dissolved Sodium	5.46	17	81.76	62.59	100.00
Blue Ridge Mountains	Dissolved Sodium	6.51	18	90.88	76.71	100.00
Blue Ridge Mountains	Dissolved Sodium	8.62	19	100.00	100.00	100.00



Central Appalachians	Dissolved Sodium	1.00	1	5.10	0.00	13.68
Central Appalachians	Dissolved Sodium	2.06	2	26.67	0.00	56.61
Central Appalachians	Dissolved Sodium	3.40	3	31.77	1.27	62.28
Central Appalachians	Dissolved Sodium	3.94	4	35.48	5.56	65.40
Central Appalachians	Dissolved Sodium	4.41	5	39.19	10.12	68.25
Central Appalachians	Dissolved Sodium	6.49	6	42.89	15.22	70.56
Central Appalachians	Dissolved Sodium	6.54	7	47.99	21.81	74.18
Central Appalachians	Dissolved Sodium	7.60	8	51.70	24.78	78.61
Central Appalachians	Dissolved Sodium	10.30	9	55.41	28.67	82.14
Central Appalachians	Dissolved Sodium	10.60	10	60.51	32.70	88.32
Central Appalachians	Dissolved Sodium	18.40	11	64.21	36.18	92.25
Central Appalachians	Dissolved Sodium	19.50	12	85.78	73.12	98.44
Central Appalachians	Dissolved Sodium	21.20	13	87.88	76.01	99.76
Central Appalachians	Dissolved Sodium	25.40	14	89.99	79.23	100.00
Central Appalachians	Dissolved Sodium	27.60	15	92.09	82.29	100.00
Central Appalachians	Dissolved Sodium	42.10	16	94.19	85.96	100.00
Central Appalachians	Dissolved Sodium	43.70	17	96.29	89.38	100.00
Central Appalachians	Dissolved Sodium	124.00	18	100.00	100.00	100.00

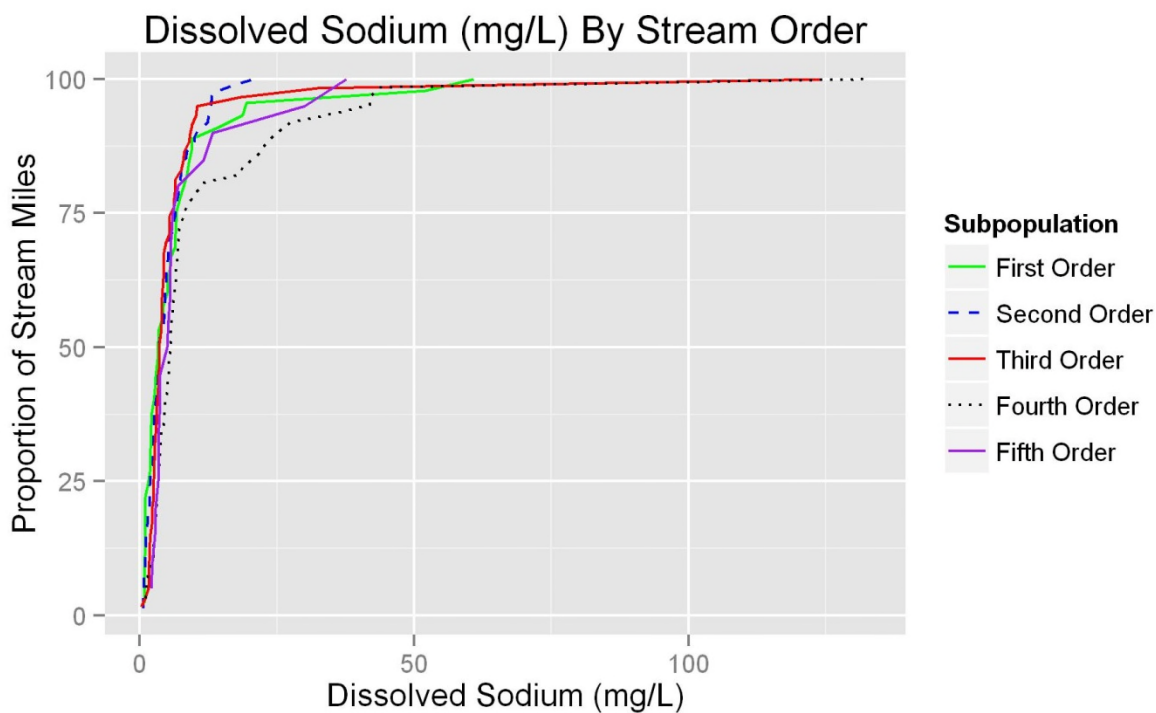


Figure 79. Dissolved Sodium by Stream Order CDF graph.

Dissolved sodium CDF curves by stream order are shown in Figure 79. Table 46 corresponds to Figure 79. Ninety-eight percent of third order stream miles have dissolved sodium concentrations less than 32.4 mg/L. Ninety-five percent of first order stream miles have less than 19.5 mg/L dissolved sodium. The 98<sup>th</sup> percentile of second order streams is 16.6 mg/L. Eighty-five percent of fourth order stream miles have dissolved sodium concentrations below

21.2 mg/L. One hundred percent of fifth order streams have dissolved sodium concentrations less than 37.7 mg/L.

Table 46. Dissolved Sodium Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Dissolved Sodium	0.76	1	2.22	0.00	6.04
First Order	Dissolved Sodium	1.00	9	20.00	12.07	27.93
First Order	Dissolved Sodium	1.04	10	22.22	13.43	31.02
First Order	Dissolved Sodium	1.49	11	24.44	14.98	33.91
First Order	Dissolved Sodium	1.88	12	26.67	16.80	36.53
First Order	Dissolved Sodium	1.99	13	28.89	18.91	38.87
First Order	Dissolved Sodium	2.00	14	31.11	21.07	41.15
First Order	Dissolved Sodium	2.06	15	33.33	23.09	43.58
First Order	Dissolved Sodium	2.07	16	35.56	25.82	45.29
First Order	Dissolved Sodium	2.25	17	37.78	28.05	47.50
First Order	Dissolved Sodium	2.51	18	40.00	29.55	50.45
First Order	Dissolved Sodium	2.74	19	42.22	32.21	52.23
First Order	Dissolved Sodium	2.88	20	44.44	34.82	54.06
First Order	Dissolved Sodium	3.09	21	46.67	36.64	56.70
First Order	Dissolved Sodium	3.40	22	48.89	38.13	59.65
First Order	Dissolved Sodium	3.42	23	51.11	41.04	61.18
First Order	Dissolved Sodium	3.49	24	53.33	42.84	63.83
First Order	Dissolved Sodium	4.16	25	55.56	44.85	66.26
First Order	Dissolved Sodium	4.33	26	57.78	46.75	68.80
First Order	Dissolved Sodium	5.00	27	60.00	49.17	70.83
First Order	Dissolved Sodium	5.06	28	62.22	51.24	73.21
First Order	Dissolved Sodium	5.45	29	64.44	53.53	75.36
First Order	Dissolved Sodium	5.62	30	66.67	55.83	77.51
First Order	Dissolved Sodium	6.48	31	68.89	57.65	80.13
First Order	Dissolved Sodium	6.51	32	71.11	60.18	82.04
First Order	Dissolved Sodium	6.64	33	73.33	63.04	83.62
First Order	Dissolved Sodium	6.78	34	75.56	64.98	86.13
First Order	Dissolved Sodium	7.27	35	77.78	67.45	88.10
First Order	Dissolved Sodium	8.05	36	80.00	69.63	90.37
First Order	Dissolved Sodium	8.62	37	82.22	72.32	92.12
First Order	Dissolved Sodium	8.97	38	84.44	75.12	93.77
First Order	Dissolved Sodium	9.39	39	86.67	77.95	95.38
First Order	Dissolved Sodium	9.51	40	88.89	80.64	97.14
First Order	Dissolved Sodium	14.70	41	91.11	83.73	98.49
First Order	Dissolved Sodium	18.70	42	93.33	86.92	99.74
First Order	Dissolved Sodium	19.50	43	95.56	90.14	100.00
First Order	Dissolved Sodium	52.10	44	97.78	93.88	100.00
First Order	Dissolved Sodium	60.90	45	100.00	100.00	100.00
Second Order	Dissolved Sodium	0.62	1	1.35	0.00	3.60
Second Order	Dissolved Sodium	1.00	9	12.16	5.83	18.50
Second Order	Dissolved Sodium	1.09	10	13.51	7.11	19.92
Second Order	Dissolved Sodium	1.12	11	14.86	8.34	21.39
Second Order	Dissolved Sodium	1.17	12	16.22	9.44	22.99
Second Order	Dissolved Sodium	1.45	13	17.57	10.97	24.16
Second Order	Dissolved Sodium	1.55	14	18.92	12.26	25.58
Second Order	Dissolved Sodium	1.78	15	20.27	13.19	27.35

Second Order	Dissolved Sodium	1.84	16	21.62	14.39	28.85
Second Order	Dissolved Sodium	1.86	17	22.97	15.70	30.25
Second Order	Dissolved Sodium	1.89	18	24.32	16.86	31.79
Second Order	Dissolved Sodium	1.99	19	25.68	18.40	32.96
Second Order	Dissolved Sodium	2.04	20	27.03	19.49	34.56
Second Order	Dissolved Sodium	2.44	21	28.38	20.56	36.20
Second Order	Dissolved Sodium	2.47	22	29.73	22.14	37.32
Second Order	Dissolved Sodium	2.50	23	31.08	23.15	39.01
Second Order	Dissolved Sodium	2.53	24	32.43	24.31	40.56
Second Order	Dissolved Sodium	2.54	25	33.78	25.54	42.02
Second Order	Dissolved Sodium	2.64	26	35.14	26.84	43.43
Second Order	Dissolved Sodium	2.67	27	36.49	28.08	44.89
Second Order	Dissolved Sodium	2.71	28	37.84	29.18	46.49
Second Order	Dissolved Sodium	2.83	29	39.19	30.50	47.88
Second Order	Dissolved Sodium	3.02	30	40.54	31.77	49.31
Second Order	Dissolved Sodium	3.22	31	41.89	33.26	50.53
Second Order	Dissolved Sodium	3.26	32	43.24	34.43	52.06
Second Order	Dissolved Sodium	3.40	33	44.59	35.66	53.53
Second Order	Dissolved Sodium	3.51	34	45.95	36.88	55.01
Second Order	Dissolved Sodium	3.55	35	47.30	38.35	56.24
Second Order	Dissolved Sodium	3.60	37	50.00	41.29	58.71
Second Order	Dissolved Sodium	3.61	38	51.35	42.95	59.76
Second Order	Dissolved Sodium	3.90	39	52.70	44.01	61.40
Second Order	Dissolved Sodium	4.19	40	54.05	45.43	62.68
Second Order	Dissolved Sodium	4.42	41	55.41	46.50	64.32
Second Order	Dissolved Sodium	4.51	42	56.76	47.93	65.58
Second Order	Dissolved Sodium	4.57	43	58.11	49.24	66.97
Second Order	Dissolved Sodium	4.64	44	59.46	50.47	68.44
Second Order	Dissolved Sodium	4.65	45	60.81	51.88	69.74
Second Order	Dissolved Sodium	4.88	46	62.16	52.97	71.36
Second Order	Dissolved Sodium	4.90	47	63.51	54.58	72.45
Second Order	Dissolved Sodium	5.00	48	64.86	56.19	73.54
Second Order	Dissolved Sodium	5.11	49	66.22	57.52	74.91
Second Order	Dissolved Sodium	5.26	50	67.57	58.67	76.46
Second Order	Dissolved Sodium	5.38	51	68.92	60.04	77.80
Second Order	Dissolved Sodium	5.44	52	70.27	61.63	78.91
Second Order	Dissolved Sodium	5.96	53	71.62	63.07	80.18
Second Order	Dissolved Sodium	6.04	54	72.97	64.70	81.25
Second Order	Dissolved Sodium	6.37	55	74.32	66.07	82.58
Second Order	Dissolved Sodium	6.54	56	75.68	67.55	83.81
Second Order	Dissolved Sodium	6.79	57	77.03	69.21	84.84
Second Order	Dissolved Sodium	7.03	58	78.38	70.81	85.94
Second Order	Dissolved Sodium	7.08	59	79.73	72.19	87.27
Second Order	Dissolved Sodium	7.35	60	81.08	73.72	88.44
Second Order	Dissolved Sodium	7.55	61	82.43	75.40	89.46
Second Order	Dissolved Sodium	7.72	62	83.78	77.08	90.48
Second Order	Dissolved Sodium	8.43	63	85.14	78.89	91.38
Second Order	Dissolved Sodium	8.57	64	86.49	80.64	92.33
Second Order	Dissolved Sodium	9.86	65	87.84	82.41	93.27
Second Order	Dissolved Sodium	10.00	66	89.19	83.63	94.75
Second Order	Dissolved Sodium	10.60	67	90.54	85.48	95.60
Second Order	Dissolved Sodium	12.30	68	91.89	86.99	96.79
Second Order	Dissolved Sodium	12.60	69	93.24	88.89	97.60

Second Order	Dissolved Sodium	12.80	70	94.59	90.52	98.67
Second Order	Dissolved Sodium	13.00	71	95.95	92.56	99.33
Second Order	Dissolved Sodium	13.20	72	97.30	94.77	99.82
Second Order	Dissolved Sodium	16.60	73	98.65	96.44	100.00
Second Order	Dissolved Sodium	20.60	74	100.00	100.00	100.00
Third Order	Dissolved Sodium	0.32	1	1.69	0.00	4.47
Third Order	Dissolved Sodium	1.03	2	3.39	0.00	7.35
Third Order	Dissolved Sodium	1.57	3	5.08	0.96	9.21
Third Order	Dissolved Sodium	1.70	4	6.78	1.71	11.85
Third Order	Dissolved Sodium	1.71	5	8.47	2.70	14.25
Third Order	Dissolved Sodium	1.76	6	10.17	4.53	15.81
Third Order	Dissolved Sodium	1.80	7	11.86	5.92	17.81
Third Order	Dissolved Sodium	1.81	8	13.56	7.03	20.09
Third Order	Dissolved Sodium	1.95	9	15.25	8.12	22.39
Third Order	Dissolved Sodium	2.19	10	16.95	9.75	24.14
Third Order	Dissolved Sodium	2.33	11	18.64	11.76	25.53
Third Order	Dissolved Sodium	2.35	12	20.34	12.93	27.75
Third Order	Dissolved Sodium	2.49	13	22.03	14.13	29.94
Third Order	Dissolved Sodium	2.54	14	23.73	15.76	31.70
Third Order	Dissolved Sodium	2.59	15	25.42	17.23	33.61
Third Order	Dissolved Sodium	2.61	16	27.12	18.94	35.29
Third Order	Dissolved Sodium	2.63	17	28.81	20.76	36.87
Third Order	Dissolved Sodium	2.74	18	30.51	22.40	38.61
Third Order	Dissolved Sodium	2.80	19	32.20	23.73	40.68
Third Order	Dissolved Sodium	2.90	20	33.90	25.24	42.56
Third Order	Dissolved Sodium	3.04	21	35.59	27.18	44.01
Third Order	Dissolved Sodium	3.11	22	37.29	29.02	45.56
Third Order	Dissolved Sodium	3.12	23	38.98	30.22	47.74
Third Order	Dissolved Sodium	3.21	24	40.68	31.66	49.69
Third Order	Dissolved Sodium	3.32	25	42.37	32.99	51.76
Third Order	Dissolved Sodium	3.49	26	44.07	34.57	53.57
Third Order	Dissolved Sodium	3.51	27	45.76	36.12	55.40
Third Order	Dissolved Sodium	3.55	28	47.46	37.56	57.35
Third Order	Dissolved Sodium	3.57	29	49.15	39.19	59.12
Third Order	Dissolved Sodium	3.59	30	50.85	40.90	60.79
Third Order	Dissolved Sodium	3.85	31	52.54	42.67	62.41
Third Order	Dissolved Sodium	3.94	32	54.24	44.46	64.02
Third Order	Dissolved Sodium	4.04	34	57.63	47.75	67.50
Third Order	Dissolved Sodium	4.12	35	59.32	49.49	69.16
Third Order	Dissolved Sodium	4.13	36	61.02	50.97	71.07
Third Order	Dissolved Sodium	4.28	37	62.71	52.88	72.54
Third Order	Dissolved Sodium	4.41	38	64.41	54.78	74.03
Third Order	Dissolved Sodium	4.43	39	66.10	56.66	75.54
Third Order	Dissolved Sodium	4.45	40	67.80	58.47	77.12
Third Order	Dissolved Sodium	4.81	41	69.49	60.50	78.48
Third Order	Dissolved Sodium	5.43	42	71.19	62.28	80.09
Third Order	Dissolved Sodium	5.46	43	72.88	64.14	81.62
Third Order	Dissolved Sodium	5.47	44	74.58	65.86	83.29
Third Order	Dissolved Sodium	6.23	45	76.27	67.68	84.86
Third Order	Dissolved Sodium	6.29	46	77.97	69.40	86.53
Third Order	Dissolved Sodium	6.49	47	79.66	71.38	87.95
Third Order	Dissolved Sodium	6.56	48	81.36	73.51	89.20
Third Order	Dissolved Sodium	7.60	49	83.05	74.81	91.29

Third Order	Dissolved Sodium	7.95	50	84.75	76.82	92.67
Third Order	Dissolved Sodium	8.20	51	86.44	79.01	93.87
Third Order	Dissolved Sodium	8.99	52	88.14	81.33	94.94
Third Order	Dissolved Sodium	9.23	53	89.83	83.62	96.04
Third Order	Dissolved Sodium	9.50	54	91.53	85.93	97.12
Third Order	Dissolved Sodium	10.30	55	93.22	87.76	98.68
Third Order	Dissolved Sodium	10.50	56	94.92	90.20	99.63
Third Order	Dissolved Sodium	18.40	57	96.61	92.45	100.00
Third Order	Dissolved Sodium	32.40	58	98.31	95.47	100.00
Third Order	Dissolved Sodium	124.00	59	100.00	100.00	100.00
Fourth Order	Dissolved Sodium	1.00	2	3.23	0.00	6.99
Fourth Order	Dissolved Sodium	1.21	3	4.84	0.24	9.43
Fourth Order	Dissolved Sodium	1.24	4	6.45	1.70	11.20
Fourth Order	Dissolved Sodium	1.58	5	8.06	3.67	12.46
Fourth Order	Dissolved Sodium	2.24	6	9.68	4.51	14.85
Fourth Order	Dissolved Sodium	2.55	7	11.29	5.99	16.59
Fourth Order	Dissolved Sodium	2.56	8	12.90	6.93	18.88
Fourth Order	Dissolved Sodium	2.71	9	14.52	8.08	20.95
Fourth Order	Dissolved Sodium	2.90	10	16.13	9.37	22.88
Fourth Order	Dissolved Sodium	2.93	11	17.74	10.49	24.99
Fourth Order	Dissolved Sodium	3.13	12	19.35	12.15	26.55
Fourth Order	Dissolved Sodium	3.14	14	22.58	15.06	30.10
Fourth Order	Dissolved Sodium	3.40	15	24.19	16.44	31.94
Fourth Order	Dissolved Sodium	3.44	16	25.81	18.09	33.52
Fourth Order	Dissolved Sodium	3.47	17	27.42	20.14	34.70
Fourth Order	Dissolved Sodium	3.55	18	29.03	21.33	36.73
Fourth Order	Dissolved Sodium	3.67	19	30.65	22.88	38.41
Fourth Order	Dissolved Sodium	3.84	20	32.26	24.05	40.46
Fourth Order	Dissolved Sodium	3.98	21	33.87	25.22	42.53
Fourth Order	Dissolved Sodium	4.26	22	35.48	26.86	44.11
Fourth Order	Dissolved Sodium	4.51	23	37.10	28.54	45.66
Fourth Order	Dissolved Sodium	4.58	24	38.71	30.12	47.30
Fourth Order	Dissolved Sodium	4.74	25	40.32	31.49	49.15
Fourth Order	Dissolved Sodium	5.03	26	41.94	32.84	51.04
Fourth Order	Dissolved Sodium	5.13	27	43.55	34.61	52.49
Fourth Order	Dissolved Sodium	5.29	28	45.16	35.97	54.36
Fourth Order	Dissolved Sodium	5.39	29	46.77	37.45	56.10
Fourth Order	Dissolved Sodium	5.45	30	48.39	39.34	57.43
Fourth Order	Dissolved Sodium	5.57	31	50.00	41.23	58.77
Fourth Order	Dissolved Sodium	5.67	32	51.61	42.89	60.33
Fourth Order	Dissolved Sodium	5.70	33	53.23	44.52	61.94
Fourth Order	Dissolved Sodium	5.86	34	54.84	46.51	63.17
Fourth Order	Dissolved Sodium	6.00	35	56.45	48.15	64.76
Fourth Order	Dissolved Sodium	6.05	36	58.06	49.62	66.51
Fourth Order	Dissolved Sodium	6.25	37	59.68	51.65	67.71
Fourth Order	Dissolved Sodium	6.47	38	61.29	53.11	69.47
Fourth Order	Dissolved Sodium	6.61	39	62.90	55.06	70.75
Fourth Order	Dissolved Sodium	6.63	40	64.52	56.73	72.30
Fourth Order	Dissolved Sodium	6.84	41	66.13	58.85	73.41
Fourth Order	Dissolved Sodium	7.02	43	69.35	62.13	76.58
Fourth Order	Dissolved Sodium	7.11	44	70.97	64.22	77.71
Fourth Order	Dissolved Sodium	7.25	45	72.58	65.63	79.53
Fourth Order	Dissolved Sodium	7.96	46	74.19	67.53	80.86

Fourth Order	Dissolved Sodium	8.33	47	75.81	69.09	82.52
Fourth Order	Dissolved Sodium	9.30	48	77.42	71.30	83.54
Fourth Order	Dissolved Sodium	10.40	49	79.03	73.12	84.94
Fourth Order	Dissolved Sodium	11.50	50	80.65	75.14	86.15
Fourth Order	Dissolved Sodium	18.00	51	82.26	77.47	87.05
Fourth Order	Dissolved Sodium	19.00	52	83.87	79.86	87.88
Fourth Order	Dissolved Sodium	21.20	53	85.48	80.63	90.34
Fourth Order	Dissolved Sodium	22.40	54	87.10	82.26	91.93
Fourth Order	Dissolved Sodium	23.60	55	88.71	83.38	94.04
Fourth Order	Dissolved Sodium	25.40	56	90.32	84.89	95.75
Fourth Order	Dissolved Sodium	27.60	57	91.94	86.49	97.38
Fourth Order	Dissolved Sodium	35.20	58	93.55	88.32	98.78
Fourth Order	Dissolved Sodium	42.00	59	95.16	90.53	99.79
Fourth Order	Dissolved Sodium	42.10	60	96.77	92.94	100.00
Fourth Order	Dissolved Sodium	43.70	61	98.39	95.77	100.00
Fourth Order	Dissolved Sodium	133.00	62	100.00	100.00	100.00
Fifth Order	Dissolved Sodium	2.05	1	5.00	0.00	13.49
Fifth Order	Dissolved Sodium	2.29	2	10.00	0.00	21.18
Fifth Order	Dissolved Sodium	2.74	3	15.00	0.92	29.08
Fifth Order	Dissolved Sodium	2.87	4	20.00	5.76	34.24
Fifth Order	Dissolved Sodium	3.41	5	25.00	9.07	40.93
Fifth Order	Dissolved Sodium	3.43	7	35.00	17.21	52.79
Fifth Order	Dissolved Sodium	3.67	8	40.00	21.27	58.73
Fifth Order	Dissolved Sodium	3.75	9	45.00	27.31	62.69
Fifth Order	Dissolved Sodium	4.98	10	50.00	33.75	66.25
Fifth Order	Dissolved Sodium	5.19	11	55.00	36.85	73.15
Fifth Order	Dissolved Sodium	5.53	12	60.00	42.08	77.92
Fifth Order	Dissolved Sodium	5.54	13	65.00	46.66	83.34
Fifth Order	Dissolved Sodium	5.65	14	70.00	52.72	87.28
Fifth Order	Dissolved Sodium	6.10	15	75.00	58.17	91.83
Fifth Order	Dissolved Sodium	6.99	16	80.00	64.46	95.54
Fifth Order	Dissolved Sodium	11.70	17	85.00	70.53	99.47
Fifth Order	Dissolved Sodium	13.30	18	90.00	78.31	100.00
Fifth Order	Dissolved Sodium	30.10	19	95.00	86.90	100.00
Fifth Order	Dissolved Sodium	37.70	20	100.00	100.00	100.00

## Appendix J. Total Dissolved Sulfate Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Rivers and streams with increasing ionic strength (as measured by dissolved sulfates) are unable to support healthy aquatic communities (VDEQ-WQS, 2012). Dissolved sulfates over 75 mg/L increase the likelihood of a stream site having a low VSCI score. The scatterplot in Figure 80 shows decreasing VSCI scores as dissolved sulfates increase. The case for this increased risk to the aquatic community is presented in this appendix.

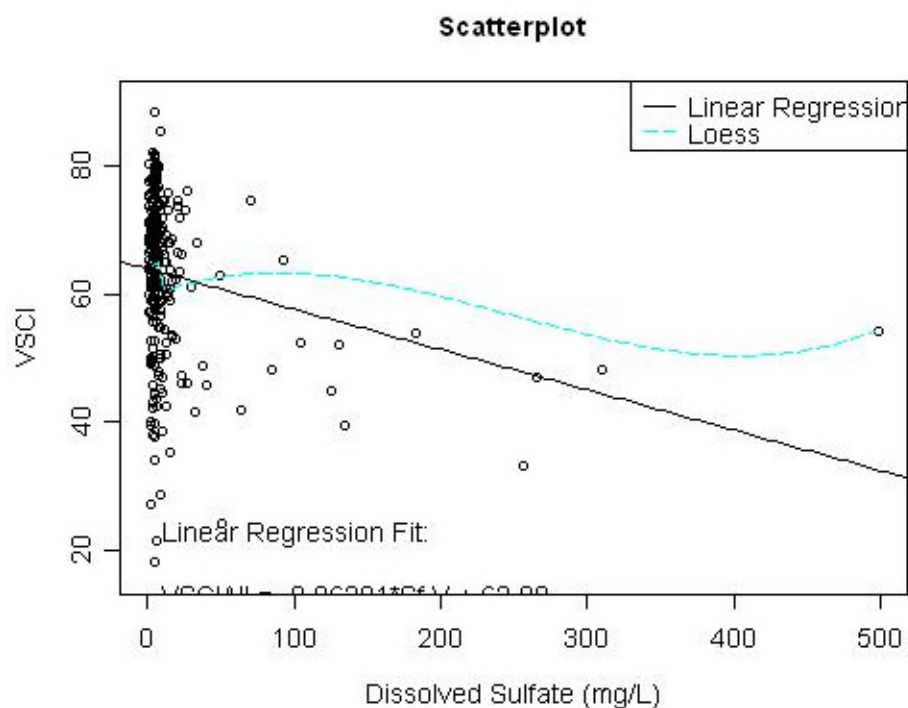


Figure 80. Total Dissolved Sulfate Stressor Gradient Scatterplot.

### *Total Dissolved Sulfate Relative Risk Results*

An optimal level of less than 10 mg/L was selected based on the low risk to aquatic life. VDEQ estimates 80% of Virginia streams have dissolved sulfates less than 10 mg/L (Table 47, Figure 85). Dissolved sulfate concentrations above 75 mg/L are considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 81) and scatter plot graphs. Only 1.6% of Virginia streams have a dissolved sulfate concentration above 75 mg/L (Figure 82). VDEQ relative risk calculations found that a VSCI score is 4.3 times more likely to be below 50

when dissolved sulfate concentrations are above 75 mg/L than when dissolved sulfates is below 10 mg/L (Figure 82).

Table 47. Total Dissolved Sulfates Relative Risk Categories.

Stressor Parameters	Optimal	Suboptimal
Dissolved Sulfate (mg/L)	<10	>75

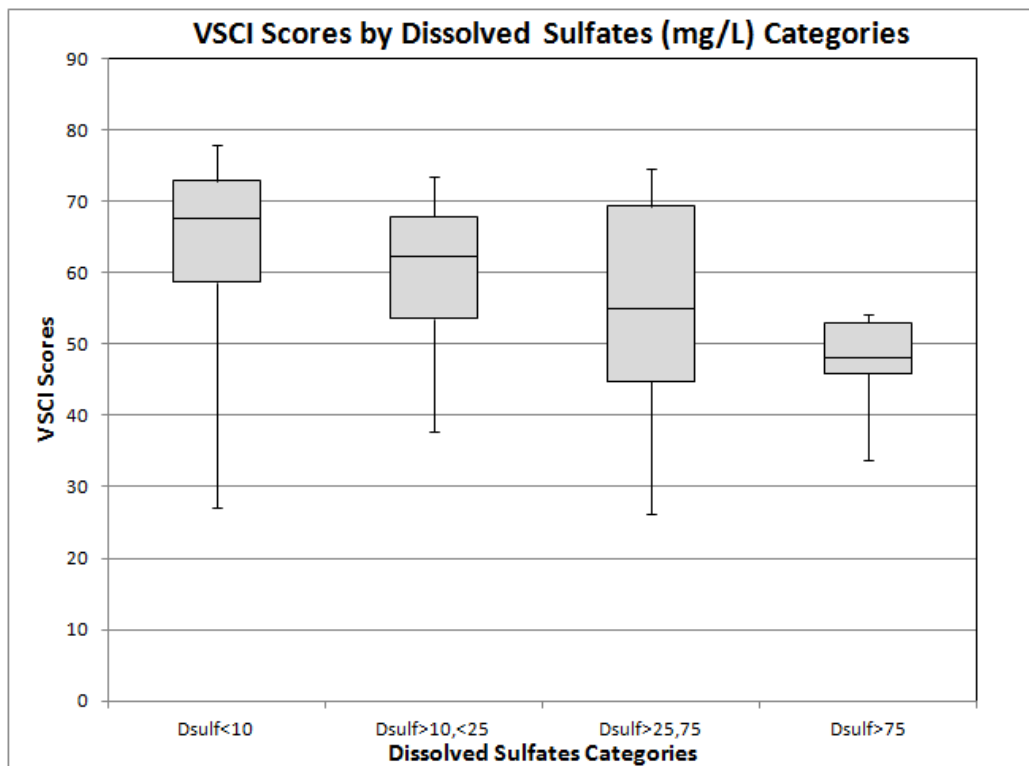


Figure 81. VSCI Scores by Dissolved Sulfates Categories.



Figure 82. Dissolved Sulfates Relative Extent (Dissolved sulfates > 75 mg/L) and Risk Results.



### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 12 sites with dissolved sulfates over 75 mg/L. One site out of twelve has a VSCI over 60. The probability of having VSCI score less than 60 when dissolved sulfates are 75 mg/L is 80% and the probability of impairment is 100% when dissolved sulfate concentrations are above 100 mg/L (Figure 83).

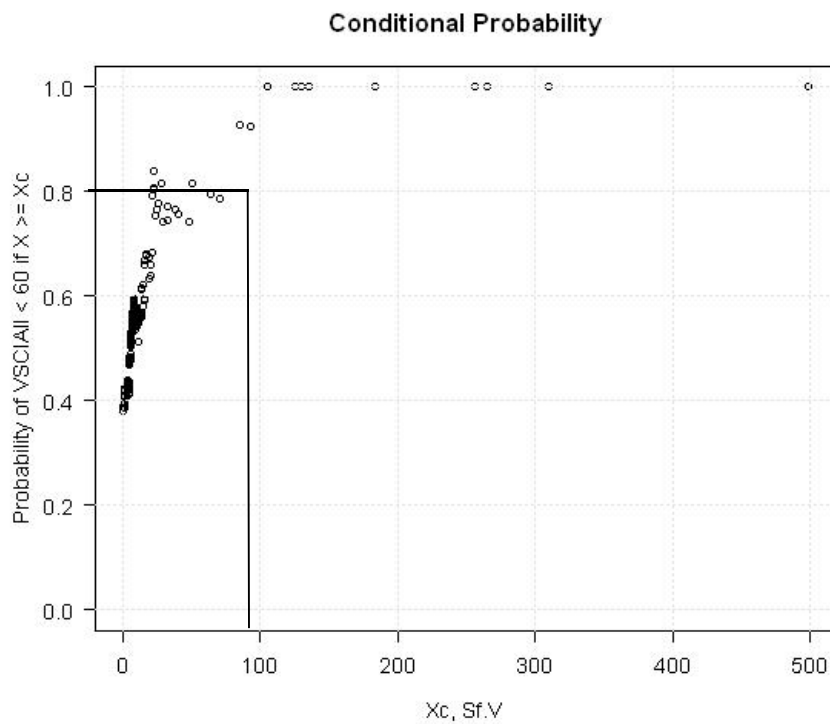


Figure 83. Probability of VSCI less than 60 if Dissolved Sulfates > 75 mg/L.

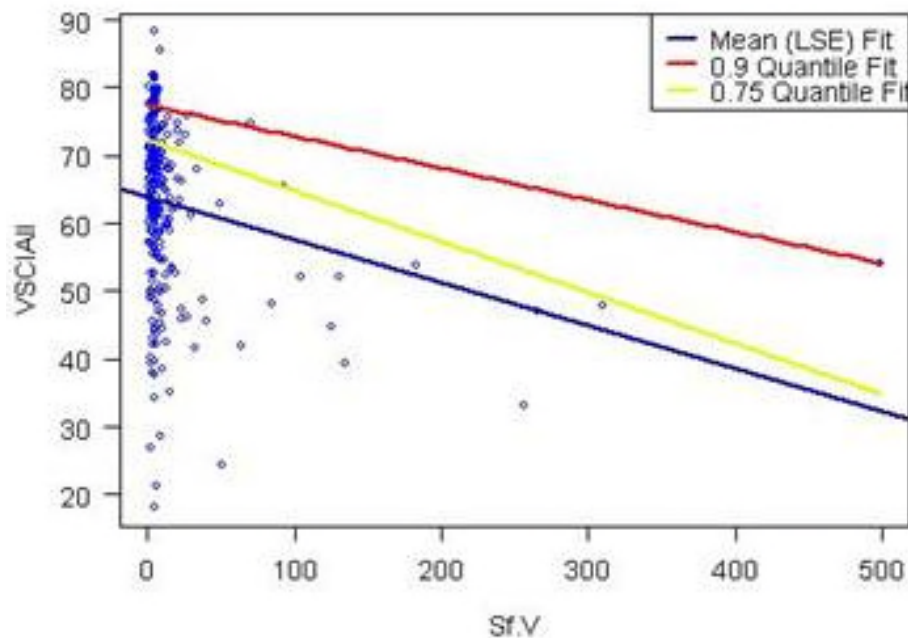


Figure 84. Quantile Regression VSCI versus Dissolved Sulfates (mg/L).

Dissolved sulfate quantile regression is displayed in Figure 84. The 0.9 quantile (red line) fit regression analysis shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores in relation to dissolved sulfates values. The 50<sup>th</sup> percentile of percentile of reference crosses at 118 mg/L, 25th percentile intersects at 246 mg/L, and the 10<sup>th</sup> percentile is equal to 375 mg/L. The 50<sup>th</sup> percentile of reference is associated with protective water chemistry values, while values at the 10<sup>th</sup> percentile tend to represent a number where the aquatic community is already stressed (Figure 84).

### *Dissolved Sulfate Concentrations and Probability of Stress to Aquatic Life*

VSCI scores are not likely to be depressed from dissolved sulfate concentrations below 10 mg/L (Table 48). Streams with dissolved sulfate above 75 mg/L do not support healthy benthic communities and are associated with VSCI scores less than 60.

Table 48. Total Dissolved Sulfates (mg/L) concentrations and probability of stress to aquatic life (based on VSCI scores).

Total Dissolved Sulfate	
Probability of Stress to Aquatic Life	Concentration (mg/L)
High	> 75
Medium	> 25, < 75
Low	> 10, < 25
None	< 10

### *Dissolved Sulfates Cumulative Distribution Function curves*

Dissolved sulfate cumulative distribution functions (CDF) are shown statewide, by major basin, major ecoregion (level III), and stream order in Figures 85-88. Tables 49-52 correspond to the aforementioned figures.

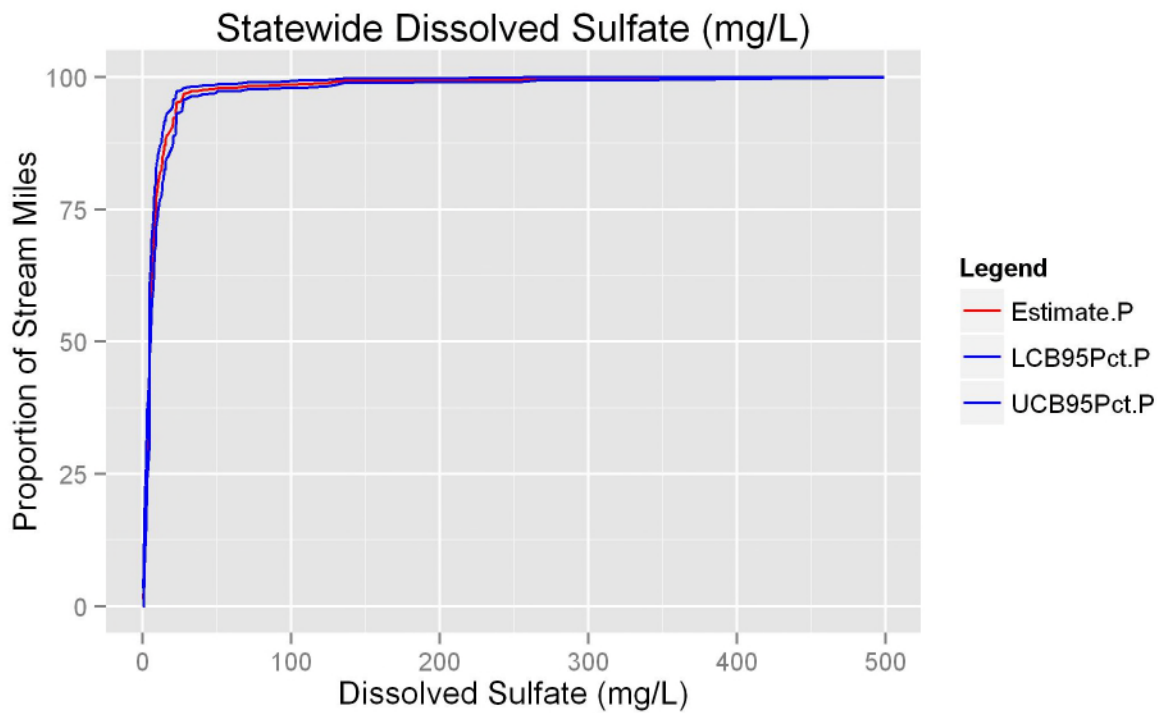


Figure 85. Dissolved Sulfates Statewide CDF graph.

Figure 85 shows that 95.3% of Virginia stream miles have dissolved sulfate concentrations less than 25.3 mg/L. Ninety-eight percent of Virginia stream miles are less than 70.2 mg/L.

Table 48. Dissolved Sulfates Population Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Dissolved sulfate	0.53	1	1.25	0.00	3.32
Virginia	Dissolved sulfate	0.71	2	2.50	0.00	5.28
Virginia	Dissolved sulfate	0.88	3	2.80	0.00	5.61
Virginia	Dissolved sulfate	0.90	4	3.01	0.18	5.85
Virginia	Dissolved sulfate	0.99	5	4.27	0.89	7.65
Virginia	Dissolved sulfate	1.00	7	4.86	1.45	8.27
Virginia	Dissolved sulfate	1.05	8	5.15	1.72	8.59
Virginia	Dissolved sulfate	1.06	9	6.41	2.64	10.17
Virginia	Dissolved sulfate	1.16	10	7.66	3.53	11.78
Virginia	Dissolved sulfate	1.27	11	8.91	4.49	13.33
Virginia	Dissolved sulfate	1.30	13	10.38	5.64	15.11
Virginia	Dissolved sulfate	1.35	14	10.67	5.91	15.43
Virginia	Dissolved sulfate	1.38	15	10.89	6.12	15.65
Virginia	Dissolved sulfate	1.54	18	12.65	7.56	17.74
Virginia	Dissolved sulfate	1.62	19	12.95	7.83	18.06
Virginia	Dissolved sulfate	1.64	20	13.16	8.04	18.28
Virginia	Dissolved sulfate	1.66	21	13.46	8.32	18.59

Virginia	Dissolved sulfate	1.72	22	14.71	9.26	20.16
Virginia	Dissolved sulfate	1.74	24	15.22	9.75	20.69
Virginia	Dissolved sulfate	1.84	25	15.43	9.95	20.92
Virginia	Dissolved sulfate	1.87	26	15.56	10.09	21.02
Virginia	Dissolved sulfate	1.88	27	15.77	10.32	21.22
Virginia	Dissolved sulfate	2.07	29	17.15	11.45	22.84
Virginia	Dissolved sulfate	2.12	30	17.27	11.59	22.95
Virginia	Dissolved sulfate	2.15	31	17.56	11.88	23.25
Virginia	Dissolved sulfate	2.16	32	17.69	11.99	23.38
Virginia	Dissolved sulfate	2.22	33	17.90	12.24	23.56
Virginia	Dissolved sulfate	2.25	34	17.97	12.32	23.62
Virginia	Dissolved sulfate	2.35	35	18.05	12.39	23.70
Virginia	Dissolved sulfate	2.39	36	18.17	12.51	23.82
Virginia	Dissolved sulfate	2.40	38	19.71	13.90	25.53
Virginia	Dissolved sulfate	2.44	39	19.79	13.96	25.61
Virginia	Dissolved sulfate	2.47	40	20.08	14.24	25.92
Virginia	Dissolved sulfate	2.64	41	20.21	14.36	26.05
Virginia	Dissolved sulfate	2.65	43	20.80	14.92	26.68
Virginia	Dissolved sulfate	2.71	44	22.05	15.98	28.12
Virginia	Dissolved sulfate	2.75	45	22.26	16.22	28.31
Virginia	Dissolved sulfate	2.79	46	22.39	16.36	28.41
Virginia	Dissolved sulfate	2.81	47	23.64	17.44	29.84
Virginia	Dissolved sulfate	2.84	48	23.71	17.51	29.91
Virginia	Dissolved sulfate	2.85	49	23.92	17.71	30.14
Virginia	Dissolved sulfate	2.87	50	24.05	17.83	30.27
Virginia	Dissolved sulfate	2.88	52	24.29	18.07	30.52
Virginia	Dissolved sulfate	2.89	54	24.88	18.72	31.05
Virginia	Dissolved sulfate	2.90	55	25.01	18.84	31.17
Virginia	Dissolved sulfate	2.92	56	25.13	18.95	31.30
Virginia	Dissolved sulfate	2.94	57	25.25	19.07	31.43
Virginia	Dissolved sulfate	3.07	59	25.54	19.37	31.70
Virginia	Dissolved sulfate	3.09	60	26.79	20.49	33.09
Virginia	Dissolved sulfate	3.10	61	28.04	21.58	34.50
Virginia	Dissolved sulfate	3.14	62	28.34	21.90	34.77
Virginia	Dissolved sulfate	3.18	65	30.02	23.50	36.53
Virginia	Dissolved sulfate	3.19	66	30.09	23.57	36.61
Virginia	Dissolved sulfate	3.24	67	30.39	23.86	36.92
Virginia	Dissolved sulfate	3.28	68	30.60	24.06	37.14
Virginia	Dissolved sulfate	3.38	69	30.90	24.34	37.45
Virginia	Dissolved sulfate	3.42	70	31.02	24.47	37.57
Virginia	Dissolved sulfate	3.45	71	31.32	24.75	37.88
Virginia	Dissolved sulfate	3.53	72	31.44	24.86	38.01
Virginia	Dissolved sulfate	3.63	73	31.51	24.93	38.08
Virginia	Dissolved sulfate	3.64	74	31.54	24.97	38.12
Virginia	Dissolved sulfate	3.69	75	31.76	25.17	38.34
Virginia	Dissolved sulfate	3.73	76	31.88	25.29	38.48
Virginia	Dissolved sulfate	3.75	77	32.00	25.42	38.58
Virginia	Dissolved sulfate	3.81	78	32.13	25.54	38.71
Virginia	Dissolved sulfate	3.86	79	32.42	25.84	39.00
Virginia	Dissolved sulfate	3.95	80	32.72	26.13	39.31
Virginia	Dissolved sulfate	4.11	81	32.93	26.33	39.53
Virginia	Dissolved sulfate	4.16	82	34.18	27.46	40.91
Virginia	Dissolved sulfate	4.30	83	34.40	27.69	41.11

Virginia	Dissolved sulfate	4.35	84	34.70	27.97	41.42
Virginia	Dissolved sulfate	4.51	85	34.91	28.20	41.62
Virginia	Dissolved sulfate	4.60	86	36.16	29.32	43.00
Virginia	Dissolved sulfate	4.65	87	36.28	29.44	43.12
Virginia	Dissolved sulfate	4.78	88	37.54	30.57	44.50
Virginia	Dissolved sulfate	4.85	90	38.05	31.04	45.05
Virginia	Dissolved sulfate	5.00	120	52.78	45.95	59.60
Virginia	Dissolved sulfate	5.02	121	53.07	46.24	59.90
Virginia	Dissolved sulfate	5.09	122	53.37	46.55	60.19
Virginia	Dissolved sulfate	5.10	123	54.62	47.83	61.41
Virginia	Dissolved sulfate	5.14	124	54.92	48.13	61.70
Virginia	Dissolved sulfate	5.20	125	55.04	48.26	61.82
Virginia	Dissolved sulfate	5.21	126	55.25	48.49	62.01
Virginia	Dissolved sulfate	5.22	127	55.37	48.62	62.13
Virginia	Dissolved sulfate	5.23	128	55.67	48.95	62.39
Virginia	Dissolved sulfate	5.27	129	55.89	49.19	62.58
Virginia	Dissolved sulfate	5.29	130	55.96	49.27	62.64
Virginia	Dissolved sulfate	5.37	131	56.25	49.55	62.96
Virginia	Dissolved sulfate	5.43	132	56.55	49.84	63.26
Virginia	Dissolved sulfate	5.55	133	56.58	49.87	63.30
Virginia	Dissolved sulfate	5.56	134	56.66	49.94	63.37
Virginia	Dissolved sulfate	5.58	135	56.95	50.24	63.67
Virginia	Dissolved sulfate	5.62	136	57.25	50.54	63.95
Virginia	Dissolved sulfate	5.74	137	58.50	51.80	65.20
Virginia	Dissolved sulfate	5.76	138	58.72	52.01	65.42
Virginia	Dissolved sulfate	5.84	139	58.93	52.24	65.62
Virginia	Dissolved sulfate	5.85	140	59.05	52.35	65.75
Virginia	Dissolved sulfate	5.92	141	59.17	52.47	65.87
Virginia	Dissolved sulfate	5.93	142	59.25	52.55	65.94
Virginia	Dissolved sulfate	5.95	143	59.46	52.78	66.15
Virginia	Dissolved sulfate	5.96	144	59.68	53.01	66.35
Virginia	Dissolved sulfate	6.00	145	59.97	53.31	66.64
Virginia	Dissolved sulfate	6.02	146	60.05	53.38	66.71
Virginia	Dissolved sulfate	6.03	147	60.26	53.61	66.92
Virginia	Dissolved sulfate	6.06	149	60.68	54.04	67.31
Virginia	Dissolved sulfate	6.17	151	62.23	55.70	68.76
Virginia	Dissolved sulfate	6.18	152	62.44	55.92	68.97
Virginia	Dissolved sulfate	6.29	153	62.56	56.04	69.08
Virginia	Dissolved sulfate	6.31	154	62.86	56.36	69.36
Virginia	Dissolved sulfate	6.35	155	63.07	56.58	69.56
Virginia	Dissolved sulfate	6.41	157	63.50	57.03	69.98
Virginia	Dissolved sulfate	6.49	158	63.80	57.34	70.26
Virginia	Dissolved sulfate	6.50	159	63.87	57.42	70.33
Virginia	Dissolved sulfate	6.71	160	64.17	57.75	70.59
Virginia	Dissolved sulfate	6.72	161	64.47	58.04	70.89
Virginia	Dissolved sulfate	6.83	162	64.76	58.35	71.17
Virginia	Dissolved sulfate	6.84	163	64.88	58.48	71.29
Virginia	Dissolved sulfate	7.01	164	65.01	58.60	71.42
Virginia	Dissolved sulfate	7.15	165	65.22	58.80	71.64
Virginia	Dissolved sulfate	7.18	166	65.44	59.01	71.86
Virginia	Dissolved sulfate	7.19	167	65.65	59.23	72.07
Virginia	Dissolved sulfate	7.26	168	65.95	59.52	72.38
Virginia	Dissolved sulfate	7.31	169	66.16	59.73	72.59

Virginia	Dissolved sulfate	7.32	170	66.46	60.00	72.91
Virginia	Dissolved sulfate	7.42	172	67.05	60.60	73.50
Virginia	Dissolved sulfate	7.46	173	67.26	60.82	73.71
Virginia	Dissolved sulfate	7.49	174	67.56	61.09	74.03
Virginia	Dissolved sulfate	7.54	177	68.27	61.82	74.73
Virginia	Dissolved sulfate	7.79	178	68.40	61.94	74.86
Virginia	Dissolved sulfate	7.91	179	68.69	62.25	75.14
Virginia	Dissolved sulfate	7.93	180	69.94	63.57	76.32
Virginia	Dissolved sulfate	8.07	181	71.20	64.95	77.44
Virginia	Dissolved sulfate	8.11	182	71.41	65.17	77.65
Virginia	Dissolved sulfate	8.15	183	71.53	65.29	77.77
Virginia	Dissolved sulfate	8.17	184	71.66	65.42	77.89
Virginia	Dissolved sulfate	8.35	185	71.87	65.64	78.10
Virginia	Dissolved sulfate	8.37	186	71.99	65.77	78.22
Virginia	Dissolved sulfate	8.38	187	72.11	65.89	78.34
Virginia	Dissolved sulfate	8.55	188	73.37	67.33	79.40
Virginia	Dissolved sulfate	8.60	189	73.58	67.54	79.62
Virginia	Dissolved sulfate	8.86	190	73.70	67.66	79.74
Virginia	Dissolved sulfate	8.90	191	73.92	67.89	79.95
Virginia	Dissolved sulfate	9.14	192	74.21	68.19	80.23
Virginia	Dissolved sulfate	9.19	193	75.47	69.59	81.34
Virginia	Dissolved sulfate	9.22	194	75.76	69.90	81.63
Virginia	Dissolved sulfate	9.28	195	77.01	71.40	82.62
Virginia	Dissolved sulfate	9.38	196	77.31	71.68	82.94
Virginia	Dissolved sulfate	9.39	197	77.43	71.78	83.08
Virginia	Dissolved sulfate	9.66	198	77.65	72.01	83.28
Virginia	Dissolved sulfate	9.73	199	77.94	72.33	83.56
Virginia	Dissolved sulfate	9.75	200	78.24	72.64	83.84
Virginia	Dissolved sulfate	9.92	201	78.53	72.94	84.13
Virginia	Dissolved sulfate	9.98	202	78.61	73.01	84.20
Virginia	Dissolved sulfate	10.20	203	78.90	73.34	84.47
Virginia	Dissolved sulfate	10.70	204	80.15	74.88	85.43
Virginia	Dissolved sulfate	11.20	205	81.41	76.33	86.48
Virginia	Dissolved sulfate	11.50	206	81.62	76.56	86.69
Virginia	Dissolved sulfate	11.70	207	81.74	76.68	86.80
Virginia	Dissolved sulfate	11.80	208	82.04	76.97	87.11
Virginia	Dissolved sulfate	12.60	210	82.41	77.34	87.48
Virginia	Dissolved sulfate	12.80	211	82.62	77.57	87.67
Virginia	Dissolved sulfate	13.00	214	83.26	78.21	88.30
Virginia	Dissolved sulfate	13.10	215	83.55	78.51	88.60
Virginia	Dissolved sulfate	13.50	216	83.67	78.63	88.72
Virginia	Dissolved sulfate	13.60	217	83.80	78.76	88.83
Virginia	Dissolved sulfate	13.70	218	85.05	80.28	89.82
Virginia	Dissolved sulfate	14.00	219	85.17	80.40	89.94
Virginia	Dissolved sulfate	14.10	220	85.38	80.57	90.20
Virginia	Dissolved sulfate	14.70	222	86.85	82.24	91.46
Virginia	Dissolved sulfate	14.90	223	87.15	82.55	91.74
Virginia	Dissolved sulfate	15.60	224	87.22	82.62	91.82
Virginia	Dissolved sulfate	15.70	225	88.47	84.33	92.61
Virginia	Dissolved sulfate	16.00	226	88.59	84.44	92.75
Virginia	Dissolved sulfate	16.10	227	88.81	84.65	92.96
Virginia	Dissolved sulfate	16.70	228	88.93	84.78	93.08
Virginia	Dissolved sulfate	16.80	229	89.05	84.87	93.24

Virginia	Dissolved sulfate	19.60	230	90.30	86.55	94.06
Virginia	Dissolved sulfate	19.80	231	90.43	86.67	94.18
Virginia	Dissolved sulfate	20.20	232	90.72	86.95	94.50
Virginia	Dissolved sulfate	20.30	233	91.02	87.28	94.76
Virginia	Dissolved sulfate	21.00	234	92.27	88.82	95.72
Virginia	Dissolved sulfate	21.60	235	92.39	88.95	95.84
Virginia	Dissolved sulfate	22.40	236	92.69	89.29	96.09
Virginia	Dissolved sulfate	22.50	237	93.94	91.00	96.88
Virginia	Dissolved sulfate	22.80	238	95.19	93.12	97.26
Virginia	Dissolved sulfate	23.70	239	95.26	93.20	97.33
Virginia	Dissolved sulfate	25.30	240	95.34	93.28	97.40
Virginia	Dissolved sulfate	26.50	241	95.55	93.53	97.58
Virginia	Dissolved sulfate	27.70	242	96.80	95.69	97.91
Virginia	Dissolved sulfate	29.60	243	96.92	95.84	98.01
Virginia	Dissolved sulfate	32.20	244	97.22	96.28	98.16
Virginia	Dissolved sulfate	33.10	245	97.29	96.36	98.22
Virginia	Dissolved sulfate	38.10	246	97.42	96.52	98.31
Virginia	Dissolved sulfate	40.30	247	97.54	96.66	98.41
Virginia	Dissolved sulfate	48.80	248	97.75	96.94	98.56
Virginia	Dissolved sulfate	50.40	249	97.97	97.26	98.67
Virginia	Dissolved sulfate	64.30	250	98.04	97.35	98.73
Virginia	Dissolved sulfate	70.20	251	98.34	97.66	99.02
Virginia	Dissolved sulfate	85.20	252	98.41	97.75	99.07
Virginia	Dissolved sulfate	93.10	253	98.53	97.88	99.18
Virginia	Dissolved sulfate	105.00	254	98.65	97.97	99.34
Virginia	Dissolved sulfate	125.00	255	98.87	98.24	99.50
Virginia	Dissolved sulfate	130.00	256	99.08	98.53	99.63
Virginia	Dissolved sulfate	135.00	257	99.30	98.90	99.69
Virginia	Dissolved sulfate	183.00	258	99.42	99.07	99.77
Virginia	Dissolved sulfate	256.00	259	99.54	99.14	99.94
Virginia	Dissolved sulfate	265.00	260	99.66	99.32	100.00
Virginia	Dissolved sulfate	310.00	261	99.78	99.43	100.00
Virginia	Dissolved sulfate	499.00	262	100.00	100.00	100.00



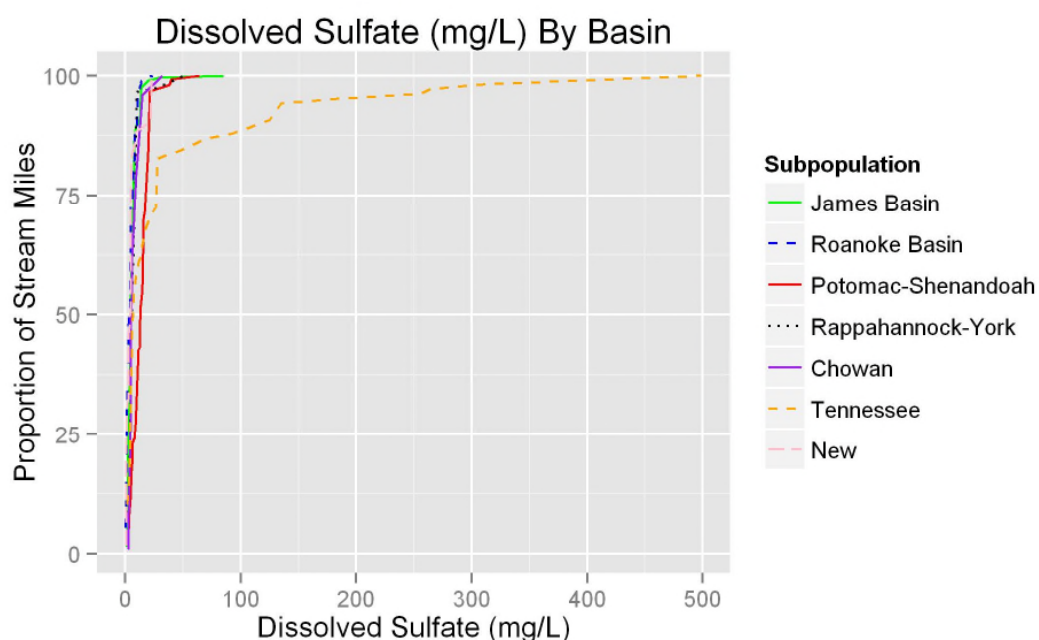


Figure 86. Dissolved Sulfates by Major Basin CDF graph.

Figure 86 displays dissolved sulfate distribution by basin. The majority of basins have similar distributions. The TennesseeBasin CDF is noticeably different around the 75<sup>th</sup> percentile. Eighty-six percent of Tennessee Basin stream miles have dissolved sulfate concentrations less than 70.2 mg/L. Ninety percent of Tennessee Basin stream miles are less than 125 mg/L dissolved sulfate.

Table 49. Dissolved Sulfates Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	Dissolved sulfate	1.35	1	1.43	0.00	3.69
James Basin	Dissolved sulfate	1.54	2	2.46	0.00	5.43
James Basin	Dissolved sulfate	1.62	3	3.89	0.03	7.74
James Basin	Dissolved sulfate	1.64	4	4.92	0.67	9.17
James Basin	Dissolved sulfate	1.72	5	10.94	0.61	21.28
James Basin	Dissolved sulfate	2.07	6	11.53	1.17	21.90
James Basin	Dissolved sulfate	2.15	7	12.96	2.43	23.48
James Basin	Dissolved sulfate	2.35	8	13.30	2.72	23.89
James Basin	Dissolved sulfate	2.40	9	19.33	6.28	32.38
James Basin	Dissolved sulfate	2.47	10	20.75	7.50	34.01
James Basin	Dissolved sulfate	2.65	11	22.18	8.87	35.49
James Basin	Dissolved sulfate	3.09	12	28.20	13.45	42.95
James Basin	Dissolved sulfate	3.18	13	34.23	18.72	49.74
James Basin	Dissolved sulfate	3.63	14	34.58	19.10	50.05
James Basin	Dissolved sulfate	3.64	15	34.74	19.26	50.22
James Basin	Dissolved sulfate	3.86	16	36.17	20.77	51.56
James Basin	Dissolved sulfate	3.95	17	37.59	22.18	53.01

James Basin	Dissolved sulfate	4.16	18	43.62	27.76	59.47
James Basin	Dissolved sulfate	4.51	19	44.65	29.01	60.29
James Basin	Dissolved sulfate	4.85	21	47.11	31.16	63.07
James Basin	Dissolved sulfate	5.00	28	57.56	42.63	72.48
James Basin	Dissolved sulfate	5.20	29	58.14	43.23	73.05
James Basin	Dissolved sulfate	5.22	30	58.73	43.89	73.57
James Basin	Dissolved sulfate	5.23	31	60.15	45.76	74.55
James Basin	Dissolved sulfate	5.43	32	61.58	47.23	75.93
James Basin	Dissolved sulfate	5.92	33	62.17	47.81	76.52
James Basin	Dissolved sulfate	5.93	34	62.52	48.20	76.83
James Basin	Dissolved sulfate	6.00	35	63.94	49.74	78.14
James Basin	Dissolved sulfate	6.17	36	69.96	58.29	81.64
James Basin	Dissolved sulfate	6.72	37	71.39	59.78	82.99
James Basin	Dissolved sulfate	7.01	38	71.98	60.37	83.59
James Basin	Dissolved sulfate	7.15	39	73.01	61.33	84.69
James Basin	Dissolved sulfate	7.18	40	74.05	62.29	85.80
James Basin	Dissolved sulfate	7.19	41	75.08	63.34	86.83
James Basin	Dissolved sulfate	7.32	42	76.51	64.51	88.50
James Basin	Dissolved sulfate	7.42	43	77.93	66.05	89.81
James Basin	Dissolved sulfate	7.49	44	79.36	67.08	91.64
James Basin	Dissolved sulfate	7.54	45	79.94	67.53	92.36
James Basin	Dissolved sulfate	7.79	46	80.53	68.09	92.98
James Basin	Dissolved sulfate	8.07	47	86.56	76.55	96.57
James Basin	Dissolved sulfate	8.11	48	87.59	77.68	97.50
James Basin	Dissolved sulfate	8.37	49	88.18	78.33	98.02
James Basin	Dissolved sulfate	9.14	50	89.60	79.95	99.26
James Basin	Dissolved sulfate	11.70	51	90.19	80.58	99.80
James Basin	Dissolved sulfate	12.60	52	91.62	81.94	100.00
James Basin	Dissolved sulfate	13.70	53	97.64	94.92	100.00
James Basin	Dissolved sulfate	20.30	54	99.06	97.83	100.00
James Basin	Dissolved sulfate	29.60	55	99.65	99.02	100.00
James Basin	Dissolved sulfate	85.20	56	100.00	100.00	100.00
Roanoke Basin	Dissolved sulfate	0.53	1	5.38	0.00	13.92
Roanoke Basin	Dissolved sulfate	0.71	2	10.76	0.00	21.97
Roanoke Basin	Dissolved sulfate	0.88	3	12.04	0.65	23.42
Roanoke Basin	Dissolved sulfate	1.00	5	14.58	3.11	26.06
Roanoke Basin	Dissolved sulfate	1.05	6	15.86	4.22	27.49
Roanoke Basin	Dissolved sulfate	1.16	7	21.24	8.16	34.32
Roanoke Basin	Dissolved sulfate	1.30	8	22.16	9.26	35.06
Roanoke Basin	Dissolved sulfate	1.38	9	23.09	10.14	36.04
Roanoke Basin	Dissolved sulfate	1.54	11	29.74	15.49	43.99
Roanoke Basin	Dissolved sulfate	1.74	13	31.94	17.57	46.31
Roanoke Basin	Dissolved sulfate	1.84	14	32.86	18.34	47.39
Roanoke Basin	Dissolved sulfate	1.87	15	33.39	18.98	47.80
Roanoke Basin	Dissolved sulfate	2.12	16	33.91	19.60	48.23
Roanoke Basin	Dissolved sulfate	2.16	17	34.44	20.00	48.87
Roanoke Basin	Dissolved sulfate	2.71	18	39.82	24.77	54.87
Roanoke Basin	Dissolved sulfate	2.75	19	40.74	25.86	55.63
Roanoke Basin	Dissolved sulfate	2.79	20	41.27	26.50	56.04
Roanoke Basin	Dissolved sulfate	2.89	21	42.54	27.93	57.15
Roanoke Basin	Dissolved sulfate	3.07	22	42.85	28.32	57.39
Roanoke Basin	Dissolved sulfate	3.10	23	48.23	33.08	63.39
Roanoke Basin	Dissolved sulfate	3.18	24	49.16	34.07	64.25

Roanoke Basin	Dissolved sulfate	3.28	25	50.08	34.95	65.21
Roanoke Basin	Dissolved sulfate	3.42	26	50.61	35.52	65.70
Roanoke Basin	Dissolved sulfate	4.30	27	51.53	36.49	66.58
Roanoke Basin	Dissolved sulfate	4.60	28	56.91	41.65	72.18
Roanoke Basin	Dissolved sulfate	5.00	35	72.55	60.54	84.56
Roanoke Basin	Dissolved sulfate	5.96	36	73.47	61.61	85.33
Roanoke Basin	Dissolved sulfate	6.06	37	74.00	62.22	85.77
Roanoke Basin	Dissolved sulfate	6.18	38	74.92	63.21	86.63
Roanoke Basin	Dissolved sulfate	6.29	39	75.44	63.82	87.07
Roanoke Basin	Dissolved sulfate	6.31	40	76.72	65.29	88.14
Roanoke Basin	Dissolved sulfate	6.71	41	77.99	66.89	89.09
Roanoke Basin	Dissolved sulfate	6.83	42	79.26	68.34	90.19
Roanoke Basin	Dissolved sulfate	6.84	43	79.79	68.90	90.68
Roanoke Basin	Dissolved sulfate	7.26	44	81.06	70.08	92.05
Roanoke Basin	Dissolved sulfate	7.91	45	82.33	71.56	93.11
Roanoke Basin	Dissolved sulfate	8.35	46	83.26	72.53	93.99
Roanoke Basin	Dissolved sulfate	8.55	47	88.64	80.61	96.67
Roanoke Basin	Dissolved sulfate	9.98	48	88.95	80.78	97.13
Roanoke Basin	Dissolved sulfate	10.20	49	90.22	82.43	98.02
Roanoke Basin	Dissolved sulfate	10.70	50	95.61	92.47	98.75
Roanoke Basin	Dissolved sulfate	11.50	51	96.53	93.87	99.20
Roanoke Basin	Dissolved sulfate	13.00	52	97.80	96.30	99.31
Roanoke Basin	Dissolved sulfate	13.60	53	98.33	97.24	99.42
Roanoke Basin	Dissolved sulfate	14.00	54	98.85	97.77	99.93
Roanoke Basin	Dissolved sulfate	15.60	55	99.16	98.27	100.00
Roanoke Basin	Dissolved sulfate	19.80	56	99.69	99.16	100.00
Roanoke Basin	Dissolved sulfate	23.70	57	100.00	100.00	100.00
Potomac-Shenandoah	Dissolved sulfate	2.40	1	3.00	0.00	7.50
Potomac-Shenandoah	Dissolved sulfate	2.85	2	5.18	0.00	11.33
Potomac-Shenandoah	Dissolved sulfate	3.38	3	8.18	0.00	16.37
Potomac-Shenandoah	Dissolved sulfate	4.35	4	11.18	1.27	21.09
Potomac-Shenandoah	Dissolved sulfate	5.00	5	14.18	3.17	25.19
Potomac-Shenandoah	Dissolved sulfate	5.58	6	17.18	5.62	28.74
Potomac-Shenandoah	Dissolved sulfate	6.17	7	20.18	6.69	33.67
Potomac-Shenandoah	Dissolved sulfate	6.49	8	23.18	9.73	36.64
Potomac-Shenandoah	Dissolved sulfate	8.15	9	24.42	10.70	38.14
Potomac-Shenandoah	Dissolved sulfate	8.38	10	25.66	11.75	39.56
Potomac-Shenandoah	Dissolved sulfate	9.38	11	28.66	12.99	44.32
Potomac-Shenandoah	Dissolved sulfate	9.39	12	29.89	13.71	46.08
Potomac-Shenandoah	Dissolved sulfate	11.20	13	42.58	21.62	63.53
Potomac-Shenandoah	Dissolved sulfate	12.60	14	43.31	22.50	64.12
Potomac-Shenandoah	Dissolved sulfate	12.80	15	45.49	25.07	65.92
Potomac-Shenandoah	Dissolved sulfate	13.00	17	48.91	27.81	70.01
Potomac-Shenandoah	Dissolved sulfate	13.10	18	51.91	30.23	73.59
Potomac-Shenandoah	Dissolved sulfate	14.10	19	54.09	31.41	76.76
Potomac-Shenandoah	Dissolved sulfate	14.70	20	56.27	32.93	79.61
Potomac-Shenandoah	Dissolved sulfate	15.70	21	68.95	48.59	89.31
Potomac-Shenandoah	Dissolved sulfate	16.00	22	70.19	49.36	91.02
Potomac-Shenandoah	Dissolved sulfate	16.80	23	71.42	49.85	93.00
Potomac-Shenandoah	Dissolved sulfate	19.60	24	84.11	69.49	98.73
Potomac-Shenandoah	Dissolved sulfate	21.00	25	96.79	93.39	100.00
Potomac-Shenandoah	Dissolved sulfate	38.10	26	98.03	95.73	100.00
Potomac-Shenandoah	Dissolved sulfate	40.30	27	99.27	97.93	100.00

Potomac-Shenandoah	Dissolved sulfate	64.30	28	100.00	100.00	100.00
Rappahannock-York	Dissolved sulfate	1.66	1	2.74	0.00	7.45
Rappahannock-York	Dissolved sulfate	2.39	2	3.86	0.00	9.05
Rappahannock-York	Dissolved sulfate	2.87	3	4.99	0.00	10.52
Rappahannock-York	Dissolved sulfate	2.88	4	6.12	0.03	12.21
Rappahannock-York	Dissolved sulfate	3.07	5	8.10	0.93	15.28
Rappahannock-York	Dissolved sulfate	3.14	6	10.84	2.00	19.68
Rappahannock-York	Dissolved sulfate	3.19	7	11.51	2.42	20.60
Rappahannock-York	Dissolved sulfate	5.00	13	32.04	14.96	49.12
Rappahannock-York	Dissolved sulfate	5.09	14	34.77	17.43	52.12
Rappahannock-York	Dissolved sulfate	5.10	15	46.34	28.50	64.18
Rappahannock-York	Dissolved sulfate	5.21	16	48.33	31.07	65.59
Rappahannock-York	Dissolved sulfate	5.62	17	51.06	34.01	68.12
Rappahannock-York	Dissolved sulfate	5.76	18	53.05	36.26	69.84
Rappahannock-York	Dissolved sulfate	5.85	19	54.18	36.90	71.45
Rappahannock-York	Dissolved sulfate	6.02	20	54.85	37.61	72.08
Rappahannock-York	Dissolved sulfate	6.35	21	56.83	39.96	73.70
Rappahannock-York	Dissolved sulfate	6.41	22	58.82	42.30	75.34
Rappahannock-York	Dissolved sulfate	6.50	23	59.49	43.07	75.90
Rappahannock-York	Dissolved sulfate	7.42	24	62.22	45.56	78.89
Rappahannock-York	Dissolved sulfate	7.93	25	73.79	59.59	87.99
Rappahannock-York	Dissolved sulfate	8.86	26	74.92	60.71	89.12
Rappahannock-York	Dissolved sulfate	9.19	27	86.48	76.01	96.95
Rappahannock-York	Dissolved sulfate	9.22	28	89.22	79.84	98.60
Rappahannock-York	Dissolved sulfate	9.66	29	91.20	82.94	99.47
Rappahannock-York	Dissolved sulfate	9.73	30	93.94	87.56	100.00
Rappahannock-York	Dissolved sulfate	9.75	31	96.68	92.61	100.00
Rappahannock-York	Dissolved sulfate	25.30	32	97.34	93.51	100.00
Rappahannock-York	Dissolved sulfate	33.10	33	98.01	94.44	100.00
Rappahannock-York	Dissolved sulfate	50.40	34	100.00	100.00	100.00
Chowan	Dissolved sulfate	2.44	1	0.98	0.00	2.78
Chowan	Dissolved sulfate	2.84	2	1.95	0.00	4.48
Chowan	Dissolved sulfate	2.88	3	3.60	0.00	7.40
Chowan	Dissolved sulfate	2.90	4	5.25	0.24	10.26
Chowan	Dissolved sulfate	2.92	5	6.90	0.55	13.25
Chowan	Dissolved sulfate	2.94	6	8.55	1.55	15.55
Chowan	Dissolved sulfate	3.45	7	12.55	1.46	23.63
Chowan	Dissolved sulfate	3.53	8	14.20	2.34	26.05
Chowan	Dissolved sulfate	4.78	9	31.11	4.20	58.01
Chowan	Dissolved sulfate	5.00	11	50.92	21.33	80.52
Chowan	Dissolved sulfate	5.55	12	51.39	21.76	81.02
Chowan	Dissolved sulfate	5.56	13	52.37	22.68	82.05
Chowan	Dissolved sulfate	5.84	14	55.27	25.84	84.70
Chowan	Dissolved sulfate	6.03	15	58.18	28.58	87.78
Chowan	Dissolved sulfate	6.06	16	62.18	32.45	91.90
Chowan	Dissolved sulfate	9.28	17	79.09	58.06	100.00
Chowan	Dissolved sulfate	14.70	18	96.00	88.91	100.00
Chowan	Dissolved sulfate	32.20	19	100.00	100.00	100.00
Tennessee	Dissolved sulfate	1.27	1	10.24	0.00	23.77
Tennessee	Dissolved sulfate	2.22	2	12.00	0.00	24.53
Tennessee	Dissolved sulfate	2.64	3	13.00	0.28	25.72
Tennessee	Dissolved sulfate	3.18	4	14.76	1.75	27.78
Tennessee	Dissolved sulfate	3.24	5	17.19	3.75	30.62

Tennessee	Dissolved sulfate	3.75	6	18.18	5.25	31.12
Tennessee	Dissolved sulfate	4.11	7	19.94	6.71	33.18
Tennessee	Dissolved sulfate	5.00	9	32.61	14.73	50.49
Tennessee	Dissolved sulfate	5.02	10	35.03	17.05	53.02
Tennessee	Dissolved sulfate	5.29	11	35.63	17.91	53.34
Tennessee	Dissolved sulfate	5.74	12	45.87	26.95	64.79
Tennessee	Dissolved sulfate	5.95	13	47.63	29.20	66.06
Tennessee	Dissolved sulfate	6.41	14	49.39	31.24	67.54
Tennessee	Dissolved sulfate	7.31	15	51.15	33.21	69.09
Tennessee	Dissolved sulfate	7.46	16	52.91	35.30	70.52
Tennessee	Dissolved sulfate	7.54	17	55.33	38.47	72.20
Tennessee	Dissolved sulfate	8.17	18	56.33	39.80	72.86
Tennessee	Dissolved sulfate	9.92	19	58.76	42.73	74.79
Tennessee	Dissolved sulfate	11.80	20	61.18	45.43	76.93
Tennessee	Dissolved sulfate	13.50	21	62.18	46.58	77.78
Tennessee	Dissolved sulfate	14.90	22	64.60	49.49	79.71
Tennessee	Dissolved sulfate	16.10	23	66.36	51.43	81.29
Tennessee	Dissolved sulfate	16.70	24	67.36	52.69	82.03
Tennessee	Dissolved sulfate	20.20	25	69.78	54.89	84.67
Tennessee	Dissolved sulfate	21.60	26	70.78	56.08	85.48
Tennessee	Dissolved sulfate	26.50	27	72.54	58.30	86.79
Tennessee	Dissolved sulfate	27.70	28	82.79	74.33	91.24
Tennessee	Dissolved sulfate	48.80	29	84.55	76.86	92.23
Tennessee	Dissolved sulfate	70.20	30	86.97	79.86	94.08
Tennessee	Dissolved sulfate	93.10	31	87.97	81.29	94.64
Tennessee	Dissolved sulfate	105.00	32	88.97	82.23	95.70
Tennessee	Dissolved sulfate	125.00	33	90.73	84.80	96.65
Tennessee	Dissolved sulfate	130.00	34	92.49	87.40	97.57
Tennessee	Dissolved sulfate	135.00	35	94.25	90.59	97.91
Tennessee	Dissolved sulfate	183.00	36	95.24	92.08	98.41
Tennessee	Dissolved sulfate	256.00	37	96.24	92.80	99.69
Tennessee	Dissolved sulfate	265.00	38	97.24	94.34	100.00
Tennessee	Dissolved sulfate	310.00	39	98.24	95.30	100.00
Tennessee	Dissolved sulfate	499.00	40	100.00	100.00	100.00
New	Dissolved sulfate	0.90	1	1.63	0.00	4.56
New	Dissolved sulfate	0.99	2	11.15	0.00	25.56
New	Dissolved sulfate	1.06	3	20.66	3.51	37.82
New	Dissolved sulfate	1.30	4	30.18	10.07	50.29
New	Dissolved sulfate	1.88	5	31.81	12.21	51.41
New	Dissolved sulfate	2.25	6	32.36	12.89	51.84
New	Dissolved sulfate	2.65	7	34.61	14.79	54.44
New	Dissolved sulfate	2.81	8	44.13	23.51	64.75
New	Dissolved sulfate	2.89	9	46.38	26.61	66.15
New	Dissolved sulfate	3.69	10	48.01	28.11	67.92
New	Dissolved sulfate	3.73	11	48.94	28.81	69.07
New	Dissolved sulfate	3.81	12	49.87	29.65	70.09
New	Dissolved sulfate	4.65	13	50.80	30.47	71.12
New	Dissolved sulfate	5.00	18	76.58	61.20	91.95
New	Dissolved sulfate	5.14	19	78.83	63.66	94.00
New	Dissolved sulfate	5.27	20	80.46	65.60	95.33
New	Dissolved sulfate	5.37	21	82.71	67.12	98.31
New	Dissolved sulfate	7.54	22	84.97	69.46	100.00
New	Dissolved sulfate	8.60	23	86.60	71.07	100.00

New	Dissolved sulfate	8.90	24	88.23	72.77	100.00
New	Dissolved sulfate	22.40	25	90.49	75.26	100.00
New	Dissolved sulfate	22.80	26	100.00	100.00	100.00

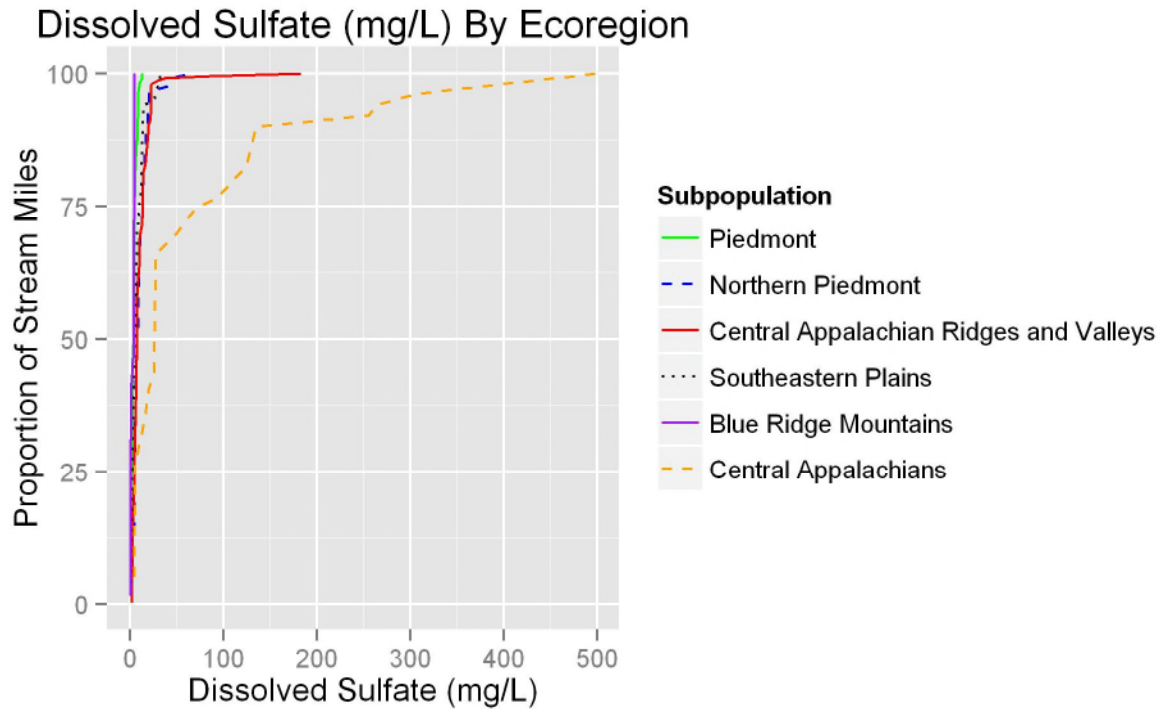


Figure 87. Dissolved Sulfates by Major Ecoregion (Level III) CDF graph.

Dissolved sulfate CDF curves by ecoregion are shown in Figure 87 with the percentiles and values listed in Table 50. The Central Appalachians CDF curve separates from the other ecoregions around the 31<sup>st</sup> percentile (11.8 mg/L dissolved sulfate). Seventy-four percent of Central Appalachian stream miles have dissolved sulfate concentrations estimated at 70.20 mg/L which is just below the high probability of stress cutoff of >75 mg/L (Table 48).

Table 50. Dissolved Sulfates Population Estimates by Major Ecoregion (Level III).

Subpopulation	Indicator	Value	NRes p	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Dissolved sulfate	0.53	1	3.38	0.00	9.01
Piedmont	Dissolved sulfate	0.71	2	6.75	0.00	14.14
Piedmont	Dissolved sulfate	0.88	3	7.55	0.07	15.03
Piedmont	Dissolved sulfate	1.00	4	8.35	0.86	15.84
Piedmont	Dissolved sulfate	1.05	5	9.15	1.58	16.72
Piedmont	Dissolved sulfate	1.16	6	12.53	3.83	21.23
Piedmont	Dissolved sulfate	1.30	7	13.11	4.53	21.69
Piedmont	Dissolved sulfate	1.38	8	13.69	5.09	22.29

Piedmont	Dissolved sulfate	1.54	10	17.86	8.18	27.54
Piedmont	Dissolved sulfate	1.64	11	18.44	8.74	28.14
Piedmont	Dissolved sulfate	1.66	12	19.24	9.49	28.99
Piedmont	Dissolved sulfate	1.72	13	22.62	12.28	32.96
Piedmont	Dissolved sulfate	1.74	15	24.00	13.60	34.40
Piedmont	Dissolved sulfate	1.84	16	24.58	14.10	35.06
Piedmont	Dissolved sulfate	1.87	17	24.91	14.49	35.33
Piedmont	Dissolved sulfate	2.12	18	25.24	14.88	35.59
Piedmont	Dissolved sulfate	2.16	19	25.57	15.15	35.98
Piedmont	Dissolved sulfate	2.35	20	25.76	15.32	36.20
Piedmont	Dissolved sulfate	2.40	21	26.56	16.07	37.05
Piedmont	Dissolved sulfate	2.47	22	27.36	16.76	37.96
Piedmont	Dissolved sulfate	2.71	23	30.74	19.62	41.86
Piedmont	Dissolved sulfate	2.75	24	31.32	20.29	42.35
Piedmont	Dissolved sulfate	2.79	25	31.65	20.68	42.61
Piedmont	Dissolved sulfate	2.85	26	32.23	21.26	43.19
Piedmont	Dissolved sulfate	2.88	27	32.56	21.58	43.53
Piedmont	Dissolved sulfate	2.89	28	33.35	22.47	44.24
Piedmont	Dissolved sulfate	2.90	29	33.68	22.79	44.58
Piedmont	Dissolved sulfate	2.92	30	34.01	23.07	44.95
Piedmont	Dissolved sulfate	2.94	31	34.34	23.40	45.29
Piedmont	Dissolved sulfate	3.07	33	35.12	24.22	46.02
Piedmont	Dissolved sulfate	3.09	34	38.49	27.31	49.68
Piedmont	Dissolved sulfate	3.10	35	41.87	30.31	53.44
Piedmont	Dissolved sulfate	3.18	37	45.83	34.24	57.42
Piedmont	Dissolved sulfate	3.28	38	46.41	34.78	58.03
Piedmont	Dissolved sulfate	3.42	39	46.74	35.14	58.34
Piedmont	Dissolved sulfate	3.45	40	47.54	35.86	59.22
Piedmont	Dissolved sulfate	3.53	41	47.87	36.17	59.56
Piedmont	Dissolved sulfate	3.63	42	48.06	36.37	59.75
Piedmont	Dissolved sulfate	3.64	43	48.16	36.47	59.84
Piedmont	Dissolved sulfate	3.95	44	48.95	37.25	60.65
Piedmont	Dissolved sulfate	4.16	45	52.33	40.59	64.07
Piedmont	Dissolved sulfate	4.30	46	52.91	41.24	64.58
Piedmont	Dissolved sulfate	4.51	47	53.49	41.90	65.09
Piedmont	Dissolved sulfate	4.60	48	56.87	45.17	68.57
Piedmont	Dissolved sulfate	4.78	49	60.25	48.45	72.04
Piedmont	Dissolved sulfate	5.00	63	75.69	66.57	84.81
Piedmont	Dissolved sulfate	5.20	64	76.02	66.92	85.12
Piedmont	Dissolved sulfate	5.23	65	76.82	67.91	85.73
Piedmont	Dissolved sulfate	5.56	66	77.01	68.07	85.96
Piedmont	Dissolved sulfate	5.62	67	77.81	68.98	86.65
Piedmont	Dissolved sulfate	5.84	68	78.39	69.64	87.15
Piedmont	Dissolved sulfate	5.93	69	78.59	69.86	87.31
Piedmont	Dissolved sulfate	5.96	70	79.17	70.50	87.84
Piedmont	Dissolved sulfate	6.00	71	79.97	71.36	88.58
Piedmont	Dissolved sulfate	6.02	72	80.16	71.55	88.77
Piedmont	Dissolved sulfate	6.03	73	80.74	72.21	89.27
Piedmont	Dissolved sulfate	6.06	75	81.87	73.43	90.31
Piedmont	Dissolved sulfate	6.18	76	82.45	74.02	90.88
Piedmont	Dissolved sulfate	6.29	77	82.78	74.38	91.18
Piedmont	Dissolved sulfate	6.31	78	83.58	75.27	91.89
Piedmont	Dissolved sulfate	6.71	79	84.38	76.24	92.52

Piedmont	Dissolved sulfate	6.84	80	84.71	76.58	92.83
Piedmont	Dissolved sulfate	7.01	81	85.04	76.88	93.19
Piedmont	Dissolved sulfate	7.42	83	86.63	78.57	94.70
Piedmont	Dissolved sulfate	7.91	84	87.43	79.48	95.38
Piedmont	Dissolved sulfate	8.35	85	88.01	80.05	95.98
Piedmont	Dissolved sulfate	8.37	86	88.34	80.41	96.28
Piedmont	Dissolved sulfate	8.55	87	91.72	85.36	98.08
Piedmont	Dissolved sulfate	9.14	88	92.52	86.28	98.75
Piedmont	Dissolved sulfate	9.22	89	93.32	87.22	99.42
Piedmont	Dissolved sulfate	9.28	90	96.69	94.12	99.27
Piedmont	Dissolved sulfate	9.73	91	97.49	95.21	99.78
Piedmont	Dissolved sulfate	10.20	92	98.29	96.53	100.00
Piedmont	Dissolved sulfate	12.80	93	98.87	97.42	100.00
Piedmont	Dissolved sulfate	13.00	94	99.67	99.09	100.00
Piedmont	Dissolved sulfate	13.60	95	100.00	100.00	100.00
Northern Piedmont	Dissolved sulfate	1.54	1	1.81	0.00	4.78
Northern Piedmont	Dissolved sulfate	1.62	2	4.30	0.00	9.66
Northern Piedmont	Dissolved sulfate	2.07	3	5.33	0.00	10.74
Northern Piedmont	Dissolved sulfate	2.15	4	7.82	1.31	14.32
Northern Piedmont	Dissolved sulfate	2.39	5	8.85	2.01	15.69
Northern Piedmont	Dissolved sulfate	2.87	6	9.87	2.92	16.83
Northern Piedmont	Dissolved sulfate	3.19	7	10.48	3.25	17.71
Northern Piedmont	Dissolved sulfate	3.86	8	12.97	5.21	20.73
Northern Piedmont	Dissolved sulfate	5.00	9	14.78	7.17	22.40
Northern Piedmont	Dissolved sulfate	5.10	10	25.32	9.33	41.30
Northern Piedmont	Dissolved sulfate	5.21	11	27.13	11.08	43.18
Northern Piedmont	Dissolved sulfate	5.22	12	28.15	12.30	44.00
Northern Piedmont	Dissolved sulfate	5.76	13	29.96	13.60	46.33
Northern Piedmont	Dissolved sulfate	5.85	14	30.99	14.45	47.53
Northern Piedmont	Dissolved sulfate	6.17	15	41.52	23.76	59.28
Northern Piedmont	Dissolved sulfate	6.35	16	43.33	25.81	60.86
Northern Piedmont	Dissolved sulfate	6.50	17	43.94	26.47	61.41
Northern Piedmont	Dissolved sulfate	9.19	18	54.47	36.06	72.88
Northern Piedmont	Dissolved sulfate	9.38	19	56.97	37.98	75.95
Northern Piedmont	Dissolved sulfate	9.39	20	57.99	38.62	77.37
Northern Piedmont	Dissolved sulfate	9.66	21	59.80	40.76	78.85
Northern Piedmont	Dissolved sulfate	11.20	22	70.33	51.94	88.73
Northern Piedmont	Dissolved sulfate	12.60	23	70.94	52.61	89.28
Northern Piedmont	Dissolved sulfate	13.00	24	71.97	53.04	90.90
Northern Piedmont	Dissolved sulfate	13.10	25	74.46	55.35	93.57
Northern Piedmont	Dissolved sulfate	15.70	26	85.00	72.21	97.78
Northern Piedmont	Dissolved sulfate	16.80	27	86.02	72.53	99.51
Northern Piedmont	Dissolved sulfate	21.00	28	96.55	92.69	100.00
Northern Piedmont	Dissolved sulfate	40.30	29	97.58	94.09	100.00
Northern Piedmont	Dissolved sulfate	50.40	30	99.39	98.33	100.00
Northern Piedmont	Dissolved sulfate	64.30	31	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	2.25	1	0.32	0.00	0.86
Central Appalachian Ridges and Valleys	Dissolved sulfate	2.40	2	5.78	0.00	13.09
Central Appalachian Ridges and Valleys	Dissolved sulfate	2.64	3	6.31	0.00	13.65
Central Appalachian Ridges and Valleys	Dissolved sulfate	2.65	4	7.60	0.00	15.21
Central Appalachian Ridges and Valleys	Dissolved sulfate	2.81	5	13.07	2.40	23.73
Central Appalachian Ridges and Valleys	Dissolved sulfate	3.18	6	14.01	3.33	24.68
Central Appalachian Ridges and Valleys	Dissolved sulfate	3.24	7	15.30	4.52	26.08



Central Appalachian Ridges and Valleys	Dissolved sulfate	3.38	8	16.59	5.67	27.51
Central Appalachian Ridges and Valleys	Dissolved sulfate	3.69	9	17.53	6.53	28.53
Central Appalachian Ridges and Valleys	Dissolved sulfate	3.73	10	18.06	7.00	29.12
Central Appalachian Ridges and Valleys	Dissolved sulfate	3.75	11	18.60	7.53	29.66
Central Appalachian Ridges and Valleys	Dissolved sulfate	4.11	12	19.53	8.39	30.67
Central Appalachian Ridges and Valleys	Dissolved sulfate	4.35	13	20.83	9.54	32.11
Central Appalachian Ridges and Valleys	Dissolved sulfate	4.65	14	21.36	10.08	32.64
Central Appalachian Ridges and Valleys	Dissolved sulfate	4.85	16	23.59	11.93	35.25
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.00	19	26.71	15.04	38.38
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.14	20	28.00	16.48	39.52
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.29	21	28.32	16.80	39.83
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.37	22	29.61	17.91	41.31
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.43	23	30.90	19.08	42.72
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.58	24	32.19	20.35	44.04
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.92	25	32.73	20.85	44.60
Central Appalachian Ridges and Valleys	Dissolved sulfate	5.95	26	33.66	21.80	45.53
Central Appalachian Ridges and Valleys	Dissolved sulfate	6.17	27	34.96	22.85	47.07
Central Appalachian Ridges and Valleys	Dissolved sulfate	6.41	28	35.90	23.76	48.03
Central Appalachian Ridges and Valleys	Dissolved sulfate	6.49	29	37.19	25.15	49.22
Central Appalachian Ridges and Valleys	Dissolved sulfate	6.72	30	38.48	26.34	50.62
Central Appalachian Ridges and Valleys	Dissolved sulfate	6.83	31	39.77	27.47	52.08
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.15	32	40.71	28.31	53.12
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.18	33	41.65	29.16	54.14
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.19	34	42.59	30.05	55.13
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.26	35	43.88	31.23	56.53
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.31	36	44.82	32.10	57.54
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.32	37	46.11	33.19	59.04
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.46	38	47.05	34.20	59.91
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.49	39	48.34	35.21	61.48
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.54	42	51.46	38.22	64.70
Central Appalachian Ridges and Valleys	Dissolved sulfate	7.79	43	51.99	38.72	65.27
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.07	44	57.46	44.40	70.51
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.11	45	58.40	45.34	71.45
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.15	46	58.93	45.83	72.03
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.17	47	59.46	46.34	72.58
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.38	48	59.99	46.84	73.15
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.60	49	60.93	47.71	74.16
Central Appalachian Ridges and Valleys	Dissolved sulfate	8.90	50	61.87	48.67	75.08
Central Appalachian Ridges and Valleys	Dissolved sulfate	9.92	51	63.16	49.92	76.41
Central Appalachian Ridges and Valleys	Dissolved sulfate	9.98	52	63.48	50.18	76.78
Central Appalachian Ridges and Valleys	Dissolved sulfate	10.70	53	68.94	55.95	81.94
Central Appalachian Ridges and Valleys	Dissolved sulfate	11.50	54	69.88	56.91	82.85
Central Appalachian Ridges and Valleys	Dissolved sulfate	12.60	55	71.18	58.15	84.20
Central Appalachian Ridges and Valleys	Dissolved sulfate	13.00	56	72.11	59.11	85.12
Central Appalachian Ridges and Valleys	Dissolved sulfate	13.50	57	72.65	59.62	85.68
Central Appalachian Ridges and Valleys	Dissolved sulfate	13.70	58	78.11	66.32	89.90
Central Appalachian Ridges and Valleys	Dissolved sulfate	14.00	59	78.64	66.84	90.44
Central Appalachian Ridges and Valleys	Dissolved sulfate	14.10	60	79.58	67.48	91.69
Central Appalachian Ridges and Valleys	Dissolved sulfate	14.70	61	80.52	68.23	92.81
Central Appalachian Ridges and Valleys	Dissolved sulfate	14.90	62	81.81	69.57	94.05
Central Appalachian Ridges and Valleys	Dissolved sulfate	15.60	63	82.13	69.89	94.37
Central Appalachian Ridges and Valleys	Dissolved sulfate	16.00	64	82.66	70.30	95.02
Central Appalachian Ridges and Valleys	Dissolved sulfate	16.70	65	83.19	70.85	95.54

Central Appalachian Ridges and Valleys	Dissolved sulfate	19.60	66	88.66	79.15	98.16
Central Appalachian Ridges and Valleys	Dissolved sulfate	19.80	67	89.19	79.71	98.67
Central Appalachian Ridges and Valleys	Dissolved sulfate	20.30	68	90.48	81.23	99.74
Central Appalachian Ridges and Valleys	Dissolved sulfate	21.60	69	91.01	81.80	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	22.40	70	92.31	83.36	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	22.80	71	97.77	95.91	99.63
Central Appalachian Ridges and Valleys	Dissolved sulfate	23.70	72	98.09	96.32	99.86
Central Appalachian Ridges and Valleys	Dissolved sulfate	29.60	73	98.62	97.15	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	38.10	74	99.15	98.03	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	85.20	75	99.47	98.53	100.00
Central Appalachian Ridges and Valleys	Dissolved sulfate	183.00	76	100.00	100.00	100.00
Southeastern Plains	Dissolved sulfate	1.35	1	4.02	0.00	11.01
Southeastern Plains	Dissolved sulfate	2.07	2	21.01	0.00	45.33
Southeastern Plains	Dissolved sulfate	2.44	3	21.99	0.00	46.42
Southeastern Plains	Dissolved sulfate	2.65	4	26.01	1.30	50.73
Southeastern Plains	Dissolved sulfate	2.84	5	27.00	2.18	51.82
Southeastern Plains	Dissolved sulfate	2.88	6	28.65	3.48	53.83
Southeastern Plains	Dissolved sulfate	3.14	7	32.67	8.81	56.54
Southeastern Plains	Dissolved sulfate	5.00	11	45.29	22.91	67.67
Southeastern Plains	Dissolved sulfate	5.09	12	49.31	26.34	72.27
Southeastern Plains	Dissolved sulfate	5.55	13	49.78	26.63	72.92
Southeastern Plains	Dissolved sulfate	6.41	14	52.70	29.92	75.48
Southeastern Plains	Dissolved sulfate	7.93	15	69.69	47.32	92.07
Southeastern Plains	Dissolved sulfate	8.86	16	71.35	48.98	93.72
Southeastern Plains	Dissolved sulfate	9.75	17	75.37	53.34	97.39
Southeastern Plains	Dissolved sulfate	11.70	18	77.02	54.89	99.16
Southeastern Plains	Dissolved sulfate	14.70	19	94.02	86.59	100.00
Southeastern Plains	Dissolved sulfate	25.30	20	95.00	87.85	100.00
Southeastern Plains	Dissolved sulfate	32.20	21	99.02	97.29	100.00
Southeastern Plains	Dissolved sulfate	33.10	22	100.00	100.00	100.00
Blue Ridge Mountains	Dissolved sulfate	0.90	1	1.57	0.00	4.44
Blue Ridge Mountains	Dissolved sulfate	0.99	2	10.68	0.00	24.57
Blue Ridge Mountains	Dissolved sulfate	1.00	3	12.84	0.00	27.15
Blue Ridge Mountains	Dissolved sulfate	1.06	4	21.96	4.47	39.45
Blue Ridge Mountains	Dissolved sulfate	1.27	5	31.08	9.94	52.22
Blue Ridge Mountains	Dissolved sulfate	1.30	6	40.19	16.88	63.51
Blue Ridge Mountains	Dissolved sulfate	1.88	7	41.76	18.60	64.92
Blue Ridge Mountains	Dissolved sulfate	2.22	8	43.33	20.23	66.43
Blue Ridge Mountains	Dissolved sulfate	2.89	9	45.48	22.85	68.12
Blue Ridge Mountains	Dissolved sulfate	3.81	10	46.37	23.59	69.16
Blue Ridge Mountains	Dissolved sulfate	5.00	18	98.43	95.69	100.00
Blue Ridge Mountains	Dissolved sulfate	5.27	19	100.00	100.00	100.00
Central Appalachians	Dissolved sulfate	5.02	1	5.10	0.00	13.68
Central Appalachians	Dissolved sulfate	5.74	2	26.67	0.00	56.61
Central Appalachians	Dissolved sulfate	11.80	3	31.77	3.69	59.86
Central Appalachians	Dissolved sulfate	16.10	4	35.48	7.89	63.07
Central Appalachians	Dissolved sulfate	20.20	5	40.58	12.56	68.60
Central Appalachians	Dissolved sulfate	26.50	6	44.29	18.19	70.38
Central Appalachians	Dissolved sulfate	27.70	7	65.86	44.51	87.21
Central Appalachians	Dissolved sulfate	48.80	8	69.56	50.11	89.01
Central Appalachians	Dissolved sulfate	70.20	9	74.66	57.26	92.07
Central Appalachians	Dissolved sulfate	93.10	10	76.77	60.88	92.65
Central Appalachians	Dissolved sulfate	105.00	11	78.87	63.27	94.47

Central Appalachians	Dissolved sulfate	125.00	12	82.58	69.36	95.79
Central Appalachians	Dissolved sulfate	130.00	13	86.28	75.19	97.38
Central Appalachians	Dissolved sulfate	135.00	14	89.99	82.43	97.54
Central Appalachians	Dissolved sulfate	256.00	15	92.09	84.32	99.86
Central Appalachians	Dissolved sulfate	265.00	16	94.19	87.55	100.00
Central Appalachians	Dissolved sulfate	310.00	17	96.29	89.84	100.00
Central Appalachians	Dissolved sulfate	499.00	18	100.00	100.00	100.00

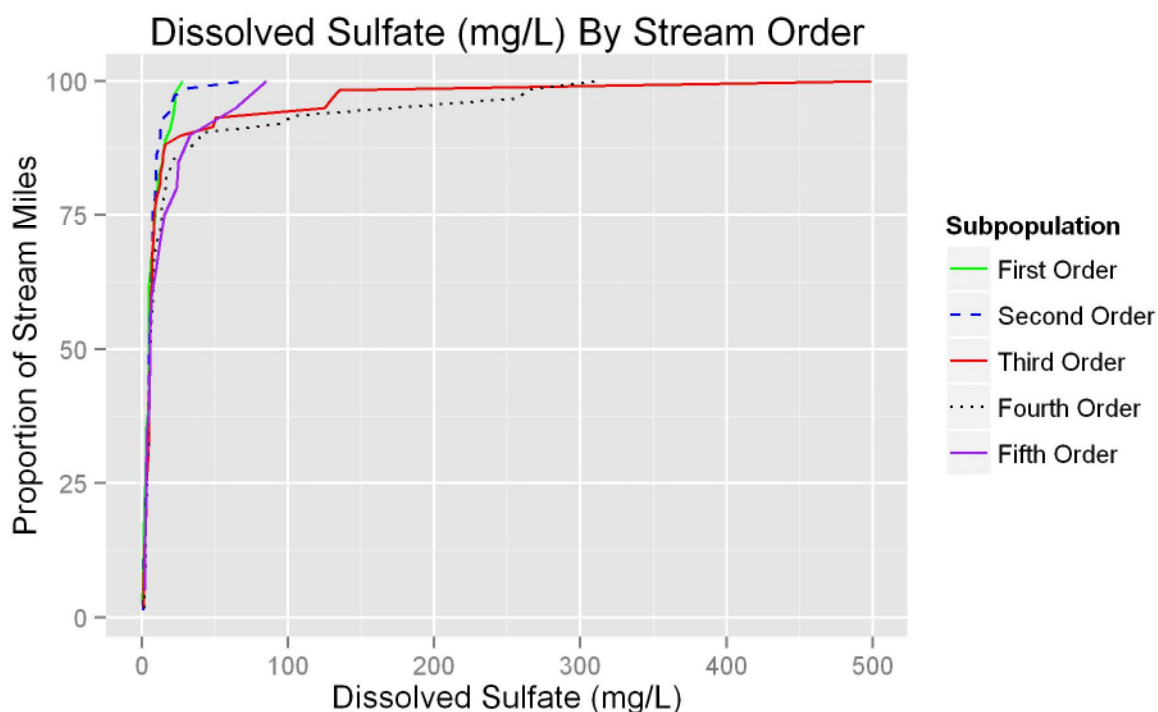


Figure 88. Dissolved Sulfates by Stream Order CDF graph.

Figure 88 shows dissolved sulfate CDF curves by stream order. Specific estimates are listed in Table 51. The CDFs are similar until the 75<sup>th</sup> percentile. The 91<sup>st</sup> percentile of third order and fourth order stream miles are 48.8 mg/L and 93.1 mg/L, respectively.

Table 51. Dissolved Sulfates Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Dissolved sulfate	0.53	1	2.22	0.00	5.81
First Order	Dissolved sulfate	0.71	2	4.44	0.00	9.15
First Order	Dissolved sulfate	0.99	3	6.67	0.74	12.60
First Order	Dissolved sulfate	1.06	4	8.89	2.55	15.23
First Order	Dissolved sulfate	1.16	5	11.11	4.80	17.43
First Order	Dissolved sulfate	1.27	6	13.33	6.00	20.67
First Order	Dissolved sulfate	1.30	7	15.56	7.88	23.23
First Order	Dissolved sulfate	1.54	8	17.78	9.25	26.30
First Order	Dissolved sulfate	1.72	9	20.00	10.69	29.31

First Order	Dissolved sulfate	2.07	10	22.22	12.22	32.22
First Order	Dissolved sulfate	2.40	11	24.44	13.86	35.03
First Order	Dissolved sulfate	2.71	12	26.67	16.44	36.89
First Order	Dissolved sulfate	2.81	13	28.89	18.17	39.60
First Order	Dissolved sulfate	3.09	14	31.11	19.91	42.31
First Order	Dissolved sulfate	3.10	15	33.33	21.85	44.82
First Order	Dissolved sulfate	3.18	16	35.56	23.93	47.18
First Order	Dissolved sulfate	4.16	17	37.78	26.30	49.26
First Order	Dissolved sulfate	4.60	18	40.00	28.53	51.47
First Order	Dissolved sulfate	4.78	19	42.22	30.45	53.99
First Order	Dissolved sulfate	5.00	27	60.00	49.12	70.88
First Order	Dissolved sulfate	5.10	28	62.22	50.94	73.50
First Order	Dissolved sulfate	5.74	29	64.44	53.20	75.69
First Order	Dissolved sulfate	6.17	30	66.67	55.99	77.35
First Order	Dissolved sulfate	7.93	31	68.89	58.05	79.73
First Order	Dissolved sulfate	8.07	32	71.11	60.39	81.83
First Order	Dissolved sulfate	8.55	33	73.33	62.95	83.71
First Order	Dissolved sulfate	9.19	34	75.56	64.86	86.25
First Order	Dissolved sulfate	9.28	35	77.78	67.52	88.03
First Order	Dissolved sulfate	10.70	36	80.00	70.37	89.63
First Order	Dissolved sulfate	11.20	37	82.22	72.81	91.63
First Order	Dissolved sulfate	13.70	38	84.44	75.78	93.11
First Order	Dissolved sulfate	14.70	39	86.67	78.55	94.79
First Order	Dissolved sulfate	15.70	40	88.89	80.84	96.94
First Order	Dissolved sulfate	19.60	41	91.11	83.86	98.36
First Order	Dissolved sulfate	21.00	42	93.33	87.02	99.65
First Order	Dissolved sulfate	22.50	43	95.56	90.37	100.00
First Order	Dissolved sulfate	22.80	44	97.78	94.21	100.00
First Order	Dissolved sulfate	27.70	45	100.00	100.00	100.00
Second Order	Dissolved sulfate	0.88	1	1.35	0.00	3.75
Second Order	Dissolved sulfate	1.00	3	4.05	0.63	7.48
Second Order	Dissolved sulfate	1.05	4	5.41	1.77	9.04
Second Order	Dissolved sulfate	1.35	5	6.76	2.45	11.06
Second Order	Dissolved sulfate	1.54	6	8.11	3.18	13.04
Second Order	Dissolved sulfate	1.62	7	9.46	4.07	14.85
Second Order	Dissolved sulfate	1.66	8	10.81	5.05	16.57
Second Order	Dissolved sulfate	1.74	9	12.16	6.26	18.06
Second Order	Dissolved sulfate	2.15	10	13.51	7.30	19.73
Second Order	Dissolved sulfate	2.40	11	14.86	8.27	21.46
Second Order	Dissolved sulfate	2.47	12	16.22	9.61	22.82
Second Order	Dissolved sulfate	2.65	14	18.92	11.64	26.20
Second Order	Dissolved sulfate	2.89	16	21.62	14.40	28.84
Second Order	Dissolved sulfate	3.14	17	22.97	15.55	30.40
Second Order	Dissolved sulfate	3.24	18	24.32	16.56	32.09
Second Order	Dissolved sulfate	3.38	19	25.68	17.62	33.73
Second Order	Dissolved sulfate	3.45	20	27.03	18.66	35.40
Second Order	Dissolved sulfate	3.86	21	28.38	20.20	36.56
Second Order	Dissolved sulfate	3.95	22	29.73	21.33	38.13
Second Order	Dissolved sulfate	4.35	23	31.08	22.78	39.38
Second Order	Dissolved sulfate	4.85	24	32.43	23.80	41.07
Second Order	Dissolved sulfate	5.00	33	44.59	35.22	53.97
Second Order	Dissolved sulfate	5.02	34	45.95	36.45	55.44
Second Order	Dissolved sulfate	5.09	35	47.30	37.96	56.64

Second Order	Dissolved sulfate	5.14	36	48.65	39.32	57.97
Second Order	Dissolved sulfate	5.23	37	50.00	40.87	59.13
Second Order	Dissolved sulfate	5.37	38	51.35	42.39	60.31
Second Order	Dissolved sulfate	5.43	39	52.70	43.59	61.82
Second Order	Dissolved sulfate	5.58	40	54.05	45.01	63.09
Second Order	Dissolved sulfate	5.62	41	55.41	46.29	64.53
Second Order	Dissolved sulfate	6.00	42	56.76	47.67	65.85
Second Order	Dissolved sulfate	6.06	43	58.11	49.11	67.10
Second Order	Dissolved sulfate	6.17	44	59.46	50.34	68.58
Second Order	Dissolved sulfate	6.31	45	60.81	51.58	70.04
Second Order	Dissolved sulfate	6.49	46	62.16	53.21	71.11
Second Order	Dissolved sulfate	6.71	47	63.51	54.76	72.27
Second Order	Dissolved sulfate	6.72	48	64.86	56.01	73.72
Second Order	Dissolved sulfate	6.83	49	66.22	57.48	74.96
Second Order	Dissolved sulfate	7.26	50	67.57	58.90	76.24
Second Order	Dissolved sulfate	7.32	51	68.92	60.17	77.67
Second Order	Dissolved sulfate	7.42	53	71.62	62.74	80.50
Second Order	Dissolved sulfate	7.49	54	72.97	64.24	81.71
Second Order	Dissolved sulfate	7.54	56	75.68	67.50	83.86
Second Order	Dissolved sulfate	7.91	57	77.03	69.13	84.92
Second Order	Dissolved sulfate	9.14	58	78.38	70.74	86.02
Second Order	Dissolved sulfate	9.22	59	79.73	72.24	87.22
Second Order	Dissolved sulfate	9.38	60	81.08	73.67	88.49
Second Order	Dissolved sulfate	9.73	61	82.43	75.26	89.61
Second Order	Dissolved sulfate	9.75	62	83.78	77.01	90.55
Second Order	Dissolved sulfate	9.92	63	85.14	78.53	91.75
Second Order	Dissolved sulfate	10.20	64	86.49	80.24	92.73
Second Order	Dissolved sulfate	11.80	65	87.84	81.44	94.23
Second Order	Dissolved sulfate	12.60	66	89.19	83.12	95.26
Second Order	Dissolved sulfate	13.00	67	90.54	84.87	96.21
Second Order	Dissolved sulfate	13.10	68	91.89	86.69	97.09
Second Order	Dissolved sulfate	14.90	69	93.24	88.46	98.02
Second Order	Dissolved sulfate	20.20	70	94.59	90.08	99.11
Second Order	Dissolved sulfate	20.30	71	95.95	92.11	99.78
Second Order	Dissolved sulfate	22.40	72	97.30	94.20	100.00
Second Order	Dissolved sulfate	32.20	73	98.65	96.44	100.00
Second Order	Dissolved sulfate	70.20	74	100.00	100.00	100.00
Third Order	Dissolved sulfate	0.90	1	1.69	0.00	4.45
Third Order	Dissolved sulfate	1.30	2	3.39	0.00	7.37
Third Order	Dissolved sulfate	1.38	3	5.08	0.50	9.66
Third Order	Dissolved sulfate	1.54	4	6.78	1.37	12.19
Third Order	Dissolved sulfate	1.64	5	8.47	2.30	14.65
Third Order	Dissolved sulfate	1.74	6	10.17	3.46	16.88
Third Order	Dissolved sulfate	1.84	7	11.86	4.72	19.01
Third Order	Dissolved sulfate	1.88	8	13.56	6.29	20.83
Third Order	Dissolved sulfate	2.22	9	15.25	7.44	23.07
Third Order	Dissolved sulfate	2.75	10	16.95	9.25	24.65
Third Order	Dissolved sulfate	2.85	11	18.64	10.42	26.87
Third Order	Dissolved sulfate	3.07	12	20.34	11.78	28.90
Third Order	Dissolved sulfate	3.18	14	23.73	14.99	32.46
Third Order	Dissolved sulfate	3.28	15	25.42	16.46	34.39
Third Order	Dissolved sulfate	3.69	16	27.12	17.83	36.41
Third Order	Dissolved sulfate	4.11	17	28.81	19.12	38.51

Third Order	Dissolved sulfate	4.30	18	30.51	21.19	39.83
Third Order	Dissolved sulfate	4.51	19	32.20	22.83	41.58
Third Order	Dissolved sulfate	4.85	20	33.90	24.09	43.70
Third Order	Dissolved sulfate	5.00	25	42.37	32.44	52.31
Third Order	Dissolved sulfate	5.21	26	44.07	33.91	54.23
Third Order	Dissolved sulfate	5.27	27	45.76	35.73	55.79
Third Order	Dissolved sulfate	5.76	28	47.46	37.63	57.28
Third Order	Dissolved sulfate	5.84	29	49.15	39.49	58.82
Third Order	Dissolved sulfate	5.95	30	50.85	41.16	60.53
Third Order	Dissolved sulfate	5.96	31	52.54	42.65	62.43
Third Order	Dissolved sulfate	6.03	32	54.24	44.80	63.67
Third Order	Dissolved sulfate	6.18	33	55.93	46.61	65.25
Third Order	Dissolved sulfate	6.35	34	57.63	48.53	66.72
Third Order	Dissolved sulfate	6.41	36	61.02	52.27	69.77
Third Order	Dissolved sulfate	7.15	37	62.71	53.76	71.66
Third Order	Dissolved sulfate	7.18	38	64.41	55.62	73.19
Third Order	Dissolved sulfate	7.19	39	66.10	57.48	74.72
Third Order	Dissolved sulfate	7.31	40	67.80	58.87	76.73
Third Order	Dissolved sulfate	7.46	41	69.49	60.69	78.30
Third Order	Dissolved sulfate	8.11	42	71.19	62.78	79.59
Third Order	Dissolved sulfate	8.35	43	72.88	64.95	80.82
Third Order	Dissolved sulfate	8.60	44	74.58	67.12	82.04
Third Order	Dissolved sulfate	8.90	45	76.27	69.11	83.43
Third Order	Dissolved sulfate	9.66	46	77.97	70.56	85.37
Third Order	Dissolved sulfate	11.50	47	79.66	72.81	86.51
Third Order	Dissolved sulfate	12.80	48	81.36	74.90	87.82
Third Order	Dissolved sulfate	13.00	49	83.05	76.86	89.24
Third Order	Dissolved sulfate	14.10	50	84.75	78.59	90.90
Third Order	Dissolved sulfate	14.70	51	86.44	80.89	91.99
Third Order	Dissolved sulfate	16.10	52	88.14	82.67	93.60
Third Order	Dissolved sulfate	26.50	53	89.83	84.85	94.81
Third Order	Dissolved sulfate	48.80	54	91.53	87.36	95.69
Third Order	Dissolved sulfate	50.40	55	93.22	90.37	96.07
Third Order	Dissolved sulfate	125.00	56	94.92	91.17	98.66
Third Order	Dissolved sulfate	130.00	57	96.61	92.92	100.00
Third Order	Dissolved sulfate	135.00	58	98.31	95.39	100.00
Third Order	Dissolved sulfate	499.00	59	100.00	100.00	100.00
Fourth Order	Dissolved sulfate	1.87	1	1.61	0.00	4.28
Fourth Order	Dissolved sulfate	2.07	2	3.23	0.00	7.12
Fourth Order	Dissolved sulfate	2.12	3	4.84	0.74	8.94
Fourth Order	Dissolved sulfate	2.16	4	6.45	1.58	11.32
Fourth Order	Dissolved sulfate	2.39	5	8.06	2.54	13.59
Fourth Order	Dissolved sulfate	2.64	6	9.68	3.50	15.86
Fourth Order	Dissolved sulfate	2.79	7	11.29	4.54	18.04
Fourth Order	Dissolved sulfate	2.87	8	12.90	6.06	19.75
Fourth Order	Dissolved sulfate	2.88	10	16.13	8.27	23.99
Fourth Order	Dissolved sulfate	2.90	11	17.74	9.65	25.84
Fourth Order	Dissolved sulfate	2.92	12	19.35	11.32	27.39
Fourth Order	Dissolved sulfate	2.94	13	20.97	13.25	28.68
Fourth Order	Dissolved sulfate	3.42	14	22.58	14.60	30.56
Fourth Order	Dissolved sulfate	3.53	15	24.19	16.18	32.21
Fourth Order	Dissolved sulfate	3.73	16	25.81	17.39	34.22
Fourth Order	Dissolved sulfate	3.75	17	27.42	18.83	36.00

Fourth Order	Dissolved sulfate	3.81	18	29.03	20.50	37.57
Fourth Order	Dissolved sulfate	4.65	19	30.65	22.49	38.80
Fourth Order	Dissolved sulfate	5.00	27	43.55	35.25	51.84
Fourth Order	Dissolved sulfate	5.20	28	45.16	36.75	53.57
Fourth Order	Dissolved sulfate	5.22	29	46.77	38.40	55.15
Fourth Order	Dissolved sulfate	5.85	30	48.39	39.76	57.02
Fourth Order	Dissolved sulfate	5.92	31	50.00	41.13	58.87
Fourth Order	Dissolved sulfate	6.06	32	51.61	42.80	60.42
Fourth Order	Dissolved sulfate	6.29	33	53.23	44.50	61.95
Fourth Order	Dissolved sulfate	6.84	34	54.84	46.50	63.18
Fourth Order	Dissolved sulfate	7.01	35	56.45	48.31	64.59
Fourth Order	Dissolved sulfate	7.54	36	58.06	49.83	66.30
Fourth Order	Dissolved sulfate	7.79	37	59.68	51.76	67.59
Fourth Order	Dissolved sulfate	8.15	38	61.29	53.48	69.10
Fourth Order	Dissolved sulfate	8.17	39	62.90	55.14	70.67
Fourth Order	Dissolved sulfate	8.37	40	64.52	57.21	71.82
Fourth Order	Dissolved sulfate	8.38	41	66.13	59.36	72.89
Fourth Order	Dissolved sulfate	8.86	42	67.74	61.28	74.21
Fourth Order	Dissolved sulfate	9.39	43	69.35	62.49	76.22
Fourth Order	Dissolved sulfate	11.70	44	70.97	64.71	77.22
Fourth Order	Dissolved sulfate	13.00	45	72.58	66.09	79.07
Fourth Order	Dissolved sulfate	13.50	46	74.19	67.72	80.66
Fourth Order	Dissolved sulfate	13.60	47	75.81	69.85	81.77
Fourth Order	Dissolved sulfate	14.00	48	77.42	71.37	83.47
Fourth Order	Dissolved sulfate	16.00	49	79.03	72.99	85.07
Fourth Order	Dissolved sulfate	16.70	50	80.65	74.07	87.22
Fourth Order	Dissolved sulfate	16.80	51	82.26	75.80	88.71
Fourth Order	Dissolved sulfate	19.80	52	83.87	77.74	90.00
Fourth Order	Dissolved sulfate	21.60	53	85.48	79.78	91.19
Fourth Order	Dissolved sulfate	29.60	54	87.10	82.15	92.04
Fourth Order	Dissolved sulfate	38.10	55	88.71	84.52	92.90
Fourth Order	Dissolved sulfate	40.30	56	90.32	87.05	93.60
Fourth Order	Dissolved sulfate	93.10	57	91.94	88.60	95.27
Fourth Order	Dissolved sulfate	105.00	58	93.55	90.25	96.84
Fourth Order	Dissolved sulfate	183.00	59	95.16	91.61	98.72
Fourth Order	Dissolved sulfate	256.00	60	96.77	93.20	100.00
Fourth Order	Dissolved sulfate	265.00	61	98.39	95.63	100.00
Fourth Order	Dissolved sulfate	310.00	62	100.00	100.00	100.00
Fifth Order	Dissolved sulfate	2.25	1	5.00	0.00	13.49
Fifth Order	Dissolved sulfate	2.35	2	10.00	0.00	22.04
Fifth Order	Dissolved sulfate	2.44	3	15.00	0.52	29.48
Fifth Order	Dissolved sulfate	2.84	4	20.00	5.15	34.85
Fifth Order	Dissolved sulfate	3.07	5	25.00	8.46	41.54
Fifth Order	Dissolved sulfate	3.19	6	30.00	11.48	48.52
Fifth Order	Dissolved sulfate	3.63	7	35.00	15.62	54.38
Fifth Order	Dissolved sulfate	5.29	8	40.00	20.50	59.50
Fifth Order	Dissolved sulfate	5.56	9	45.00	26.08	63.92
Fifth Order	Dissolved sulfate	5.93	10	50.00	31.74	68.26
Fifth Order	Dissolved sulfate	6.02	11	55.00	36.84	73.16
Fifth Order	Dissolved sulfate	6.50	12	60.00	41.53	78.47
Fifth Order	Dissolved sulfate	9.98	13	65.00	46.83	83.17
Fifth Order	Dissolved sulfate	12.60	14	70.00	52.25	87.75
Fifth Order	Dissolved sulfate	15.60	15	75.00	57.96	92.04

Fifth Order	Dissolved sulfate	23.70	16	80.00	64.46	95.54
Fifth Order	Dissolved sulfate	25.30	17	85.00	70.48	99.52
Fifth Order	Dissolved sulfate	33.10	18	90.00	78.31	100.00
Fifth Order	Dissolved sulfate	64.30	19	95.00	86.56	100.00
Fifth Order	Dissolved sulfate	85.20	20	100.00	100.00	100.00



## Appendix K. Total Habitat Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Total Habitat scores reflective of degraded habitat have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Total Habitat scores less than 120 increase the likelihood of having a low VSCI score. When Total Habitat scores fall below 13, protections from the deleterious impacts of nutrients are minimal. Figure 89 shows decreasing VSCI scores as total habitat scores decline. The case for this increased risk to the aquatic community is presented in this appendix.

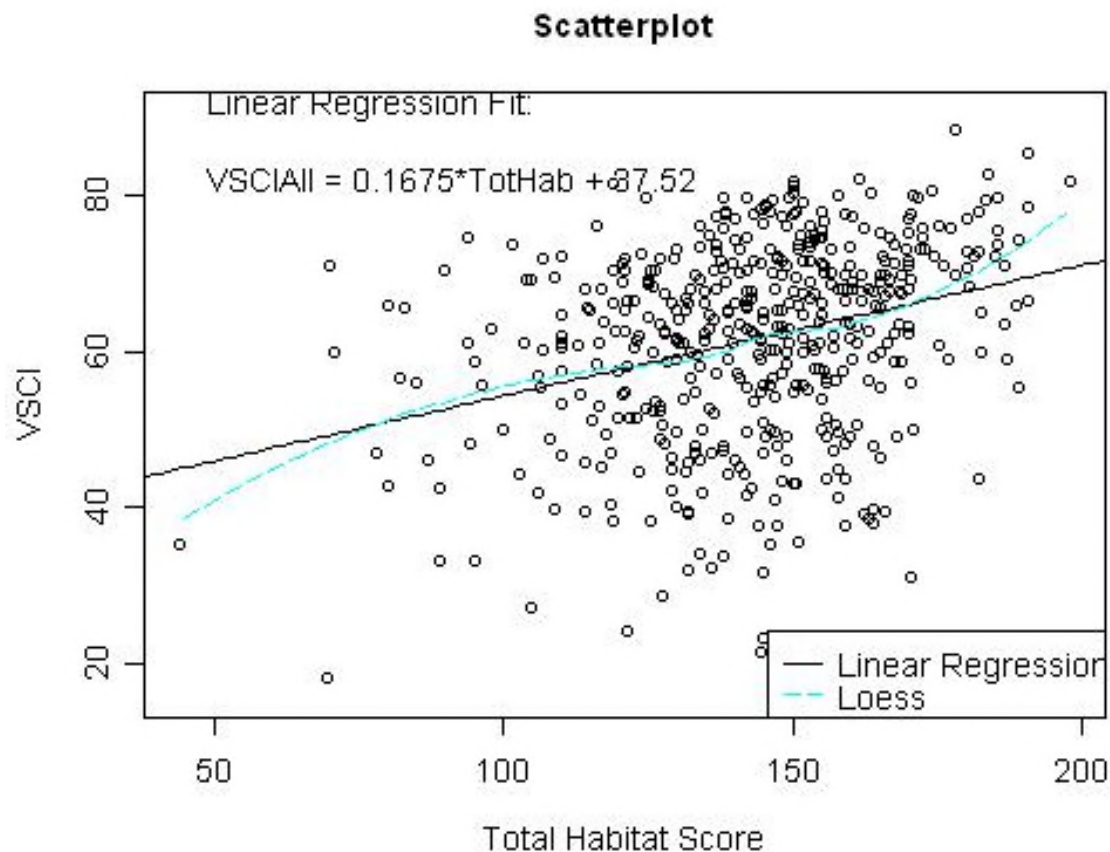


Figure 89. Total Habitat Stressor Gradient Scatterplot.

### *Total Habitat Relative Risk Results*

An optimal Total Habitat score is above 150 and was selected based on least disturbed conditions in Virginia watersheds. Total Habitat Scores of greater than 150 are used as a reference filter to select reference sites (VDEQ, 2006). VDEQ estimates 35% of Virginia streams have a Total Habitat value above 150 (Table 52). A Total Habitat score under 120 was considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 90) and scatter plot graphs. An estimated 16% of Virginia streams have a Total Habitat score below 120 (Figure 91). VDEQ relative risk calculations found that a VSCI score is 4.1 times more likely to be below 50 when the Total Habitat is below 120 than when the Total Habitat concentration is above 150 (Figure 91).

Table 52. Total Habitat Relative Risk Categories.

Stressor Parameter	Optimal	Suboptimal
Total Habitat	>150	<120

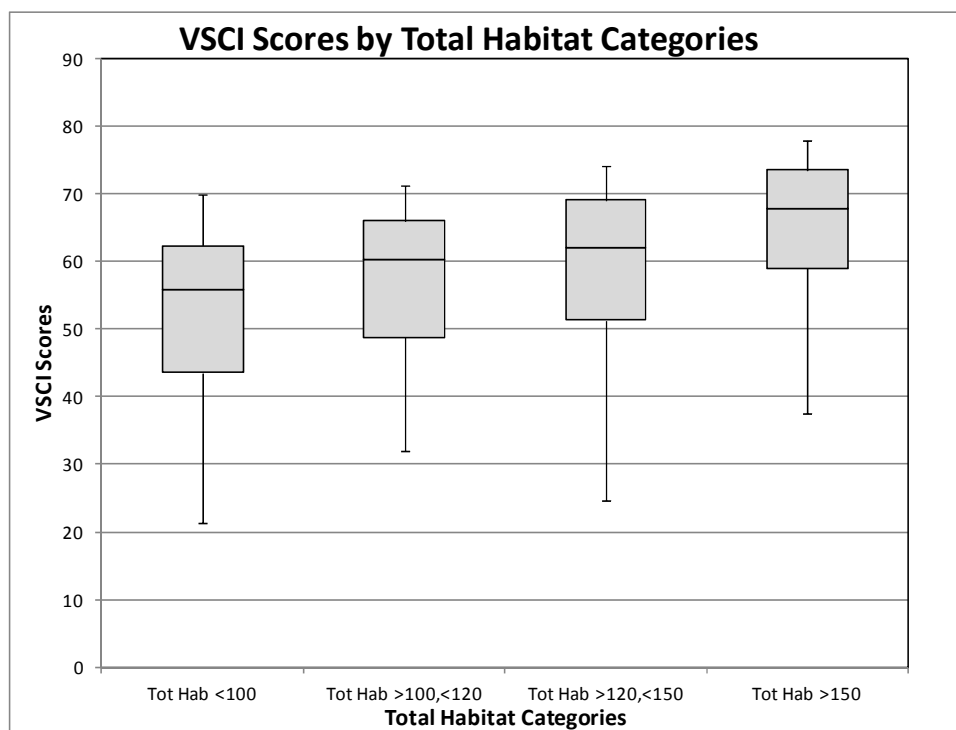


Figure 90. VSCI Scores by Total Habitat Categories.

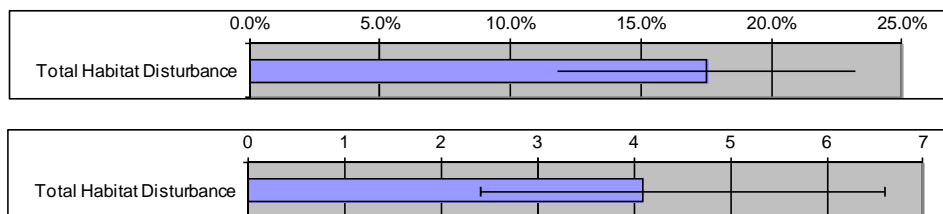


Figure 91. Total Habitat Relative Extent and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 67 sites with Total Habitat values under 120. Thirty-six out of 67 sites have VSCI scores less than 60. Twenty-two sites in the database have Total Habitat scores under 100 and 15 out of 22 sites have a VSCI less than 60. The probability of having VSCI score less than 60 when the Total Habitat is fewer than 100 is 90% (Figure 92). The probability of impairment is high (80%) and characterized by Total Habitat scores below 110 (Figure 92). Quantile regression results (Figure 94) indicate sites with Total Habitat above 120 are somewhat protected. As mentioned in the TP and TN sections, protective riparian zones and instream habitat can ameliorate nutrient stress.

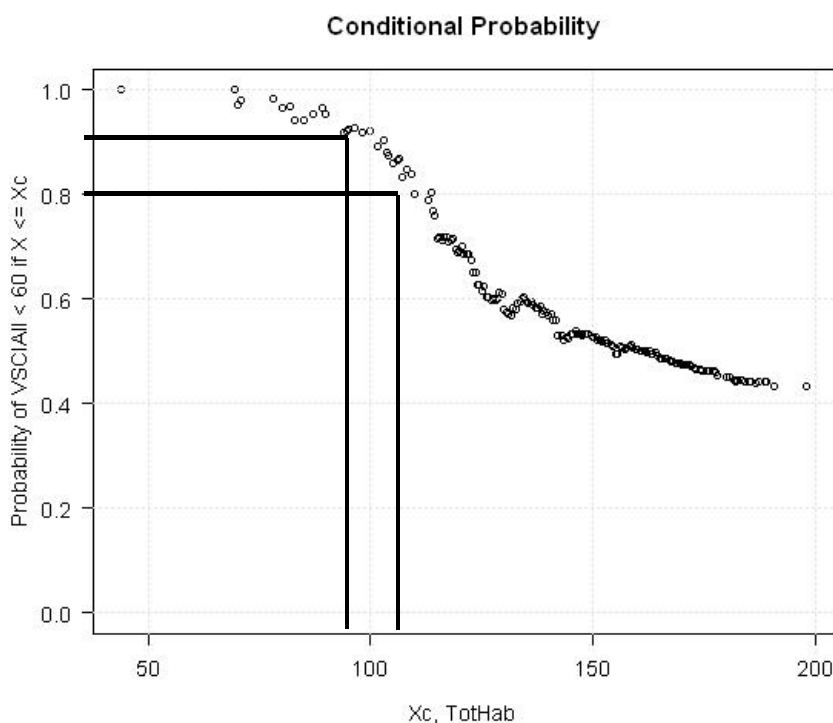


Figure 92. Probability of VSCI less than 60 if Total Habitat Scores Less than 100 and 110.

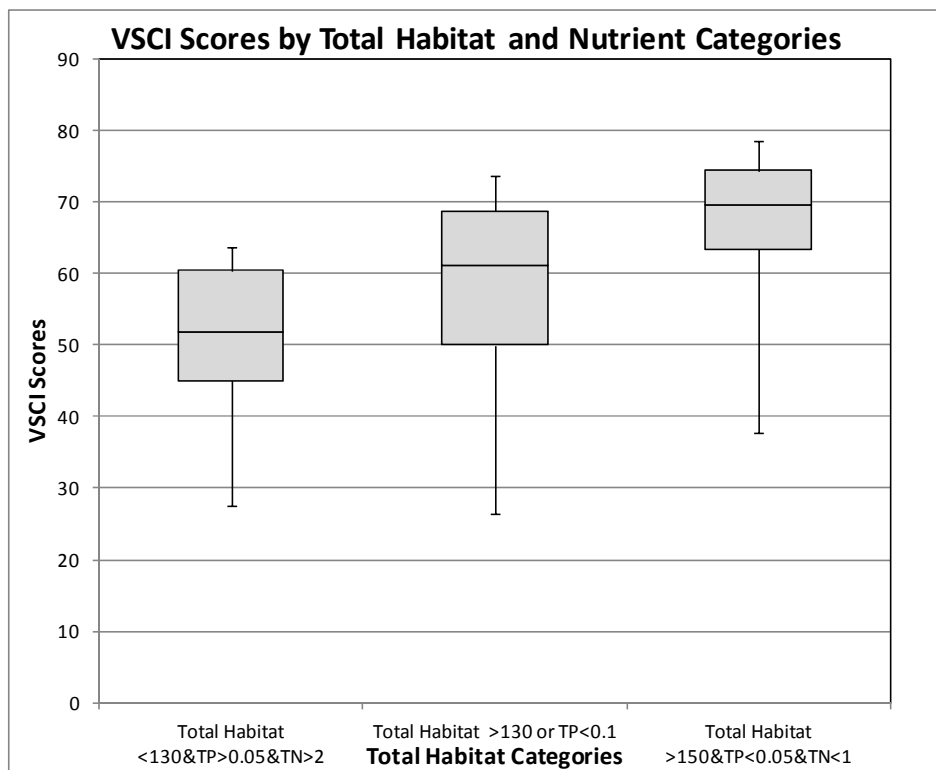


Figure 93. VSCI Scores applying Nutrient and Habitat Stressors Categories.

Box-and-whisker plots showing distribution of habitat and nutrient categories is presented in Figure 93. Figure 93 shows a *low total habitat/high nutrient* group including sites with a Total Habitat <130, TP over 0.05 mg/L, and TN over 2 mg/L grouped together (n=32, box-and-whisker plot on the left). The *low total habitat/high nutrient* group has a 72% VSCI assessment failure rate (e.g. VSCI<60). Another category of sites called *high total habitat/low nutrient* included sites with total habitat >150, TP under 0.05 mg/L, and TN under 1 mg/L (n=150, Figure 92, box-and-whisker plot on the right). This group has 82% VSCI assessment pass rate (e.g. VSCI>60). The relative risk of having a VSCI<50 in the *low total habitat/elevated nutrient* group is 9.4 times higher than with the *high total habitat/low nutrient* group. This combination of stressors effectively doubles the probability of stress to aquatic life. It is important to note that low Total Habitat (<130) scores in conjunction with elevated nutrients (TN > 2 mg/L or TP > 0.05 mg/L) can increase the probability of stress to aquatic life.

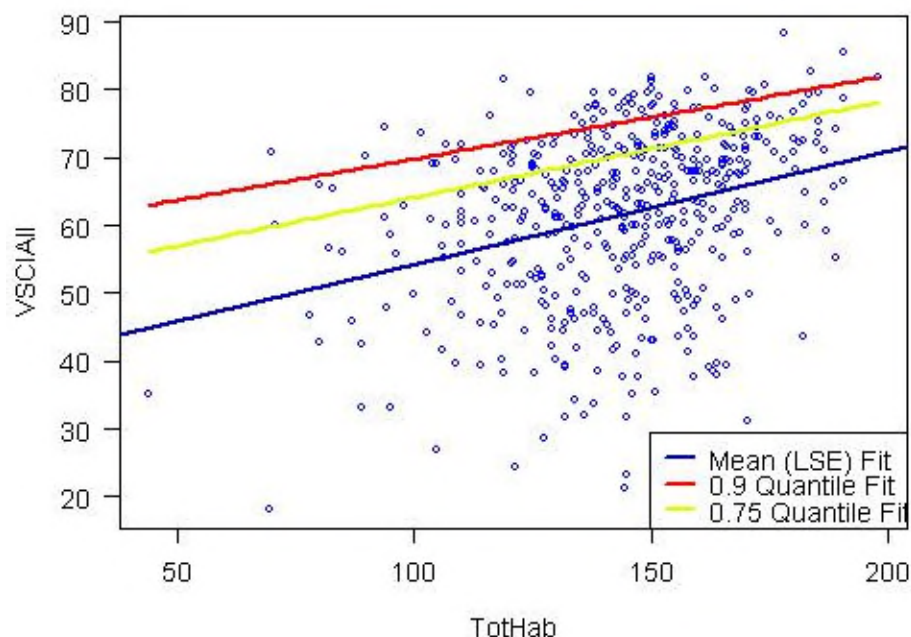


Figure 94. **Quantile Regression VSCI versus Total Habitat Scores.**

Quantile regression techniques are applied to total habitat in Figure 94. The 0.9 quantile (red line) fit regression analysis shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to Total Habitat scores. The 50<sup>th</sup> percentile of reference crosses at 120, 25<sup>th</sup> percentile intersects at 75, and the 10<sup>th</sup> percentile is equal to 28. The 50<sup>th</sup> percentile of reference is associated with more protective water chemistry values, while values at the 10<sup>th</sup> percentile tend represent number where the aquatic community is already stressed.

### *Total Habitat and Probability of Stress to Aquatic Life*

Decreases in Total Habitat scores have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Aquatic health is measured by VDEQ with a multimetric biomonitoring tool known as the Virginia Stream Condition Index (VSCI). Total Habitat scores less than 100 increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). When Total Habitat scores fall below 130 protections from the deleterious impacts of nutrients is reduced.

Table 53. Total Habitat Score ranges and probability of stress to aquatic life (based on VSCI Scores).

Total Habitat - Qualitative	
Probability of Stress to Aquatic Life	Total Habitat (unitless)
High	< 100
Medium	> 100 , < 130
Low	> 130, < 150
None	< 150

### *Total Habitat Cumulative Distribution Function curves*

Total Habitat cumulative distribution function (CDF) curves are shown statewide, by major basin, major ecoregion (level III), and by stream order in Figures 95-98. Tables 54-57 correspond to Figures 95-98, respectively.

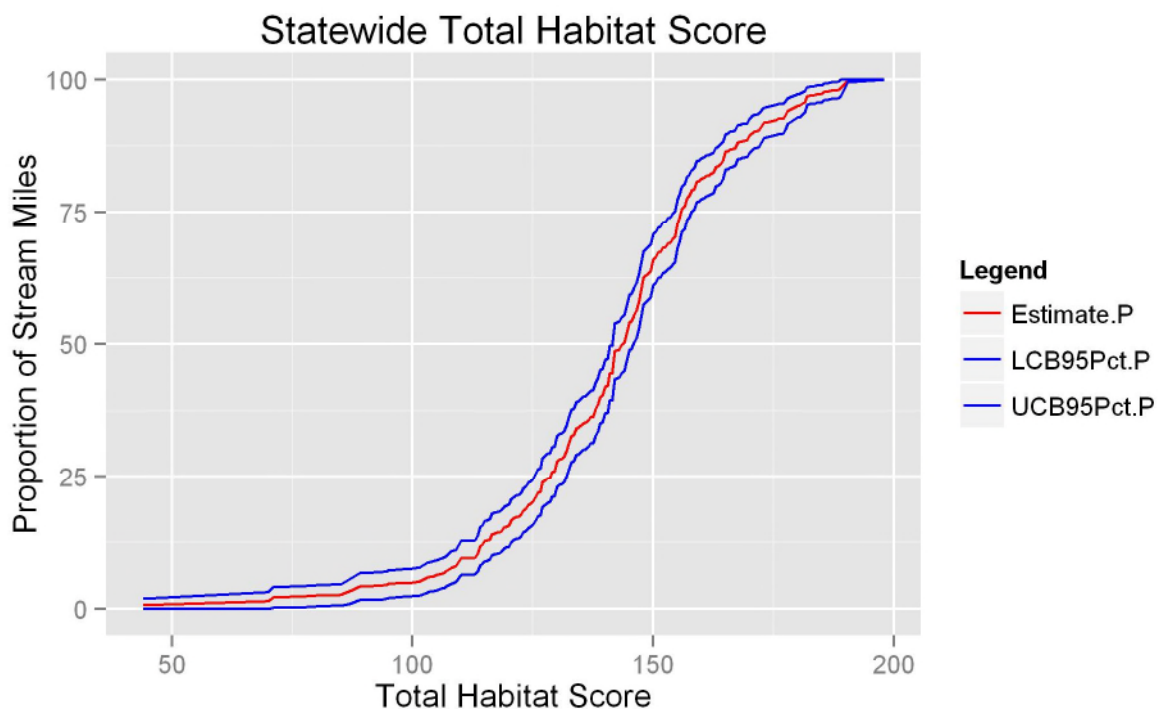


Figure 95. **Total Habitat Statewide CDF graph.**

Figure 95 and Table 54 contain CDF curve information for total habitat in Virginia. Just under five percent of stream miles in Virginia have total habitat scores less than 100. Twenty-eight

percent of stream miles have total habitat scores less than 130 which is the threshold for medium probability of stress to aquatic life (Table 53).

Table 54. **Statewide Total Habitat Estimates.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Total Habitat	44	1	0.71	0.00	1.86
Virginia	Total Habitat	69.5	2	1.41	0.00	3.05
Virginia	Total Habitat	70	3	1.46	0.00	3.09
Virginia	Total Habitat	71	4	2.16	0.20	4.12
Virginia	Total Habitat	78	5	2.33	0.35	4.31
Virginia	Total Habitat	80	7	2.44	0.45	4.43
Virginia	Total Habitat	82	8	2.48	0.49	4.47
Virginia	Total Habitat	83	9	2.55	0.56	4.54
Virginia	Total Habitat	85	10	2.59	0.60	4.58
Virginia	Total Habitat	87	11	3.30	0.97	5.62
Virginia	Total Habitat	89	13	4.17	1.60	6.75
Virginia	Total Habitat	90	14	4.21	1.64	6.79
Virginia	Total Habitat	94	16	4.38	1.79	6.96
Virginia	Total Habitat	94.5	17	4.44	1.86	7.03
Virginia	Total Habitat	95	19	4.64	2.04	7.23
Virginia	Total Habitat	96.5	20	4.76	2.16	7.36
Virginia	Total Habitat	98	21	4.80	2.20	7.40
Virginia	Total Habitat	100	22	4.96	2.35	7.58
Virginia	Total Habitat	101.5	23	5.13	2.50	7.76
Virginia	Total Habitat	103	24	5.84	3.03	8.64
Virginia	Total Habitat	103.5	25	6.01	3.19	8.82
Virginia	Total Habitat	104	26	6.05	3.23	8.87
Virginia	Total Habitat	105	28	6.34	3.50	9.18
Virginia	Total Habitat	106	30	6.63	3.77	9.48
Virginia	Total Habitat	106.5	31	6.75	3.88	9.61
Virginia	Total Habitat	107	33	7.04	4.15	9.92
Virginia	Total Habitat	108	34	7.74	4.70	10.78
Virginia	Total Habitat	109	36	8.03	4.98	11.09
Virginia	Total Habitat	110	44	9.53	6.32	12.74
Virginia	Total Habitat	113	45	9.65	6.43	12.87
Virginia	Total Habitat	113.5	46	10.36	6.97	13.75
Virginia	Total Habitat	114	49	11.84	8.21	15.48
Virginia	Total Habitat	114.5	50	12.01	8.36	15.66
Virginia	Total Habitat	115	51	12.72	8.93	16.50
Virginia	Total Habitat	115.5	52	12.84	9.06	16.62
Virginia	Total Habitat	116	54	13.08	9.30	16.85
Virginia	Total Habitat	116.5	56	13.95	10.04	17.86
Virginia	Total Habitat	117	58	14.16	10.24	18.07
Virginia	Total Habitat	117.5	59	14.33	10.41	18.25
Virginia	Total Habitat	118	60	14.39	10.49	18.30
Virginia	Total Habitat	118.5	62	14.64	10.72	18.55
Virginia	Total Habitat	119	66	15.31	11.37	19.24
Virginia	Total Habitat	119.5	67	15.47	11.52	19.43
Virginia	Total Habitat	120	69	15.68	11.72	19.65
Virginia	Total Habitat	120.5	72	16.53	12.44	20.61
Virginia	Total Habitat	121	77	16.95	12.85	21.05

Virginia	Total Habitat	121.5	80	17.23	13.12	21.34
Virginia	Total Habitat	122	81	17.35	13.24	21.47
Virginia	Total Habitat	122.5	83	17.69	13.56	21.81
Virginia	Total Habitat	123	85	18.52	14.33	22.71
Virginia	Total Habitat	123.5	87	18.81	14.61	23.00
Virginia	Total Habitat	124	88	19.51	15.20	23.82
Virginia	Total Habitat	124.5	90	19.75	15.43	24.07
Virginia	Total Habitat	125	94	20.12	15.80	24.45
Virginia	Total Habitat	125.5	96	21.00	16.58	25.41
Virginia	Total Habitat	126	99	21.82	17.34	26.30
Virginia	Total Habitat	126.5	101	22.06	17.57	26.55
Virginia	Total Habitat	127	106	23.88	19.22	28.53
Virginia	Total Habitat	127.5	108	24.17	19.50	28.83
Virginia	Total Habitat	128	112	24.64	19.96	29.33
Virginia	Total Habitat	128.5	113	24.81	20.13	29.49
Virginia	Total Habitat	129	117	25.80	21.06	30.54
Virginia	Total Habitat	129.5	118	25.97	21.23	30.70
Virginia	Total Habitat	130	125	27.92	23.09	32.75
Virginia	Total Habitat	130.5	127	28.21	23.37	33.05
Virginia	Total Habitat	131	129	28.42	23.58	33.26
Virginia	Total Habitat	131.5	132	28.78	23.93	33.62
Virginia	Total Habitat	132	137	29.96	25.12	34.80
Virginia	Total Habitat	132.5	140	31.54	26.59	36.49
Virginia	Total Habitat	133	144	32.65	27.69	37.62
Virginia	Total Habitat	133.5	145	32.82	27.86	37.79
Virginia	Total Habitat	134	151	34.05	29.07	39.03
Virginia	Total Habitat	134.5	153	34.26	29.28	39.24
Virginia	Total Habitat	135	157	34.68	29.71	39.66
Virginia	Total Habitat	135.5	161	35.08	30.09	40.08
Virginia	Total Habitat	136	163	35.25	30.25	40.24
Virginia	Total Habitat	136.5	166	35.66	30.65	40.66
Virginia	Total Habitat	137	171	36.26	31.27	41.24
Virginia	Total Habitat	137.5	172	36.30	31.31	41.29
Virginia	Total Habitat	138	178	37.65	32.61	42.69
Virginia	Total Habitat	138.5	181	38.69	33.62	43.77
Virginia	Total Habitat	139	187	40.04	35.02	45.06
Virginia	Total Habitat	139.5	189	40.33	35.30	45.36
Virginia	Total Habitat	140	193	41.98	36.91	47.05
Virginia	Total Habitat	140.5	194	42.15	37.08	47.22
Virginia	Total Habitat	141	200	44.48	39.33	49.63
Virginia	Total Habitat	141.5	201	44.52	39.37	49.67
Virginia	Total Habitat	142	212	48.65	43.43	53.86
Virginia	Total Habitat	143	216	48.99	43.78	54.21
Virginia	Total Habitat	143.5	220	49.88	44.64	55.12
Virginia	Total Habitat	144	223	50.24	45.00	55.48
Virginia	Total Habitat	144.5	230	52.25	47.03	57.46
Virginia	Total Habitat	145	239	54.15	48.98	59.32
Virginia	Total Habitat	145.5	242	54.28	49.11	59.45
Virginia	Total Habitat	146	248	55.37	50.22	60.52
Virginia	Total Habitat	146.5	251	56.32	51.17	61.48
Virginia	Total Habitat	147	256	58.15	53.01	63.28
Virginia	Total Habitat	147.5	262	60.06	54.96	65.16
Virginia	Total Habitat	148	270	62.60	57.59	67.62



Virginia	Total Habitat	149	276	63.36	58.37	68.36
Virginia	Total Habitat	149.5	280	63.80	58.82	68.78
Virginia	Total Habitat	150	287	65.86	60.99	70.73
Virginia	Total Habitat	150.5	291	66.34	61.48	71.20
Virginia	Total Habitat	151	295	67.28	62.48	72.08
Virginia	Total Habitat	151.5	296	67.35	62.55	72.15
Virginia	Total Habitat	152	303	68.18	63.37	72.98
Virginia	Total Habitat	152.5	304	68.34	63.53	73.16
Virginia	Total Habitat	153	310	69.01	64.20	73.83
Virginia	Total Habitat	153.5	311	69.05	64.24	73.87
Virginia	Total Habitat	154	316	69.75	64.92	74.57
Virginia	Total Habitat	154.5	320	70.27	65.46	75.08
Virginia	Total Habitat	155	328	72.81	68.21	77.41
Virginia	Total Habitat	155.5	332	73.82	69.30	78.34
Virginia	Total Habitat	156	337	75.65	71.34	79.96
Virginia	Total Habitat	156.5	340	76.00	71.71	80.30
Virginia	Total Habitat	157	343	77.59	73.51	81.66
Virginia	Total Habitat	157.5	345	77.92	73.87	81.97
Virginia	Total Habitat	158	350	79.03	75.11	82.96
Virginia	Total Habitat	158.5	352	79.32	75.41	83.24
Virginia	Total Habitat	159	359	80.73	76.88	84.58
Virginia	Total Habitat	159.5	360	80.78	76.93	84.62
Virginia	Total Habitat	160	365	81.24	77.41	85.08
Virginia	Total Habitat	160.5	369	81.46	77.63	85.30
Virginia	Total Habitat	161	372	81.82	77.99	85.65
Virginia	Total Habitat	161.5	373	81.89	78.06	85.72
Virginia	Total Habitat	162	376	82.17	78.35	86.00
Virginia	Total Habitat	162.5	378	82.41	78.60	86.22
Virginia	Total Habitat	163	382	83.53	79.86	87.20
Virginia	Total Habitat	163.5	383	83.65	79.97	87.33
Virginia	Total Habitat	164	388	84.07	80.41	87.74
Virginia	Total Habitat	164.5	389	84.78	81.26	88.29
Virginia	Total Habitat	165	397	86.38	83.03	89.72
Virginia	Total Habitat	165.5	398	86.44	83.10	89.79
Virginia	Total Habitat	166	402	86.79	83.44	90.14
Virginia	Total Habitat	166.5	403	86.86	83.51	90.21
Virginia	Total Habitat	167	406	87.06	83.72	90.41
Virginia	Total Habitat	167.5	410	88.17	84.98	91.36
Virginia	Total Habitat	168	411	88.21	85.02	91.40
Virginia	Total Habitat	168.5	413	88.40	85.23	91.58
Virginia	Total Habitat	169	416	88.51	85.33	91.68
Virginia	Total Habitat	169.5	417	88.63	85.45	91.80
Virginia	Total Habitat	170	424	89.29	86.12	92.45
Virginia	Total Habitat	170.5	428	89.86	86.68	93.04
Virginia	Total Habitat	171	430	90.20	87.05	93.35
Virginia	Total Habitat	171.5	431	90.32	87.16	93.48
Virginia	Total Habitat	172	432	90.39	87.23	93.54
Virginia	Total Habitat	172.5	434	91.14	88.12	94.16
Virginia	Total Habitat	173	435	91.84	88.98	94.71
Virginia	Total Habitat	174	436	92.01	89.16	94.86
Virginia	Total Habitat	174.5	437	92.18	89.34	95.02
Virginia	Total Habitat	175.5	439	92.41	89.59	95.24
Virginia	Total Habitat	176	440	92.58	89.75	95.42

Virginia	Total Habitat	177	441	92.60	89.77	95.44
Virginia	Total Habitat	177.5	442	93.31	90.67	95.95
Virginia	Total Habitat	178	444	94.08	91.64	96.53
Virginia	Total Habitat	180	447	95.03	92.81	97.25
Virginia	Total Habitat	180.5	448	95.10	92.88	97.31
Virginia	Total Habitat	181.5	449	95.80	93.82	97.79
Virginia	Total Habitat	182	452	96.80	95.12	98.48
Virginia	Total Habitat	182.5	454	97.01	95.36	98.66
Virginia	Total Habitat	183.5	455	97.05	95.39	98.71
Virginia	Total Habitat	184	456	97.22	95.58	98.85
Virginia	Total Habitat	185	457	97.29	95.66	98.91
Virginia	Total Habitat	185.5	460	97.69	96.10	99.28
Virginia	Total Habitat	186.5	462	97.85	96.28	99.43
Virginia	Total Habitat	187	463	97.97	96.40	99.55
Virginia	Total Habitat	188.5	464	98.04	96.47	99.62
Virginia	Total Habitat	189	466	98.38	96.79	99.96
Virginia	Total Habitat	190.5	469	99.83	99.55	100.00
Virginia	Total Habitat	198	470	100.00	100.00	100.00

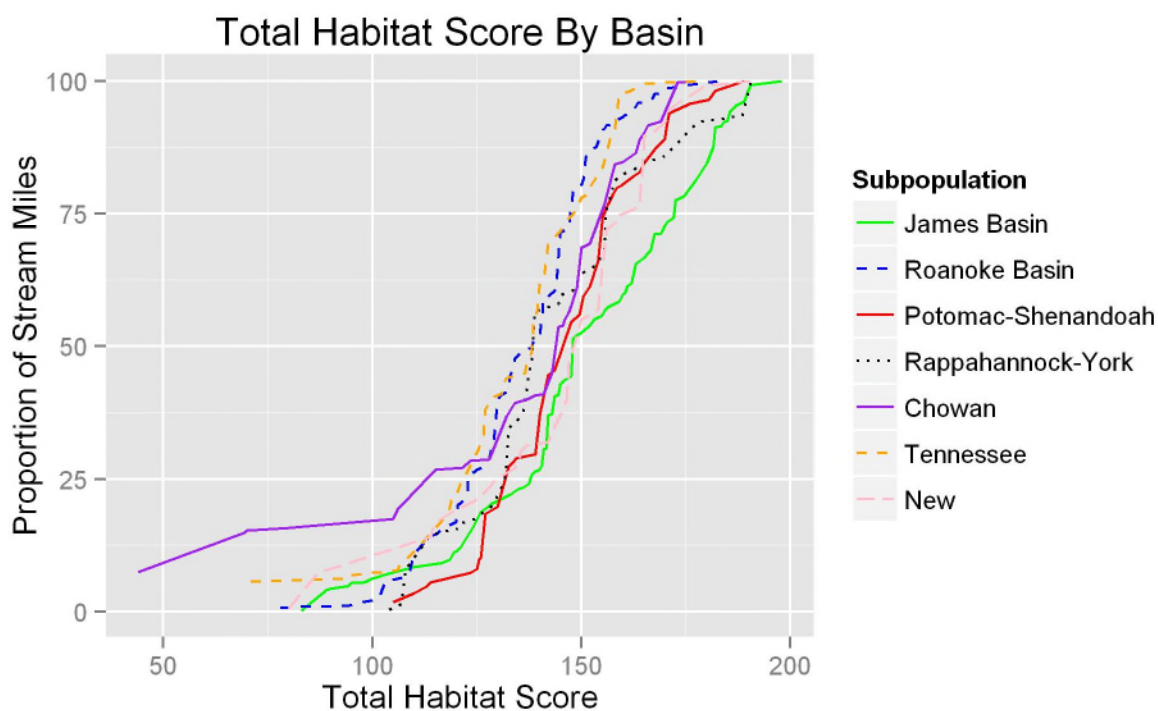


Figure 96. Total Habitat by Major Basin CDF graph.

Figure 96 displays CDF curves for total habitat by major river basin. Table 55 contains the corresponding data. The Potomac-Shenandoah Basin shows 19.7% of stream miles with total habitat scores less than 130. Twenty-one percent of James Basin and 39.3% of Roanoke Basin stream miles have total habitat scores less than 130. 36.9% of Chowan and 26.3% of

Rappahannock-York stream miles have total habitat scores less than 132. 40.8% of Tennessee stream miles are less than 130 total habitat. The New Basin is estimated to have 27.2% of stream miles with total habitat scores less than 134.

Table 55. **Total Habitat Estimates by Major Basin.**

Subpopulation	Indicator	Value	NResp	Estimate.P
James Basin	Total Habitat	83	1	0.30
James Basin	Total Habitat	89	3	4.17
James Basin	Total Habitat	90	4	4.35
James Basin	Total Habitat	94	5	4.88
James Basin	Total Habitat	95	6	5.42
James Basin	Total Habitat	98	7	5.60
James Basin	Total Habitat	100	8	6.34
James Basin	Total Habitat	103.5	9	7.08
James Basin	Total Habitat	110	12	8.45
James Basin	Total Habitat	116.5	13	9.19
James Basin	Total Habitat	118.5	14	9.73
James Basin	Total Habitat	119	15	10.47
James Basin	Total Habitat	119.5	16	11.21
James Basin	Total Habitat	120	17	11.39
James Basin	Total Habitat	121	19	12.10
James Basin	Total Habitat	121.5	20	12.64
James Basin	Total Habitat	124	21	15.76
James Basin	Total Habitat	126	22	18.88
James Basin	Total Habitat	127.5	23	19.62
James Basin	Total Habitat	128.5	24	20.36
James Basin	Total Habitat	133	27	22.14
James Basin	Total Habitat	134	28	22.68
James Basin	Total Habitat	135	29	23.22
James Basin	Total Habitat	136	30	23.40
James Basin	Total Habitat	137	31	23.93
James Basin	Total Habitat	137.5	32	24.11
James Basin	Total Habitat	138	35	25.69
James Basin	Total Habitat	139	36	26.43
James Basin	Total Habitat	140	37	26.74
James Basin	Total Habitat	140.5	38	27.47
James Basin	Total Habitat	141	39	30.60
James Basin	Total Habitat	141.5	40	30.78
James Basin	Total Habitat	142	42	37.02
James Basin	Total Habitat	143	44	37.29
James Basin	Total Habitat	143.5	46	40.59
James Basin	Total Habitat	144.5	47	40.90
James Basin	Total Habitat	145	50	42.91
James Basin	Total Habitat	146	51	43.65
James Basin	Total Habitat	147.5	52	44.39
James Basin	Total Habitat	148	56	51.47
James Basin	Total Habitat	149	58	52.08
James Basin	Total Habitat	149.5	59	52.38
James Basin	Total Habitat	152	62	53.96
James Basin	Total Habitat	153	65	55.11

James Basin	Total Habitat	154.5	66	55.65
James Basin	Total Habitat	155	67	55.95
James Basin	Total Habitat	155.5	68	56.69
James Basin	Total Habitat	156.5	69	57.43
James Basin	Total Habitat	159	72	58.53
James Basin	Total Habitat	160	74	59.80
James Basin	Total Habitat	160.5	75	60.11
James Basin	Total Habitat	161	77	61.38
James Basin	Total Habitat	162	78	61.92
James Basin	Total Habitat	163	80	65.58
James Basin	Total Habitat	165	82	66.65
James Basin	Total Habitat	166	84	67.69
James Basin	Total Habitat	166.5	85	68.00
James Basin	Total Habitat	167.5	86	71.12
James Basin	Total Habitat	169	87	71.30
James Basin	Total Habitat	169.5	88	71.84
James Basin	Total Habitat	170	90	72.68
James Basin	Total Habitat	170.5	91	73.41
James Basin	Total Habitat	171.5	92	73.95
James Basin	Total Habitat	172	93	74.26
James Basin	Total Habitat	172.5	95	77.56
James Basin	Total Habitat	174.5	96	78.30
James Basin	Total Habitat	177.5	97	81.42
James Basin	Total Habitat	180	98	84.54
James Basin	Total Habitat	181.5	99	87.66
James Basin	Total Habitat	182	101	91.32
James Basin	Total Habitat	183.5	102	91.50
James Basin	Total Habitat	184	103	92.24
James Basin	Total Habitat	185	104	92.55
James Basin	Total Habitat	185.5	107	94.33
James Basin	Total Habitat	186.5	108	94.86
James Basin	Total Habitat	187	109	95.40
James Basin	Total Habitat	189	110	96.14
James Basin	Total Habitat	190.5	111	99.26
James Basin	Total Habitat	198	112	100.00
Roanoke Basin	Total Habitat	78	1	0.76
Roanoke Basin	Total Habitat	82	2	0.95
Roanoke Basin	Total Habitat	94	3	1.13
Roanoke Basin	Total Habitat	96.5	4	1.69
Roanoke Basin	Total Habitat	101.5	5	2.45
Roanoke Basin	Total Habitat	103	6	5.67
Roanoke Basin	Total Habitat	107	7	6.43
Roanoke Basin	Total Habitat	109	9	7.74
Roanoke Basin	Total Habitat	110	10	10.96
Roanoke Basin	Total Habitat	113.5	11	14.18
Roanoke Basin	Total Habitat	115.5	12	14.73
Roanoke Basin	Total Habitat	116	13	15.05
Roanoke Basin	Total Habitat	117	14	15.81
Roanoke Basin	Total Habitat	118	15	16.12
Roanoke Basin	Total Habitat	120	16	16.89
Roanoke Basin	Total Habitat	120.5	17	20.10
Roanoke Basin	Total Habitat	121	18	20.42
Roanoke Basin	Total Habitat	122.5	20	21.94

Roanoke Basin	Total Habitat	123	22	25.71
Roanoke Basin	Total Habitat	124.5	23	26.47
Roanoke Basin	Total Habitat	125	24	26.79
Roanoke Basin	Total Habitat	127	25	27.55
Roanoke Basin	Total Habitat	127.5	26	28.10
Roanoke Basin	Total Habitat	128	27	28.86
Roanoke Basin	Total Habitat	129	29	32.27
Roanoke Basin	Total Habitat	130	32	39.47
Roanoke Basin	Total Habitat	130.5	34	40.78
Roanoke Basin	Total Habitat	132	35	41.34
Roanoke Basin	Total Habitat	133	36	44.56
Roanoke Basin	Total Habitat	134	37	47.77
Roanoke Basin	Total Habitat	135	39	48.40
Roanoke Basin	Total Habitat	135.5	41	49.14
Roanoke Basin	Total Habitat	138	42	49.69
Roanoke Basin	Total Habitat	138.5	44	51.22
Roanoke Basin	Total Habitat	140	45	51.98
Roanoke Basin	Total Habitat	141	48	58.97
Roanoke Basin	Total Habitat	142	49	59.52
Roanoke Basin	Total Habitat	143	50	60.08
Roanoke Basin	Total Habitat	143.5	51	60.39
Roanoke Basin	Total Habitat	144	54	62.02
Roanoke Basin	Total Habitat	144.5	57	66.76
Roanoke Basin	Total Habitat	145	60	71.50
Roanoke Basin	Total Habitat	146.5	61	72.06
Roanoke Basin	Total Habitat	147	62	72.82
Roanoke Basin	Total Habitat	147.5	64	76.22
Roanoke Basin	Total Habitat	148	66	79.63
Roanoke Basin	Total Habitat	150	67	80.39
Roanoke Basin	Total Habitat	150.5	69	81.50
Roanoke Basin	Total Habitat	151	73	85.77
Roanoke Basin	Total Habitat	152	74	86.08
Roanoke Basin	Total Habitat	152.5	75	86.84
Roanoke Basin	Total Habitat	153	76	87.40
Roanoke Basin	Total Habitat	153.5	77	87.58
Roanoke Basin	Total Habitat	155	78	90.80
Roanoke Basin	Total Habitat	155.5	79	91.11
Roanoke Basin	Total Habitat	156	80	91.67
Roanoke Basin	Total Habitat	158	81	91.85
Roanoke Basin	Total Habitat	158.5	82	92.61
Roanoke Basin	Total Habitat	160	84	93.24
Roanoke Basin	Total Habitat	160.5	85	93.56
Roanoke Basin	Total Habitat	161	86	93.87
Roanoke Basin	Total Habitat	162	87	94.42
Roanoke Basin	Total Habitat	162.5	88	94.74
Roanoke Basin	Total Habitat	163	89	95.29
Roanoke Basin	Total Habitat	163.5	90	95.84
Roanoke Basin	Total Habitat	166	91	96.03
Roanoke Basin	Total Habitat	167	93	96.77
Roanoke Basin	Total Habitat	167.5	94	97.53
Roanoke Basin	Total Habitat	169	95	97.72
Roanoke Basin	Total Habitat	170	96	98.48
Roanoke Basin	Total Habitat	175.5	97	99.24

Roanoke Basin	Total Habitat	182.5	98	100.00
Potomac-Shenandoah	Total Habitat	105	1	1.77
Potomac-Shenandoah	Total Habitat	110	2	3.54
Potomac-Shenandoah	Total Habitat	113	3	4.83
Potomac-Shenandoah	Total Habitat	114	4	5.56
Potomac-Shenandoah	Total Habitat	123.5	5	7.33
Potomac-Shenandoah	Total Habitat	125	6	8.06
Potomac-Shenandoah	Total Habitat	125.5	7	9.83
Potomac-Shenandoah	Total Habitat	126	8	10.27
Potomac-Shenandoah	Total Habitat	127	10	18.49
Potomac-Shenandoah	Total Habitat	130	11	19.77
Potomac-Shenandoah	Total Habitat	132.5	12	27.26
Potomac-Shenandoah	Total Habitat	134	13	28.55
Potomac-Shenandoah	Total Habitat	134.5	14	28.98
Potomac-Shenandoah	Total Habitat	139	15	29.71
Potomac-Shenandoah	Total Habitat	140	16	37.20
Potomac-Shenandoah	Total Habitat	142	17	44.69
Potomac-Shenandoah	Total Habitat	143.5	18	45.42
Potomac-Shenandoah	Total Habitat	147.5	20	54.69
Potomac-Shenandoah	Total Habitat	149.5	21	55.97
Potomac-Shenandoah	Total Habitat	150	22	57.74
Potomac-Shenandoah	Total Habitat	150.5	23	59.52
Potomac-Shenandoah	Total Habitat	152	24	61.29
Potomac-Shenandoah	Total Habitat	154	27	66.12
Potomac-Shenandoah	Total Habitat	155	29	74.34
Potomac-Shenandoah	Total Habitat	156	30	76.11
Potomac-Shenandoah	Total Habitat	156.5	31	76.84
Potomac-Shenandoah	Total Habitat	157.5	32	78.61
Potomac-Shenandoah	Total Habitat	158.5	33	79.90
Potomac-Shenandoah	Total Habitat	159.5	34	80.33
Potomac-Shenandoah	Total Habitat	162.5	35	82.10
Potomac-Shenandoah	Total Habitat	164	36	82.83
Potomac-Shenandoah	Total Habitat	165	37	84.61
Potomac-Shenandoah	Total Habitat	167.5	39	87.11
Potomac-Shenandoah	Total Habitat	170	41	89.12
Potomac-Shenandoah	Total Habitat	170.5	43	92.18
Potomac-Shenandoah	Total Habitat	171	44	93.95
Potomac-Shenandoah	Total Habitat	176	45	95.73
Potomac-Shenandoah	Total Habitat	180.5	46	96.46
Potomac-Shenandoah	Total Habitat	182	47	98.23
Potomac-Shenandoah	Total Habitat	189	48	100.00
Rappahannock-York	Total Habitat	104	1	0.38
Rappahannock-York	Total Habitat	107	2	1.51
Rappahannock-York	Total Habitat	108	3	8.09
Rappahannock-York	Total Habitat	114	4	14.67
Rappahannock-York	Total Habitat	117	5	15.05
Rappahannock-York	Total Habitat	120.5	6	15.69
Rappahannock-York	Total Habitat	121.5	7	16.82
Rappahannock-York	Total Habitat	124.5	8	17.46
Rappahannock-York	Total Habitat	127	9	19.01
Rappahannock-York	Total Habitat	129	10	20.14
Rappahannock-York	Total Habitat	130	12	22.08
Rappahannock-York	Total Habitat	131	13	23.64

Rappahannock-York	Total Habitat	131.5	14	24.77
Rappahannock-York	Total Habitat	132	15	26.32
Rappahannock-York	Total Habitat	132.5	17	34.46
Rappahannock-York	Total Habitat	134.5	18	36.01
Rappahannock-York	Total Habitat	135.5	19	36.65
Rappahannock-York	Total Habitat	136	20	37.78
Rappahannock-York	Total Habitat	136.5	22	40.47
Rappahannock-York	Total Habitat	138	23	47.05
Rappahannock-York	Total Habitat	139	26	56.74
Rappahannock-York	Total Habitat	142	27	57.38
Rappahannock-York	Total Habitat	144.5	28	58.02
Rappahannock-York	Total Habitat	145	29	59.58
Rappahannock-York	Total Habitat	146	30	59.96
Rappahannock-York	Total Habitat	148	31	60.60
Rappahannock-York	Total Habitat	149	32	62.15
Rappahannock-York	Total Habitat	149.5	33	63.28
Rappahannock-York	Total Habitat	150.5	34	63.93
Rappahannock-York	Total Habitat	154	35	65.48
Rappahannock-York	Total Habitat	154.5	36	67.04
Rappahannock-York	Total Habitat	155	37	67.42
Rappahannock-York	Total Habitat	155.5	38	68.06
Rappahannock-York	Total Habitat	156	40	75.77
Rappahannock-York	Total Habitat	156.5	41	76.90
Rappahannock-York	Total Habitat	157	42	78.45
Rappahannock-York	Total Habitat	157.5	43	80.01
Rappahannock-York	Total Habitat	158	44	81.14
Rappahannock-York	Total Habitat	159	45	82.27
Rappahannock-York	Total Habitat	160.5	46	82.65
Rappahannock-York	Total Habitat	162	47	83.03
Rappahannock-York	Total Habitat	165	49	84.80
Rappahannock-York	Total Habitat	168.5	50	85.44
Rappahannock-York	Total Habitat	170	51	85.82
Rappahannock-York	Total Habitat	178	52	92.40
Rappahannock-York	Total Habitat	182.5	53	92.78
Rappahannock-York	Total Habitat	188.5	54	93.42
Rappahannock-York	Total Habitat	190.5	55	100.00
Chowan	Total Habitat	44	1	7.47
Chowan	Total Habitat	69.5	2	14.93
Chowan	Total Habitat	70	3	15.36
Chowan	Total Habitat	80	4	15.79
Chowan	Total Habitat	85	5	16.23
Chowan	Total Habitat	105	6	17.51
Chowan	Total Habitat	106	7	19.27
Chowan	Total Habitat	115	8	26.74
Chowan	Total Habitat	121.5	9	27.17
Chowan	Total Habitat	123.5	10	28.45
Chowan	Total Habitat	128	11	28.66
Chowan	Total Habitat	132	13	36.86
Chowan	Total Habitat	133.5	14	38.62
Chowan	Total Habitat	134	15	39.35
Chowan	Total Habitat	137	16	40.08
Chowan	Total Habitat	139	17	40.80
Chowan	Total Habitat	141	18	41.01

Chowan	Total Habitat	142	20	43.21
Chowan	Total Habitat	143	21	44.97
Chowan	Total Habitat	144.5	23	53.72
Chowan	Total Habitat	145.5	24	53.93
Chowan	Total Habitat	146	26	55.09
Chowan	Total Habitat	147	27	56.37
Chowan	Total Habitat	147.5	28	57.65
Chowan	Total Habitat	149	30	61.19
Chowan	Total Habitat	150	31	68.65
Chowan	Total Habitat	152	32	69.38
Chowan	Total Habitat	155.5	33	76.85
Chowan	Total Habitat	158	34	84.31
Chowan	Total Habitat	160	35	84.74
Chowan	Total Habitat	163	36	86.51
Chowan	Total Habitat	164	39	88.95
Chowan	Total Habitat	165	40	90.23
Chowan	Total Habitat	165.5	41	90.96
Chowan	Total Habitat	166	42	91.69
Chowan	Total Habitat	168	43	92.12
Chowan	Total Habitat	169	44	92.33
Chowan	Total Habitat	173	45	99.79
Chowan	Total Habitat	177	46	100.00
Tennessee	Total Habitat	71	1	5.72
Tennessee	Total Habitat	94.5	2	6.28
Tennessee	Total Habitat	95	3	6.84
Tennessee	Total Habitat	106	4	7.82
Tennessee	Total Habitat	106.5	5	8.80
Tennessee	Total Habitat	110	8	11.32
Tennessee	Total Habitat	116.5	9	17.05
Tennessee	Total Habitat	117.5	10	18.40
Tennessee	Total Habitat	118.5	11	19.38
Tennessee	Total Habitat	119	13	22.09
Tennessee	Total Habitat	120.5	14	22.65
Tennessee	Total Habitat	121	16	24.19
Tennessee	Total Habitat	122	17	25.17
Tennessee	Total Habitat	125.5	18	30.89
Tennessee	Total Habitat	126	19	31.45
Tennessee	Total Habitat	126.5	20	32.43
Tennessee	Total Habitat	127	21	38.15
Tennessee	Total Habitat	128	22	39.50
Tennessee	Total Habitat	129	23	40.49
Tennessee	Total Habitat	130	24	40.82
Tennessee	Total Habitat	131	25	41.15
Tennessee	Total Habitat	131.5	27	43.06
Tennessee	Total Habitat	132	28	44.04
Tennessee	Total Habitat	136.5	29	45.02
Tennessee	Total Habitat	137	31	47.36
Tennessee	Total Habitat	138	32	48.71
Tennessee	Total Habitat	138.5	33	54.43
Tennessee	Total Habitat	139.5	35	56.77
Tennessee	Total Habitat	140	36	62.49
Tennessee	Total Habitat	141	37	63.05
Tennessee	Total Habitat	142	39	69.75



Tennessee	Total Habitat	145	41	71.66
Tennessee	Total Habitat	145.5	43	72.55
Tennessee	Total Habitat	146	44	73.11
Tennessee	Total Habitat	147	45	74.09
Tennessee	Total Habitat	148	46	75.07
Tennessee	Total Habitat	149	47	76.06
Tennessee	Total Habitat	149.5	48	77.04
Tennessee	Total Habitat	150	49	78.02
Tennessee	Total Habitat	151.5	50	78.58
Tennessee	Total Habitat	152	51	79.93
Tennessee	Total Habitat	153	52	81.29
Tennessee	Total Habitat	154.5	54	83.20
Tennessee	Total Habitat	155	55	83.75
Tennessee	Total Habitat	157	56	89.48
Tennessee	Total Habitat	158	57	90.46
Tennessee	Total Habitat	159	59	97.53
Tennessee	Total Habitat	161.5	60	98.09
Tennessee	Total Habitat	165	61	99.44
Tennessee	Total Habitat	178	62	100.00
New	Total Habitat	80	1	0.66
New	Total Habitat	87	2	7.38
New	Total Habitat	114	3	14.11
New	Total Habitat	114.5	4	15.70
New	Total Habitat	116	5	17.30
New	Total Habitat	119	6	18.89
New	Total Habitat	125	8	21.14
New	Total Habitat	126.5	9	22.29
New	Total Habitat	128	10	23.45
New	Total Habitat	129.5	11	25.04
New	Total Habitat	134	13	27.02
New	Total Habitat	135	14	28.61
New	Total Habitat	135.5	15	30.20
New	Total Habitat	137	16	31.36
New	Total Habitat	142	17	32.02
New	Total Habitat	146.5	19	39.90
New	Total Habitat	147	20	46.63
New	Total Habitat	150	23	55.17
New	Total Habitat	153	24	56.32
New	Total Habitat	154	25	56.98
New	Total Habitat	155	27	65.30
New	Total Habitat	156	28	72.03
New	Total Habitat	158	29	73.19
New	Total Habitat	159	30	74.78
New	Total Habitat	160.5	31	75.17
New	Total Habitat	164	32	76.32
New	Total Habitat	164.5	33	83.05
New	Total Habitat	165	34	89.78
New	Total Habitat	167	35	90.17
New	Total Habitat	168.5	36	91.32
New	Total Habitat	170	37	91.98
New	Total Habitat	170.5	38	93.14
New	Total Habitat	171	39	94.73
New	Total Habitat	174	40	96.32

New	Total Habitat	175.5	41	96.97
New	Total Habitat	180	43	99.22
New	Total Habitat	186.5	44	99.61
New	Total Habitat	190.5	45	100.00

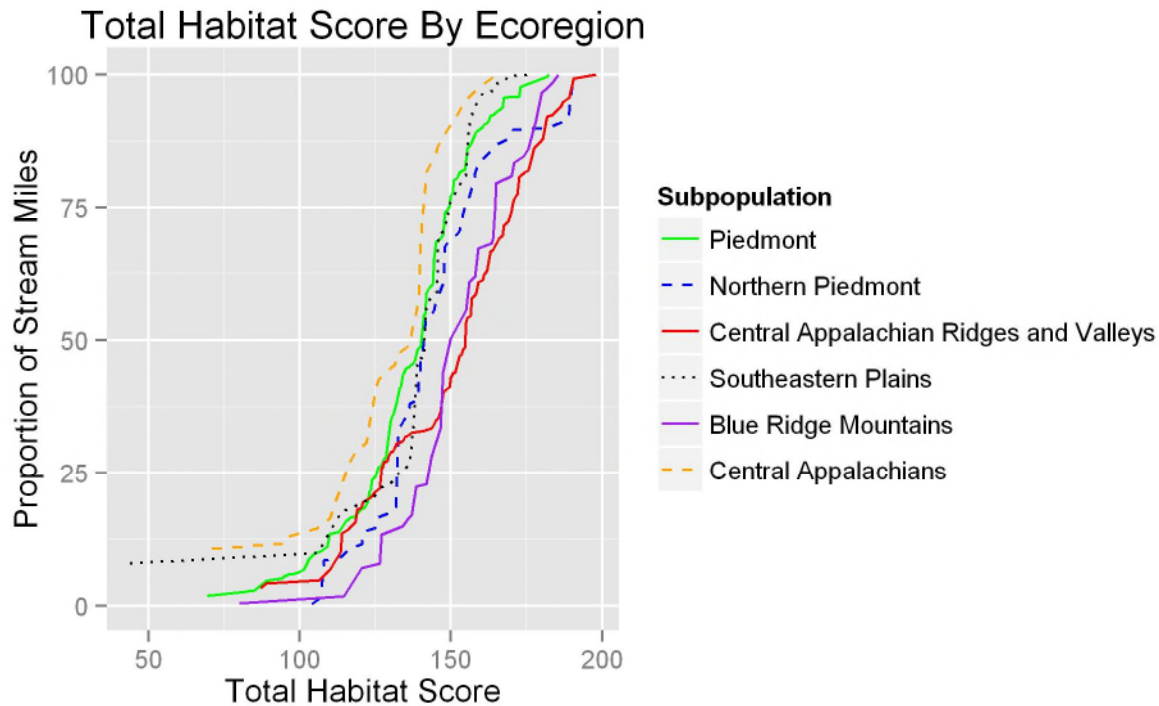


Figure 97. **Total Habitat by Major Ecoregion (Level III) CDF graph.**

Figure 97 shows CDF curves for total habitat by Level III ecoregion. Table 56 corresponds to Figure 97. Twenty-eight percent of Central Appalachian streams have total habitat scores less than 132. The Piedmont shows 34.8% of streams have total habitat scores less than 130 and the Northern Piedmont has about 17.9% of stream miles with habitat scores less than 131.5. Central Appalachian Ridges and Valleys ecoregion has 28.9% of stream miles with total habitat scores at the medium probability of stress to aquatic life threshold of 130 (Tables 53 and 56). The Southeastern Plains 23<sup>rd</sup> percentile is 130. Eight percent of Blue Ridge Mountain stream miles are less than 126.5 total habitat score.

Table 56. **Total Habitat Population Estimates by Major Ecoregion (Level III).**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Total Habitat	69.5	1	1.84	0.00	4.85
Piedmont	Total Habitat	70	2	1.94	0.00	4.97

Piedmont	Total Habitat	78	3	2.38	0.00	5.49
Piedmont	Total Habitat	80	4	2.48	0.00	5.60
Piedmont	Total Habitat	82	5	2.59	0.00	5.71
Piedmont	Total Habitat	83	6	2.77	0.00	5.91
Piedmont	Total Habitat	85	7	2.87	0.00	6.02
Piedmont	Total Habitat	89	8	4.71	0.49	8.93
Piedmont	Total Habitat	90	9	4.81	0.59	9.03
Piedmont	Total Habitat	94	11	5.24	0.98	9.49
Piedmont	Total Habitat	95	12	5.55	1.27	9.83
Piedmont	Total Habitat	96.5	13	5.87	1.55	10.19
Piedmont	Total Habitat	98	14	5.97	1.65	10.30
Piedmont	Total Habitat	100	15	6.41	2.03	10.78
Piedmont	Total Habitat	101.5	16	6.84	2.39	11.29
Piedmont	Total Habitat	103	17	8.68	3.55	13.80
Piedmont	Total Habitat	103.5	18	9.11	3.94	14.28
Piedmont	Total Habitat	105	20	9.86	4.61	15.11
Piedmont	Total Habitat	107	21	10.29	4.99	15.60
Piedmont	Total Habitat	109	23	11.04	5.67	16.42
Piedmont	Total Habitat	110	26	13.51	7.63	19.39
Piedmont	Total Habitat	113	27	13.83	7.94	19.71
Piedmont	Total Habitat	115	28	15.66	9.19	22.13
Piedmont	Total Habitat	115.5	29	15.98	9.53	22.42
Piedmont	Total Habitat	116	30	16.16	9.70	22.61
Piedmont	Total Habitat	117	31	16.59	10.13	23.05
Piedmont	Total Habitat	118	32	16.77	10.35	23.18
Piedmont	Total Habitat	119	33	17.20	10.78	23.63
Piedmont	Total Habitat	119.5	34	17.64	11.14	24.14
Piedmont	Total Habitat	120	35	18.07	11.52	24.63
Piedmont	Total Habitat	121	37	18.36	11.78	24.93
Piedmont	Total Habitat	121.5	38	18.46	11.88	25.04
Piedmont	Total Habitat	122.5	40	19.33	12.69	25.97
Piedmont	Total Habitat	123	42	21.48	14.56	28.40
Piedmont	Total Habitat	123.5	43	21.80	14.86	28.73
Piedmont	Total Habitat	124	44	23.63	16.26	31.01
Piedmont	Total Habitat	124.5	45	24.07	16.65	31.49
Piedmont	Total Habitat	125	46	24.25	16.82	31.67
Piedmont	Total Habitat	126	47	26.08	18.39	33.77
Piedmont	Total Habitat	127	48	26.52	18.80	34.23
Piedmont	Total Habitat	127.5	50	27.26	19.50	35.03
Piedmont	Total Habitat	128	51	27.70	19.87	35.53
Piedmont	Total Habitat	128.5	52	28.13	20.32	35.95
Piedmont	Total Habitat	129	54	30.28	22.22	38.35
Piedmont	Total Habitat	130	58	34.82	26.45	43.20
Piedmont	Total Habitat	130.5	60	35.57	27.17	43.97
Piedmont	Total Habitat	131	61	36.01	27.59	44.42
Piedmont	Total Habitat	132	63	38.02	29.58	46.46
Piedmont	Total Habitat	133	67	40.90	32.42	49.39
Piedmont	Total Habitat	133.5	68	41.34	32.85	49.83
Piedmont	Total Habitat	134	70	43.35	34.86	51.84
Piedmont	Total Habitat	134.5	71	43.79	35.31	52.26
Piedmont	Total Habitat	135	74	44.46	35.98	52.94
Piedmont	Total Habitat	135.5	75	44.78	36.29	53.27
Piedmont	Total Habitat	136	76	44.88	36.39	53.37

Piedmont	Total Habitat	137	78	45.38	36.88	53.87
Piedmont	Total Habitat	137.5	79	45.48	36.98	53.98
Piedmont	Total Habitat	138	82	46.29	37.82	54.76
Piedmont	Total Habitat	138.5	84	47.16	38.67	55.65
Piedmont	Total Habitat	139	87	48.21	39.69	56.73
Piedmont	Total Habitat	140	89	48.82	40.24	57.40
Piedmont	Total Habitat	141	93	54.64	45.86	63.42
Piedmont	Total Habitat	141.5	94	54.75	45.96	63.53
Piedmont	Total Habitat	142	98	58.91	50.31	67.52
Piedmont	Total Habitat	143	102	59.82	51.21	68.43
Piedmont	Total Habitat	144	104	60.57	51.95	69.19
Piedmont	Total Habitat	144.5	109	65.42	57.04	73.81
Piedmont	Total Habitat	145	113	68.44	60.33	76.56
Piedmont	Total Habitat	146	114	68.62	60.49	76.75
Piedmont	Total Habitat	147	116	69.37	61.28	77.47
Piedmont	Total Habitat	147.5	118	69.79	61.69	77.89
Piedmont	Total Habitat	148	123	74.06	66.41	81.71
Piedmont	Total Habitat	149	126	74.86	67.25	82.46
Piedmont	Total Habitat	149.5	128	75.35	67.78	82.93
Piedmont	Total Habitat	150	129	77.19	70.17	84.21
Piedmont	Total Habitat	150.5	131	77.82	70.79	84.84
Piedmont	Total Habitat	151	135	80.25	73.63	86.88
Piedmont	Total Habitat	152	137	80.61	73.98	87.24
Piedmont	Total Habitat	152.5	138	81.05	74.35	87.74
Piedmont	Total Habitat	153	140	81.68	74.99	88.36
Piedmont	Total Habitat	154.5	141	82.11	75.43	88.79
Piedmont	Total Habitat	155	142	83.95	77.65	90.24
Piedmont	Total Habitat	155.5	145	86.14	80.46	91.82
Piedmont	Total Habitat	156	146	86.45	80.79	92.12
Piedmont	Total Habitat	156.5	147	86.89	81.27	92.51
Piedmont	Total Habitat	158	149	88.83	83.83	93.83
Piedmont	Total Habitat	158.5	150	89.26	84.32	94.21
Piedmont	Total Habitat	160	153	89.94	85.03	94.84
Piedmont	Total Habitat	160.5	154	90.12	85.22	95.01
Piedmont	Total Habitat	161	155	90.55	85.71	95.39
Piedmont	Total Habitat	162	157	90.97	86.15	95.79
Piedmont	Total Habitat	162.5	158	91.15	86.35	95.96
Piedmont	Total Habitat	163	161	92.22	87.51	96.92
Piedmont	Total Habitat	164	162	92.39	87.70	97.09
Piedmont	Total Habitat	165	164	92.89	88.23	97.55
Piedmont	Total Habitat	165.5	165	93.07	88.41	97.73
Piedmont	Total Habitat	166	167	93.35	88.71	97.99
Piedmont	Total Habitat	166.5	168	93.53	88.90	98.16
Piedmont	Total Habitat	167	169	93.85	89.24	98.45
Piedmont	Total Habitat	167.5	170	95.68	91.88	99.48
Piedmont	Total Habitat	169	171	95.79	91.99	99.59
Piedmont	Total Habitat	172.5	172	95.89	92.10	99.69
Piedmont	Total Habitat	173	173	97.73	94.97	100.00
Piedmont	Total Habitat	182	174	99.57	98.88	100.00
Piedmont	Total Habitat	182.5	175	100.00	100.00	100.00
Northern Piedmont	Total Habitat	104	1	0.40	0.00	1.14
Northern Piedmont	Total Habitat	107	2	1.60	0.00	3.89
Northern Piedmont	Total Habitat	108	3	8.55	0.00	18.39

Northern Piedmont	Total Habitat	114	4	9.23	0.00	19.13
Northern Piedmont	Total Habitat	116.5	5	10.87	0.77	20.97
Northern Piedmont	Total Habitat	120.5	6	11.55	1.47	21.63
Northern Piedmont	Total Habitat	121	7	12.75	2.55	22.95
Northern Piedmont	Total Habitat	121.5	8	13.94	3.47	24.41
Northern Piedmont	Total Habitat	125	9	14.62	4.03	25.20
Northern Piedmont	Total Habitat	125.5	10	16.26	5.34	27.18
Northern Piedmont	Total Habitat	126	11	16.66	5.67	27.66
Northern Piedmont	Total Habitat	131.5	12	17.86	6.77	28.95
Northern Piedmont	Total Habitat	132	13	19.50	8.37	30.64
Northern Piedmont	Total Habitat	132.5	15	33.41	19.17	47.66
Northern Piedmont	Total Habitat	134	16	34.61	20.29	48.92
Northern Piedmont	Total Habitat	134.5	17	35.01	20.68	49.34
Northern Piedmont	Total Habitat	135.5	18	35.69	21.35	50.02
Northern Piedmont	Total Habitat	136	19	36.88	22.51	51.25
Northern Piedmont	Total Habitat	136.5	20	38.07	23.38	52.77
Northern Piedmont	Total Habitat	139	21	38.75	24.08	53.43
Northern Piedmont	Total Habitat	140	22	45.71	30.07	61.34
Northern Piedmont	Total Habitat	140.5	23	47.35	31.78	62.92
Northern Piedmont	Total Habitat	142	24	54.30	39.11	69.50
Northern Piedmont	Total Habitat	143.5	25	54.98	39.99	69.98
Northern Piedmont	Total Habitat	144.5	26	55.66	40.68	70.64
Northern Piedmont	Total Habitat	145	27	57.31	42.40	72.21
Northern Piedmont	Total Habitat	147.5	29	60.59	46.23	74.96
Northern Piedmont	Total Habitat	148	30	67.55	54.69	80.41
Northern Piedmont	Total Habitat	150	31	69.19	56.43	81.96
Northern Piedmont	Total Habitat	152	32	69.87	57.19	82.55
Northern Piedmont	Total Habitat	153	33	70.55	57.95	83.15
Northern Piedmont	Total Habitat	154	35	73.84	61.44	86.24
Northern Piedmont	Total Habitat	154.5	36	75.03	63.02	87.05
Northern Piedmont	Total Habitat	155	37	75.44	63.51	87.36
Northern Piedmont	Total Habitat	156	38	77.08	65.25	88.91
Northern Piedmont	Total Habitat	157	39	78.73	67.07	90.38
Northern Piedmont	Total Habitat	157.5	40	80.37	68.87	91.87
Northern Piedmont	Total Habitat	158	41	81.56	70.22	92.90
Northern Piedmont	Total Habitat	159	43	83.16	71.42	94.91
Northern Piedmont	Total Habitat	159.5	44	83.56	71.86	95.27
Northern Piedmont	Total Habitat	162.5	45	85.21	73.82	96.59
Northern Piedmont	Total Habitat	165	46	86.85	75.86	97.85
Northern Piedmont	Total Habitat	169.5	47	88.05	77.19	98.90
Northern Piedmont	Total Habitat	170	48	88.45	77.54	99.35
Northern Piedmont	Total Habitat	170.5	49	89.64	78.89	100.00
Northern Piedmont	Total Habitat	182.5	50	90.05	79.31	100.00
Northern Piedmont	Total Habitat	185	51	90.72	80.04	100.00
Northern Piedmont	Total Habitat	188.5	52	91.40	80.71	100.00
Northern Piedmont	Total Habitat	189	53	93.05	82.67	100.00
Northern Piedmont	Total Habitat	190.5	54	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Total Habitat	87	1	3.38	0.00	8.89
Central Appalachian Ridges and Valleys	Total Habitat	89	2	4.18	0.00	9.82
Central Appalachian Ridges and Valleys	Total Habitat	106.5	3	4.76	0.00	10.47
Central Appalachian Ridges and Valleys	Total Habitat	110	7	6.79	0.92	12.67
Central Appalachian Ridges and Valleys	Total Habitat	113.5	8	10.17	2.63	17.71
Central Appalachian Ridges and Valleys	Total Habitat	114	9	13.55	4.98	22.12

Central Appalachian Ridges and Valleys	Total Habitat	116	10	14.35	5.90	22.80
Central Appalachian Ridges and Valleys	Total Habitat	117.5	11	15.15	6.65	23.64
Central Appalachian Ridges and Valleys	Total Habitat	118.5	12	15.73	7.20	24.25
Central Appalachian Ridges and Valleys	Total Habitat	119	15	18.12	9.49	26.76
Central Appalachian Ridges and Valleys	Total Habitat	120	16	18.32	9.67	26.97
Central Appalachian Ridges and Valleys	Total Habitat	120.5	17	18.65	10.02	27.27
Central Appalachian Ridges and Valleys	Total Habitat	121	19	19.56	10.90	28.22
Central Appalachian Ridges and Valleys	Total Habitat	123.5	20	20.36	11.65	29.07
Central Appalachian Ridges and Valleys	Total Habitat	125	22	21.49	12.76	30.22
Central Appalachian Ridges and Valleys	Total Habitat	126.5	23	22.07	13.31	30.83
Central Appalachian Ridges and Valleys	Total Habitat	127	25	25.77	16.03	35.51
Central Appalachian Ridges and Valleys	Total Habitat	128	27	27.15	17.42	36.89
Central Appalachian Ridges and Valleys	Total Habitat	129	28	27.35	17.61	37.08
Central Appalachian Ridges and Valleys	Total Habitat	129.5	29	28.15	18.44	37.85
Central Appalachian Ridges and Valleys	Total Habitat	130	31	28.92	19.15	38.69
Central Appalachian Ridges and Valleys	Total Habitat	131	32	29.12	19.35	38.88
Central Appalachian Ridges and Valleys	Total Habitat	131.5	33	29.92	20.16	39.67
Central Appalachian Ridges and Valleys	Total Habitat	132	34	30.50	20.75	40.24
Central Appalachian Ridges and Valleys	Total Habitat	134	35	31.08	21.32	40.84
Central Appalachian Ridges and Valleys	Total Habitat	135	36	31.88	22.13	41.62
Central Appalachian Ridges and Valleys	Total Habitat	135.5	37	32.07	22.33	41.81
Central Appalachian Ridges and Valleys	Total Habitat	137	38	32.65	23.03	42.27
Central Appalachian Ridges and Valleys	Total Habitat	141	39	32.98	23.38	42.58
Central Appalachian Ridges and Valleys	Total Habitat	143.5	41	33.50	23.92	43.09
Central Appalachian Ridges and Valleys	Total Habitat	144	42	33.83	24.26	43.41
Central Appalachian Ridges and Valleys	Total Habitat	144.5	43	34.16	24.55	43.77
Central Appalachian Ridges and Valleys	Total Habitat	145	44	34.96	25.28	44.64
Central Appalachian Ridges and Valleys	Total Habitat	145.5	45	35.16	25.47	44.84
Central Appalachian Ridges and Valleys	Total Habitat	146	46	35.49	25.83	45.14
Central Appalachian Ridges and Valleys	Total Habitat	146.5	48	36.65	27.04	46.25
Central Appalachian Ridges and Valleys	Total Habitat	147.5	49	40.02	30.12	49.92
Central Appalachian Ridges and Valleys	Total Habitat	148	50	40.60	30.73	50.48
Central Appalachian Ridges and Valleys	Total Habitat	149.5	51	41.18	31.38	50.99
Central Appalachian Ridges and Valleys	Total Habitat	150	54	42.89	33.13	52.65
Central Appalachian Ridges and Valleys	Total Habitat	150.5	55	43.69	33.95	53.44
Central Appalachian Ridges and Valleys	Total Habitat	151.5	56	44.02	34.29	53.75
Central Appalachian Ridges and Valleys	Total Habitat	152	58	45.40	35.55	55.25
Central Appalachian Ridges and Valleys	Total Habitat	153	61	47.11	37.12	57.10
Central Appalachian Ridges and Valleys	Total Habitat	153.5	62	47.30	37.31	57.29
Central Appalachian Ridges and Valleys	Total Habitat	154	64	48.21	38.28	58.15
Central Appalachian Ridges and Valleys	Total Habitat	154.5	65	48.54	38.60	58.48
Central Appalachian Ridges and Valleys	Total Habitat	155	69	53.38	43.65	63.11
Central Appalachian Ridges and Valleys	Total Habitat	155.5	70	54.18	44.31	64.04
Central Appalachian Ridges and Valleys	Total Habitat	156.5	71	54.51	44.67	64.35
Central Appalachian Ridges and Valleys	Total Habitat	157	72	57.88	48.31	67.46
Central Appalachian Ridges and Valleys	Total Habitat	158	73	58.46	48.97	67.95
Central Appalachian Ridges and Valleys	Total Habitat	158.5	74	59.04	49.64	68.45
Central Appalachian Ridges and Valleys	Total Habitat	159	77	60.84	51.28	70.39
Central Appalachian Ridges and Valleys	Total Habitat	160.5	79	61.36	51.80	70.93
Central Appalachian Ridges and Valleys	Total Habitat	161	81	62.27	52.65	71.90
Central Appalachian Ridges and Valleys	Total Habitat	161.5	82	62.60	52.99	72.21
Central Appalachian Ridges and Valleys	Total Habitat	162	83	63.18	53.51	72.85
Central Appalachian Ridges and Valleys	Total Habitat	163	84	66.56	57.45	75.67

Central Appalachian Ridges and Valleys	Total Habitat	164	85	66.89	57.82	75.95
Central Appalachian Ridges and Valleys	Total Habitat	165	87	68.05	58.99	77.11
Central Appalachian Ridges and Valleys	Total Habitat	166	89	69.18	60.05	78.31
Central Appalachian Ridges and Valleys	Total Habitat	167	91	69.57	60.44	78.69
Central Appalachian Ridges and Valleys	Total Habitat	167.5	94	71.49	62.39	80.60
Central Appalachian Ridges and Valleys	Total Habitat	168.5	95	72.07	63.03	81.12
Central Appalachian Ridges and Valleys	Total Habitat	169	96	72.27	63.23	81.31
Central Appalachian Ridges and Valleys	Total Habitat	170	101	74.42	65.35	83.49
Central Appalachian Ridges and Valleys	Total Habitat	170.5	103	75.80	66.75	84.84
Central Appalachian Ridges and Valleys	Total Habitat	171	104	76.60	67.62	85.57
Central Appalachian Ridges and Valleys	Total Habitat	171.5	105	77.18	68.15	86.21
Central Appalachian Ridges and Valleys	Total Habitat	172	106	77.51	68.47	86.54
Central Appalachian Ridges and Valleys	Total Habitat	172.5	107	80.88	72.54	89.23
Central Appalachian Ridges and Valleys	Total Habitat	174.5	108	81.68	73.41	89.95
Central Appalachian Ridges and Valleys	Total Habitat	175.5	109	82.01	73.75	90.27
Central Appalachian Ridges and Valleys	Total Habitat	176	110	82.81	74.44	91.18
Central Appalachian Ridges and Valleys	Total Habitat	177.5	111	86.19	79.09	93.29
Central Appalachian Ridges and Valleys	Total Habitat	178	112	86.52	79.43	93.60
Central Appalachian Ridges and Valleys	Total Habitat	180	114	87.64	80.65	94.64
Central Appalachian Ridges and Valleys	Total Habitat	180.5	115	87.97	81.01	94.94
Central Appalachian Ridges and Valleys	Total Habitat	181.5	116	91.35	85.94	96.76
Central Appalachian Ridges and Valleys	Total Habitat	182	117	92.15	86.91	97.39
Central Appalachian Ridges and Valleys	Total Habitat	183.5	118	92.35	87.06	97.63
Central Appalachian Ridges and Valleys	Total Habitat	185.5	120	93.47	88.31	98.64
Central Appalachian Ridges and Valleys	Total Habitat	186.5	122	94.25	89.18	99.32
Central Appalachian Ridges and Valleys	Total Habitat	187	123	94.83	89.73	99.93
Central Appalachian Ridges and Valleys	Total Habitat	189	124	95.63	90.27	100.00
Central Appalachian Ridges and Valleys	Total Habitat	190.5	126	99.20	97.86	100.00
Central Appalachian Ridges and Valleys	Total Habitat	198	127	100.00	100.00	100.00
Southeastern Plains	Total Habitat	44	1	7.97	0.00	20.24
Southeastern Plains	Total Habitat	106	2	9.85	0.00	22.27
Southeastern Plains	Total Habitat	114	3	17.82	0.87	34.76
Southeastern Plains	Total Habitat	117	4	18.28	1.33	35.22
Southeastern Plains	Total Habitat	121.5	5	19.65	2.63	36.66
Southeastern Plains	Total Habitat	124.5	6	20.42	3.40	37.44
Southeastern Plains	Total Habitat	127	7	22.31	5.25	39.36
Southeastern Plains	Total Habitat	128	8	22.53	5.49	39.56
Southeastern Plains	Total Habitat	130	9	22.99	5.95	40.03
Southeastern Plains	Total Habitat	132.5	10	24.87	7.30	42.44
Southeastern Plains	Total Habitat	136.5	11	26.76	9.14	44.37
Southeastern Plains	Total Habitat	138	13	36.61	18.25	54.97
Southeastern Plains	Total Habitat	139	15	46.46	29.56	63.35
Southeastern Plains	Total Habitat	141	16	46.68	29.79	63.57
Southeastern Plains	Total Habitat	142	19	56.99	39.32	74.66
Southeastern Plains	Total Habitat	145	20	58.87	40.83	76.92
Southeastern Plains	Total Habitat	145.5	21	59.09	41.06	77.13
Southeastern Plains	Total Habitat	146	25	69.86	53.73	86.00
Southeastern Plains	Total Habitat	148	26	70.64	54.58	86.70
Southeastern Plains	Total Habitat	149	28	74.41	59.02	89.80
Southeastern Plains	Total Habitat	149.5	29	75.78	60.44	91.12
Southeastern Plains	Total Habitat	150.5	30	76.55	61.37	91.74
Southeastern Plains	Total Habitat	152	31	78.44	63.53	93.35
Southeastern Plains	Total Habitat	154	32	80.32	65.83	94.82

Southeastern Plains	Total Habitat	155	33	81.10	66.64	95.56
Southeastern Plains	Total Habitat	156	35	90.44	83.91	96.96
Southeastern Plains	Total Habitat	156.5	36	91.80	85.77	97.84
Southeastern Plains	Total Habitat	157.5	37	93.69	89.25	98.13
Southeastern Plains	Total Habitat	160	39	96.03	93.16	98.91
Southeastern Plains	Total Habitat	160.5	40	96.49	93.80	99.18
Southeastern Plains	Total Habitat	164	41	96.95	94.25	99.66
Southeastern Plains	Total Habitat	165	42	98.32	96.64	100.00
Southeastern Plains	Total Habitat	168	43	98.78	97.33	100.00
Southeastern Plains	Total Habitat	168.5	44	99.56	99.07	100.00
Southeastern Plains	Total Habitat	169	45	99.78	99.39	100.00
Southeastern Plains	Total Habitat	177	46	100.00	100.00	100.00
Blue Ridge Mountains	Total Habitat	80	1	0.52	0.00	1.47
Blue Ridge Mountains	Total Habitat	114.5	2	1.77	0.00	4.07
Blue Ridge Mountains	Total Habitat	120.5	3	7.09	0.00	14.94
Blue Ridge Mountains	Total Habitat	126.5	4	8.00	0.00	16.01
Blue Ridge Mountains	Total Habitat	127	5	13.31	1.66	24.97
Blue Ridge Mountains	Total Habitat	134	7	14.88	2.95	26.80
Blue Ridge Mountains	Total Habitat	135.5	8	16.13	3.89	28.38
Blue Ridge Mountains	Total Habitat	137	9	17.05	4.83	29.27
Blue Ridge Mountains	Total Habitat	138.5	10	22.36	8.95	35.77
Blue Ridge Mountains	Total Habitat	142	11	22.88	9.42	36.33
Blue Ridge Mountains	Total Habitat	143.5	12	28.19	12.57	43.81
Blue Ridge Mountains	Total Habitat	146.5	13	33.51	16.95	50.06
Blue Ridge Mountains	Total Habitat	147	14	38.82	21.73	55.91
Blue Ridge Mountains	Total Habitat	147.5	15	44.13	26.25	62.02
Blue Ridge Mountains	Total Habitat	150	17	50.36	31.80	68.92
Blue Ridge Mountains	Total Habitat	155	18	55.67	37.69	73.65
Blue Ridge Mountains	Total Habitat	156	19	60.98	43.85	78.11
Blue Ridge Mountains	Total Habitat	158	20	61.90	44.86	78.94
Blue Ridge Mountains	Total Habitat	159	21	67.21	52.16	82.26
Blue Ridge Mountains	Total Habitat	163.5	22	68.12	53.04	83.21
Blue Ridge Mountains	Total Habitat	164	23	69.04	54.13	83.94
Blue Ridge Mountains	Total Habitat	164.5	24	74.35	61.51	87.18
Blue Ridge Mountains	Total Habitat	165	25	79.66	69.06	90.26
Blue Ridge Mountains	Total Habitat	170	26	80.92	70.71	91.13
Blue Ridge Mountains	Total Habitat	170.5	27	82.18	71.42	92.93
Blue Ridge Mountains	Total Habitat	171	28	83.43	73.07	93.80
Blue Ridge Mountains	Total Habitat	174	29	84.69	74.68	94.70
Blue Ridge Mountains	Total Habitat	175.5	30	85.95	75.50	96.40
Blue Ridge Mountains	Total Habitat	178	31	91.26	82.72	99.80
Blue Ridge Mountains	Total Habitat	180	32	96.57	93.23	99.92
Blue Ridge Mountains	Total Habitat	182	33	97.49	94.35	100.00
Blue Ridge Mountains	Total Habitat	184	34	98.74	96.45	100.00
Blue Ridge Mountains	Total Habitat	185.5	35	100.00	100.00	100.00
Central Appalachians	Total Habitat	71	1	10.68	0.00	22.36
Central Appalachians	Total Habitat	94.5	2	11.72	0.00	23.50
Central Appalachians	Total Habitat	95	3	12.76	0.94	24.57
Central Appalachians	Total Habitat	106	4	14.59	2.22	26.96
Central Appalachians	Total Habitat	110	5	16.42	3.67	29.18
Central Appalachians	Total Habitat	116.5	6	27.10	8.47	45.73
Central Appalachians	Total Habitat	118.5	7	28.93	10.40	47.47
Central Appalachians	Total Habitat	122	8	30.77	11.94	49.60



Central Appalachians	Total Habitat	125.5	9	41.44	21.16	61.73
Central Appalachians	Total Habitat	126	10	42.48	22.46	62.51
Central Appalachians	Total Habitat	129	11	44.32	24.47	64.17
Central Appalachians	Total Habitat	131.5	12	45.36	25.28	65.44
Central Appalachians	Total Habitat	132	13	47.19	27.80	66.59
Central Appalachians	Total Habitat	136.5	14	49.03	29.71	68.34
Central Appalachians	Total Habitat	137	15	51.55	32.70	70.41
Central Appalachians	Total Habitat	138	16	54.08	35.15	73.01
Central Appalachians	Total Habitat	139.5	18	58.44	38.98	77.89
Central Appalachians	Total Habitat	140	19	69.11	52.43	85.80
Central Appalachians	Total Habitat	142	21	81.62	70.10	93.15
Central Appalachians	Total Habitat	145	23	85.19	75.20	95.18
Central Appalachians	Total Habitat	145.5	24	86.23	76.18	96.28
Central Appalachians	Total Habitat	147	25	88.06	78.62	97.51
Central Appalachians	Total Habitat	149	26	89.90	81.54	98.26
Central Appalachians	Total Habitat	152	27	92.42	85.43	99.42
Central Appalachians	Total Habitat	154.5	28	94.95	90.05	99.85
Central Appalachians	Total Habitat	159	29	97.47	93.43	100.00
Central Appalachians	Total Habitat	165	30	100.00	100.00	100.00

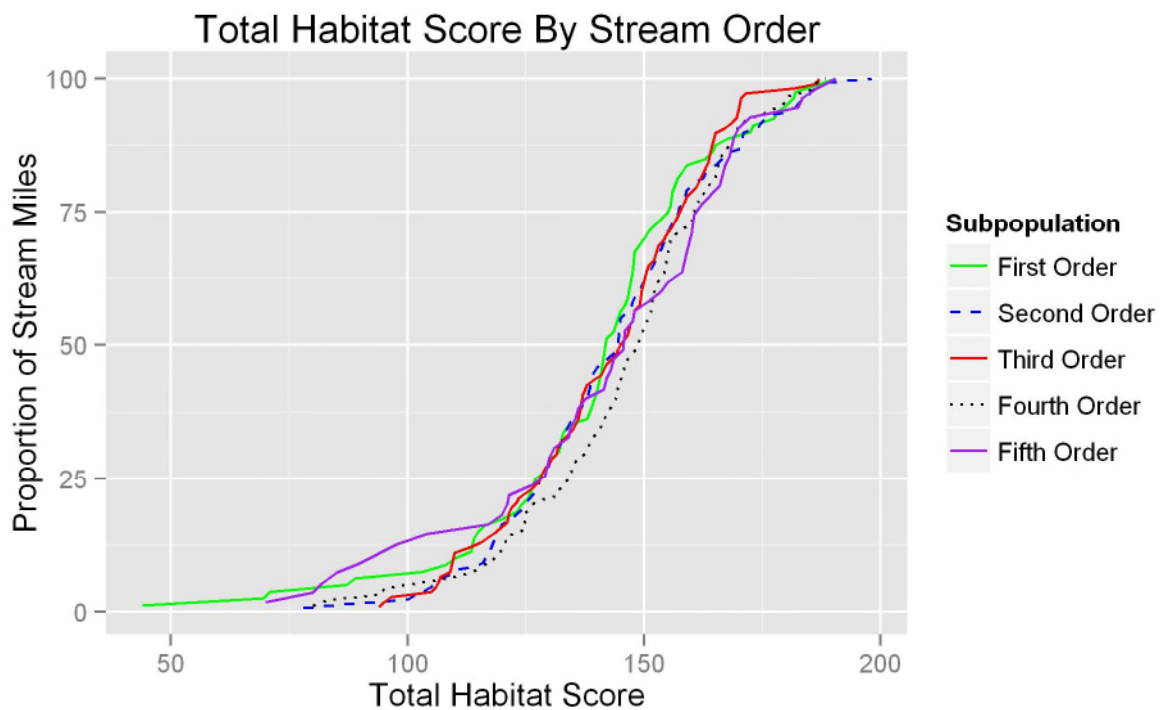


Figure 98. **Total Habitat by Stream Order CDF graph.**

Total habitat CDF curves by stream order are shown in Figure 98 with the corresponding percentiles and scores detailed in Table 57. All stream orders showed around 27-29% of stream

miles to have total habitat scores less than 130 except fourth order streams (21% of stream miles are less than 130).

**Table 57. Total Habitat Population Estimates by Stream Order.**

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Total Habitat	44	1	1.25	0.00	3.26
First Order	Total Habitat	69.5	2	2.50	0.00	5.42
First Order	Total Habitat	71	3	3.75	0.20	7.30
First Order	Total Habitat	87	4	5.00	1.01	8.99
First Order	Total Habitat	89	5	6.25	1.79	10.71
First Order	Total Habitat	103	6	7.50	2.61	12.39
First Order	Total Habitat	108	7	8.75	3.40	14.10
First Order	Total Habitat	110	8	10.00	4.38	15.62
First Order	Total Habitat	113.5	9	11.25	5.28	17.22
First Order	Total Habitat	114	11	13.75	7.56	19.94
First Order	Total Habitat	115	12	15.00	8.56	21.44
First Order	Total Habitat	116.5	13	16.25	9.47	23.03
First Order	Total Habitat	120.5	14	17.50	10.43	24.57
First Order	Total Habitat	123	15	18.75	11.51	25.99
First Order	Total Habitat	124	16	20.00	12.48	27.52
First Order	Total Habitat	125.5	17	21.25	13.61	28.89
First Order	Total Habitat	126	18	22.50	14.73	30.27
First Order	Total Habitat	127	20	25.00	16.81	33.19
First Order	Total Habitat	129	21	26.25	18.09	34.41
First Order	Total Habitat	130	23	28.75	20.26	37.24
First Order	Total Habitat	132	24	30.00	21.52	38.48
First Order	Total Habitat	132.5	26	32.50	23.85	41.15
First Order	Total Habitat	133	27	33.75	25.25	42.25
First Order	Total Habitat	134	28	35.00	26.70	43.30
First Order	Total Habitat	138	29	36.25	27.86	44.64
First Order	Total Habitat	138.5	30	37.50	29.03	45.97
First Order	Total Habitat	139	31	38.75	30.41	47.09
First Order	Total Habitat	140	33	41.25	33.18	49.32
First Order	Total Habitat	141	36	45.00	36.83	53.17
First Order	Total Habitat	142	41	51.25	43.10	59.40
First Order	Total Habitat	143.5	42	52.50	44.15	60.85
First Order	Total Habitat	144.5	44	55.00	46.66	63.34
First Order	Total Habitat	145	45	56.25	47.95	64.55
First Order	Total Habitat	146	46	57.50	49.21	65.79
First Order	Total Habitat	146.5	47	58.75	50.49	67.01
First Order	Total Habitat	147	49	61.25	52.88	69.62
First Order	Total Habitat	147.5	51	63.75	55.23	72.27
First Order	Total Habitat	148	54	67.50	59.18	75.82
First Order	Total Habitat	150	56	70.00	61.94	78.06
First Order	Total Habitat	151	57	71.25	63.37	79.13
First Order	Total Habitat	155	60	75.00	67.81	82.19
First Order	Total Habitat	155.5	61	76.25	69.00	83.50
First Order	Total Habitat	156	63	78.75	71.97	85.53
First Order	Total Habitat	157	65	81.25	75.08	87.42
First Order	Total Habitat	158	66	82.50	76.47	88.53
First Order	Total Habitat	159	67	83.75	78.09	89.41

First Order	Total Habitat	163	68	85.00	79.12	90.88
First Order	Total Habitat	164.5	69	86.25	80.70	91.80
First Order	Total Habitat	165	70	87.50	82.41	92.59
First Order	Total Habitat	167.5	71	88.75	83.82	93.68
First Order	Total Habitat	172.5	72	90.00	84.85	95.15
First Order	Total Habitat	173	73	91.25	86.56	95.94
First Order	Total Habitat	177.5	74	92.50	87.88	97.12
First Order	Total Habitat	178	75	93.75	89.36	98.14
First Order	Total Habitat	180	76	95.00	90.95	99.05
First Order	Total Habitat	181.5	77	96.25	92.70	99.80
First Order	Total Habitat	182	78	97.50	94.60	100.00
First Order	Total Habitat	190.5	80	100.00	100.00	100.00
Second Order	Total Habitat	78	1	0.78	0.00	2.10
Second Order	Total Habitat	89	2	1.55	0.00	3.38
Second Order	Total Habitat	100	3	2.33	0.07	4.59
Second Order	Total Habitat	101.5	4	3.10	0.51	5.69
Second Order	Total Habitat	103.5	5	3.88	0.97	6.78
Second Order	Total Habitat	105	6	4.65	1.49	7.81
Second Order	Total Habitat	106	7	5.43	2.02	8.83
Second Order	Total Habitat	107	8	6.20	2.57	9.83
Second Order	Total Habitat	109	9	6.98	3.20	10.75
Second Order	Total Habitat	110	10	7.75	3.75	11.75
Second Order	Total Habitat	114.5	11	8.53	4.32	12.74
Second Order	Total Habitat	116	12	9.30	4.91	13.70
Second Order	Total Habitat	116.5	13	10.08	5.50	14.65
Second Order	Total Habitat	117	14	10.85	6.22	15.48
Second Order	Total Habitat	117.5	15	11.63	6.83	16.43
Second Order	Total Habitat	119	19	14.73	9.61	19.85
Second Order	Total Habitat	119.5	20	15.50	10.28	20.73
Second Order	Total Habitat	120	21	16.28	11.00	21.56
Second Order	Total Habitat	122.5	23	17.83	12.55	23.11
Second Order	Total Habitat	123.5	24	18.60	13.23	23.98
Second Order	Total Habitat	124.5	25	19.38	13.87	24.89
Second Order	Total Habitat	125	26	20.16	14.55	25.76
Second Order	Total Habitat	125.5	27	20.93	15.17	26.69
Second Order	Total Habitat	127	29	22.48	16.42	28.54
Second Order	Total Habitat	127.5	30	23.26	17.07	29.44
Second Order	Total Habitat	128	32	24.81	18.63	30.98
Second Order	Total Habitat	128.5	33	25.58	19.47	31.70
Second Order	Total Habitat	129.5	34	26.36	20.22	32.49
Second Order	Total Habitat	130	36	27.91	21.59	34.22
Second Order	Total Habitat	130.5	37	28.68	22.37	35.00
Second Order	Total Habitat	131	38	29.46	23.10	35.82
Second Order	Total Habitat	131.5	39	30.23	23.76	36.70
Second Order	Total Habitat	132	40	31.01	24.42	37.60
Second Order	Total Habitat	132.5	41	31.78	25.08	38.49
Second Order	Total Habitat	133	43	33.33	26.61	40.06
Second Order	Total Habitat	133.5	44	34.11	27.29	40.93
Second Order	Total Habitat	134	45	34.88	28.10	41.66
Second Order	Total Habitat	134.5	46	35.66	28.97	42.35
Second Order	Total Habitat	135	47	36.43	29.76	43.11
Second Order	Total Habitat	135.5	48	37.21	30.48	43.94
Second Order	Total Habitat	136.5	49	37.98	31.17	44.80

Second Order	Total Habitat	137	50	38.76	31.83	45.69
Second Order	Total Habitat	138	52	40.31	33.28	47.34
Second Order	Total Habitat	138.5	54	41.86	34.92	48.80
Second Order	Total Habitat	139	57	44.19	37.18	51.19
Second Order	Total Habitat	139.5	58	44.96	37.96	51.97
Second Order	Total Habitat	140	59	45.74	38.68	52.80
Second Order	Total Habitat	140.5	60	46.51	39.36	53.66
Second Order	Total Habitat	142	61	47.29	40.13	54.44
Second Order	Total Habitat	143	62	48.06	40.92	55.20
Second Order	Total Habitat	144	63	48.84	41.66	56.01
Second Order	Total Habitat	144.5	65	50.39	43.31	57.47
Second Order	Total Habitat	145	71	55.04	48.07	62.00
Second Order	Total Habitat	146	72	55.81	48.85	62.77
Second Order	Total Habitat	147	73	56.59	49.75	63.43
Second Order	Total Habitat	147.5	75	58.14	51.31	64.97
Second Order	Total Habitat	149	78	60.47	53.95	66.98
Second Order	Total Habitat	150	80	62.02	55.44	68.60
Second Order	Total Habitat	150.5	81	62.79	56.13	69.45
Second Order	Total Habitat	152	84	65.12	58.55	71.69
Second Order	Total Habitat	152.5	85	65.89	59.44	72.34
Second Order	Total Habitat	153	86	66.67	60.25	73.08
Second Order	Total Habitat	154	89	68.99	62.63	75.36
Second Order	Total Habitat	154.5	91	70.54	64.35	76.73
Second Order	Total Habitat	155	92	71.32	65.14	77.50
Second Order	Total Habitat	155.5	93	72.09	65.78	78.41
Second Order	Total Habitat	156	94	72.87	66.63	79.11
Second Order	Total Habitat	156.5	95	73.64	67.54	79.75
Second Order	Total Habitat	157	96	74.42	68.43	80.41
Second Order	Total Habitat	157.5	98	75.97	70.14	81.80
Second Order	Total Habitat	158.5	99	76.74	70.94	82.55
Second Order	Total Habitat	159	102	79.07	73.35	84.79
Second Order	Total Habitat	160	103	79.84	74.28	85.41
Second Order	Total Habitat	161	104	80.62	75.13	86.11
Second Order	Total Habitat	162.5	105	81.40	76.01	86.78
Second Order	Total Habitat	163	106	82.17	76.96	87.38
Second Order	Total Habitat	165	108	83.72	78.83	88.61
Second Order	Total Habitat	166	109	84.50	79.58	89.42
Second Order	Total Habitat	167.5	111	86.05	81.17	90.92
Second Order	Total Habitat	170	112	86.82	82.03	91.61
Second Order	Total Habitat	170.5	114	88.37	83.80	92.95
Second Order	Total Habitat	171	116	89.92	85.73	94.11
Second Order	Total Habitat	174	117	90.70	86.71	94.69
Second Order	Total Habitat	174.5	118	91.47	87.68	95.27
Second Order	Total Habitat	175.5	119	92.25	88.61	95.89
Second Order	Total Habitat	176	120	93.02	89.48	96.57
Second Order	Total Habitat	180	121	93.80	90.51	97.08
Second Order	Total Habitat	182	122	94.57	91.58	97.57
Second Order	Total Habitat	182.5	123	95.35	92.67	98.03
Second Order	Total Habitat	184	124	96.12	93.50	98.74
Second Order	Total Habitat	185.5	126	97.67	95.50	99.85
Second Order	Total Habitat	189	128	99.22	97.88	100.00
Second Order	Total Habitat	198	129	100.00	100.00	100.00
Third Order	Total Habitat	94	1	0.93	0.00	2.58

Third Order	Total Habitat	95	2	1.85	0.00	4.00
Third Order	Total Habitat	96.5	3	2.78	0.11	5.44
Third Order	Total Habitat	105	4	3.70	0.58	6.82
Third Order	Total Habitat	106	5	4.63	1.13	8.13
Third Order	Total Habitat	106.5	6	5.56	1.86	9.26
Third Order	Total Habitat	107	7	6.48	2.46	10.50
Third Order	Total Habitat	109	8	7.41	3.18	11.63
Third Order	Total Habitat	110	12	11.11	6.00	16.22
Third Order	Total Habitat	113	13	12.04	6.71	17.37
Third Order	Total Habitat	115.5	14	12.96	7.51	18.42
Third Order	Total Habitat	118.5	16	14.81	9.05	20.58
Third Order	Total Habitat	121	18	16.67	10.61	22.72
Third Order	Total Habitat	121.5	20	18.52	12.18	24.86
Third Order	Total Habitat	122	21	19.44	12.94	25.94
Third Order	Total Habitat	123	22	20.37	13.76	26.98
Third Order	Total Habitat	123.5	23	21.30	14.63	27.97
Third Order	Total Habitat	126.5	25	23.15	16.21	30.09
Third Order	Total Habitat	127.5	26	24.07	17.04	31.10
Third Order	Total Habitat	128	27	25.00	17.81	32.19
Third Order	Total Habitat	129	29	26.85	19.63	34.08
Third Order	Total Habitat	130	30	27.78	20.40	35.16
Third Order	Total Habitat	130.5	31	28.70	21.33	36.08
Third Order	Total Habitat	131.5	32	29.63	22.18	37.08
Third Order	Total Habitat	132	34	31.48	23.95	39.01
Third Order	Total Habitat	134	36	33.33	25.65	41.02
Third Order	Total Habitat	135	37	34.26	26.51	42.00
Third Order	Total Habitat	135.5	38	35.19	27.28	43.09
Third Order	Total Habitat	136	39	36.11	28.17	44.05
Third Order	Total Habitat	136.5	41	37.96	30.09	45.83
Third Order	Total Habitat	137	44	40.74	32.79	48.69
Third Order	Total Habitat	138	46	42.59	34.70	50.48
Third Order	Total Habitat	139.5	47	43.52	35.69	51.34
Third Order	Total Habitat	141	48	44.44	36.69	52.20
Third Order	Total Habitat	142	50	46.30	38.55	54.05
Third Order	Total Habitat	143	51	47.22	39.41	55.04
Third Order	Total Habitat	144	52	48.15	40.42	55.88
Third Order	Total Habitat	144.5	53	49.07	41.28	56.87
Third Order	Total Habitat	145	54	50.00	42.31	57.69
Third Order	Total Habitat	146.5	56	51.85	44.18	59.52
Third Order	Total Habitat	147	58	53.70	46.23	61.18
Third Order	Total Habitat	147.5	59	54.63	47.26	62.00
Third Order	Total Habitat	148	61	56.48	49.34	63.62
Third Order	Total Habitat	149	62	57.41	50.34	64.48
Third Order	Total Habitat	149.5	65	60.19	53.14	67.23
Third Order	Total Habitat	150	67	62.04	55.14	68.93
Third Order	Total Habitat	150.5	69	63.89	57.11	70.66
Third Order	Total Habitat	151	70	64.81	57.96	71.67
Third Order	Total Habitat	152	71	65.74	58.74	72.74
Third Order	Total Habitat	153	74	68.52	61.49	75.54
Third Order	Total Habitat	154	75	69.44	62.48	76.41
Third Order	Total Habitat	154.5	76	70.37	63.56	77.18
Third Order	Total Habitat	156	78	72.22	65.63	78.81
Third Order	Total Habitat	156.5	79	73.15	66.72	79.57

Third Order	Total Habitat	158	82	75.93	69.82	82.03
Third Order	Total Habitat	158.5	83	76.85	70.79	82.92
Third Order	Total Habitat	159	84	77.78	71.80	83.76
Third Order	Total Habitat	160	85	78.70	72.75	84.65
Third Order	Total Habitat	161	86	79.63	73.67	85.59
Third Order	Total Habitat	162	88	81.48	75.45	87.52
Third Order	Total Habitat	163	90	83.33	77.72	88.95
Third Order	Total Habitat	163.5	91	84.26	78.82	89.70
Third Order	Total Habitat	164	93	86.11	80.91	91.31
Third Order	Total Habitat	165	97	89.81	85.06	94.57
Third Order	Total Habitat	167	98	90.74	86.24	95.24
Third Order	Total Habitat	168.5	99	91.67	87.44	95.89
Third Order	Total Habitat	169.5	100	92.59	88.59	96.60
Third Order	Total Habitat	170	102	94.44	90.97	97.91
Third Order	Total Habitat	170.5	104	96.30	93.61	98.98
Third Order	Total Habitat	171.5	105	97.22	94.56	99.89
Third Order	Total Habitat	182	106	98.15	96.07	100.00
Third Order	Total Habitat	186.5	107	99.07	97.55	100.00
Third Order	Total Habitat	187	108	100.00	100.00	100.00
Fourth Order	Total Habitat	80	1	1.09	0.00	2.85
Fourth Order	Total Habitat	83	2	2.17	0.00	4.73
Fourth Order	Total Habitat	94.5	3	3.26	0.11	6.42
Fourth Order	Total Habitat	95	4	4.35	1.00	7.70
Fourth Order	Total Habitat	110	6	6.52	2.41	10.63
Fourth Order	Total Habitat	114	7	7.61	3.13	12.08
Fourth Order	Total Habitat	116	8	8.70	3.88	13.51
Fourth Order	Total Habitat	118	9	9.78	4.73	14.84
Fourth Order	Total Habitat	120.5	11	11.96	6.43	17.48
Fourth Order	Total Habitat	121	13	14.13	8.40	19.87
Fourth Order	Total Habitat	124.5	14	15.22	9.22	21.21
Fourth Order	Total Habitat	125	17	18.48	12.16	24.80
Fourth Order	Total Habitat	126	18	19.57	13.19	25.94
Fourth Order	Total Habitat	127	19	20.65	14.12	27.18
Fourth Order	Total Habitat	131.5	20	21.74	15.24	28.24
Fourth Order	Total Habitat	132	21	22.83	16.12	29.53
Fourth Order	Total Habitat	133	22	23.91	17.19	30.63
Fourth Order	Total Habitat	134	23	25.00	18.07	31.93
Fourth Order	Total Habitat	135	25	27.17	20.01	34.34
Fourth Order	Total Habitat	135.5	26	28.26	20.91	35.61
Fourth Order	Total Habitat	137	27	29.35	22.15	36.55
Fourth Order	Total Habitat	138	28	30.43	23.06	37.80
Fourth Order	Total Habitat	139	30	32.61	25.17	40.05
Fourth Order	Total Habitat	140	31	33.70	26.08	41.31
Fourth Order	Total Habitat	141	32	34.78	27.13	42.43
Fourth Order	Total Habitat	142	34	36.96	29.11	44.81
Fourth Order	Total Habitat	143.5	36	39.13	31.35	46.91
Fourth Order	Total Habitat	144	37	40.22	32.48	47.96
Fourth Order	Total Habitat	144.5	39	42.39	34.44	50.34
Fourth Order	Total Habitat	145	40	43.48	35.55	51.41
Fourth Order	Total Habitat	145.5	41	44.57	36.79	52.35
Fourth Order	Total Habitat	146	43	46.74	39.09	54.38
Fourth Order	Total Habitat	148	45	48.91	41.27	56.55
Fourth Order	Total Habitat	149	47	51.09	43.42	58.75

Fourth Order	Total Habitat	149.5	48	52.17	44.64	59.71
Fourth Order	Total Habitat	150	49	53.26	45.56	60.96
Fourth Order	Total Habitat	150.5	50	54.35	46.63	62.06
Fourth Order	Total Habitat	151	51	55.43	47.60	63.27
Fourth Order	Total Habitat	151.5	52	56.52	48.66	64.38
Fourth Order	Total Habitat	152	55	59.78	51.99	67.57
Fourth Order	Total Habitat	153	57	61.96	54.41	69.50
Fourth Order	Total Habitat	154	58	63.04	55.69	70.40
Fourth Order	Total Habitat	154.5	59	64.13	56.84	71.42
Fourth Order	Total Habitat	155	62	67.39	60.33	74.45
Fourth Order	Total Habitat	155.5	64	69.57	62.77	76.36
Fourth Order	Total Habitat	156.5	65	70.65	63.70	77.60
Fourth Order	Total Habitat	160	67	72.83	65.80	79.85
Fourth Order	Total Habitat	160.5	69	75.00	67.89	82.11
Fourth Order	Total Habitat	161	70	76.09	69.09	83.08
Fourth Order	Total Habitat	161.5	71	77.17	70.39	83.96
Fourth Order	Total Habitat	162.5	72	78.26	71.72	84.81
Fourth Order	Total Habitat	164	74	80.43	73.91	86.96
Fourth Order	Total Habitat	165	75	81.52	75.20	87.85
Fourth Order	Total Habitat	165.5	76	82.61	76.50	88.72
Fourth Order	Total Habitat	166	78	84.78	79.00	90.56
Fourth Order	Total Habitat	166.5	79	85.87	80.31	91.43
Fourth Order	Total Habitat	167.5	80	86.96	81.43	92.49
Fourth Order	Total Habitat	168.5	81	88.04	82.88	93.21
Fourth Order	Total Habitat	170	84	91.30	86.43	96.18
Fourth Order	Total Habitat	172	85	92.39	87.92	96.86
Fourth Order	Total Habitat	175.5	86	93.48	89.12	97.84
Fourth Order	Total Habitat	178	87	94.57	90.57	98.56
Fourth Order	Total Habitat	180	88	95.65	92.07	99.24
Fourth Order	Total Habitat	180.5	89	96.74	93.64	99.83
Fourth Order	Total Habitat	185	90	97.83	95.31	100.00
Fourth Order	Total Habitat	185.5	91	98.91	97.12	100.00
Fourth Order	Total Habitat	188.5	92	100.00	100.00	100.00
Fifth Order	Total Habitat	70	1	1.82	0.00	4.77
Fifth Order	Total Habitat	80	2	3.64	0.26	7.01
Fifth Order	Total Habitat	82	3	5.45	1.06	9.85
Fifth Order	Total Habitat	85	4	7.27	3.15	11.40
Fifth Order	Total Habitat	90	5	9.09	3.97	14.21
Fifth Order	Total Habitat	94	6	10.91	5.69	16.12
Fifth Order	Total Habitat	98	7	12.73	6.91	18.55
Fifth Order	Total Habitat	104	8	14.55	7.90	21.19
Fifth Order	Total Habitat	117	9	16.36	9.03	23.70
Fifth Order	Total Habitat	120	10	18.18	10.20	26.17
Fifth Order	Total Habitat	121	11	20.00	11.57	28.43
Fifth Order	Total Habitat	121.5	12	21.82	13.96	29.68
Fifth Order	Total Habitat	126	13	23.64	15.35	31.92
Fifth Order	Total Habitat	129	14	25.45	16.59	34.32
Fifth Order	Total Habitat	130	16	29.09	19.49	38.70
Fifth Order	Total Habitat	131	17	30.91	21.28	40.54
Fifth Order	Total Habitat	134	18	32.73	22.66	42.79
Fifth Order	Total Habitat	134.5	19	34.55	24.46	44.63
Fifth Order	Total Habitat	135.5	20	36.36	26.07	46.66
Fifth Order	Total Habitat	136	21	38.18	27.98	48.38

Fifth Order	Total Habitat	137.5	22	40.00	29.63	50.37
Fifth Order	Total Habitat	141.5	23	41.82	31.62	52.02
Fifth Order	Total Habitat	142	24	43.64	33.03	54.24
Fifth Order	Total Habitat	143	25	45.45	35.25	55.66
Fifth Order	Total Habitat	143.5	26	47.27	36.87	57.68
Fifth Order	Total Habitat	145.5	27	49.09	38.67	59.51
Fifth Order	Total Habitat	146	29	52.73	42.18	63.28
Fifth Order	Total Habitat	147.5	30	54.55	43.74	65.35
Fifth Order	Total Habitat	148	31	56.36	45.91	66.82
Fifth Order	Total Habitat	151	32	58.18	47.77	68.60
Fifth Order	Total Habitat	153.5	33	60.00	49.56	70.44
Fifth Order	Total Habitat	155	34	61.82	51.34	72.30
Fifth Order	Total Habitat	158	35	63.64	53.36	73.91
Fifth Order	Total Habitat	159	37	67.27	57.40	77.15
Fifth Order	Total Habitat	159.5	38	69.09	59.61	78.57
Fifth Order	Total Habitat	160	39	70.91	61.34	80.48
Fifth Order	Total Habitat	160.5	41	74.55	65.18	83.91
Fifth Order	Total Habitat	162	42	76.36	67.46	85.26
Fifth Order	Total Habitat	164	43	78.18	69.51	86.85
Fifth Order	Total Habitat	166	44	80.00	71.83	88.17
Fifth Order	Total Habitat	167	46	83.64	75.87	91.40
Fifth Order	Total Habitat	168	47	85.45	78.27	92.64
Fifth Order	Total Habitat	169	49	89.09	82.68	95.50
Fifth Order	Total Habitat	170	50	90.91	84.64	97.18
Fifth Order	Total Habitat	172.5	51	92.73	87.15	98.30
Fifth Order	Total Habitat	182.5	52	94.55	89.84	99.25
Fifth Order	Total Habitat	183.5	53	96.36	92.62	100.00
Fifth Order	Total Habitat	186.5	54	98.18	95.06	100.00
Fifth Order	Total Habitat	190.5	55	100.00	100.00	100.00



## Appendix L. Relative Bed Stability Statistical Analyses

### *Stressor Linkage to Aquatic Health*

Decreases in Log Relative Bed Stability (LRBS) scores have been linked to decreases in aquatic health of Virginia streams (VDEQ, 2012) as measured by the VSCI. LRBS scores less than -1.5 increase the likelihood of having a low VSCI score. When LRBS scores fall below -1.0 the stream bed is considered unstable and the protective function of habitat is reduced.

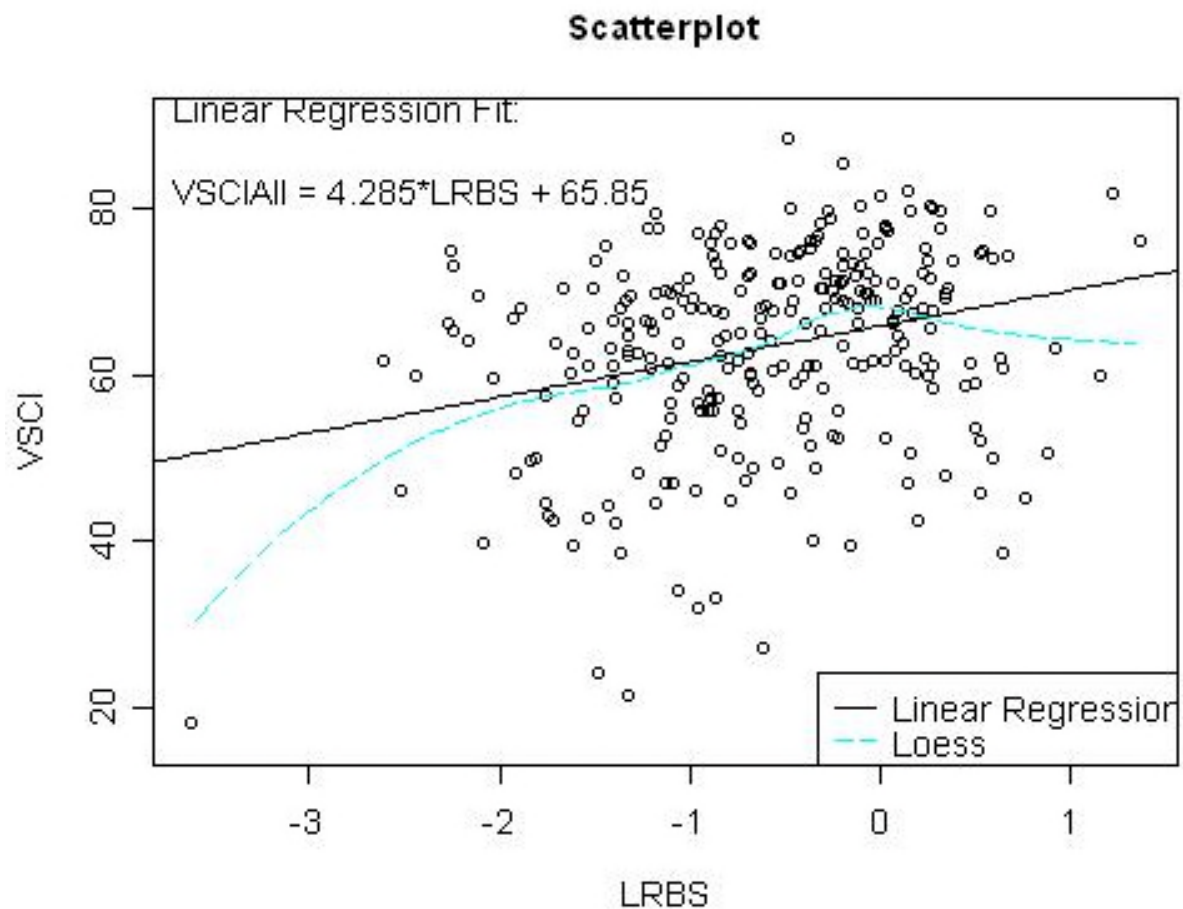


Figure 99. Stressor Gradient Scatterplot Comparing Decreasing LRBS values to Declining VSCI Scores.

### *Relative Bed Stability Relative Risk Results*

An optimal LRBS value is considered to be between -0.5 and 0.5; this LRBS score range was selected based on least disturbed conditions in Virginia watersheds. Other regional surveys confirm this is a stable streambed value for the mid-atlantic ecoregions (Kaufmann, 1999 and 2008). VDEQ estimates 33% of Virginia streams have a LRBS value between -0.5 to 0.5 (Table

58). LRBS under -1.0 was considered suboptimal based on declining VSCI scores observed in categorical boxplots (Figure 58) and scatter plot graphs. An estimated 39% of Virginia streams have a LRBS value below -1.0 (Figure 100). VDEQ relative risk calculations found that a VSCI score is 2.8 times more likely to be below 50 when the LRBS is below -1.0 than when the LRBS is in the optimal stability category (Figure 100).

Table 58. Relative Bed Stability (LRBS) Relative Risk Categories.

Stressor Parameter	Optimal	Suboptimal
LRBS	Between -0.5 to 0.5	<-1.0

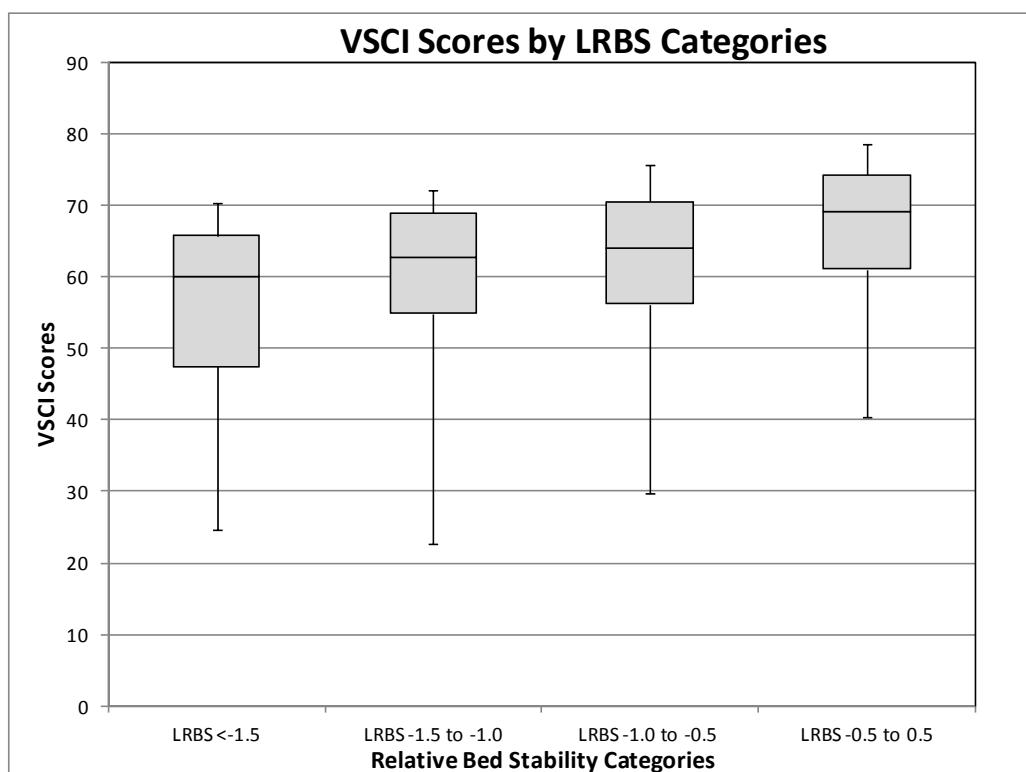


Figure 100. VSCI Scores by LRBS Categories.

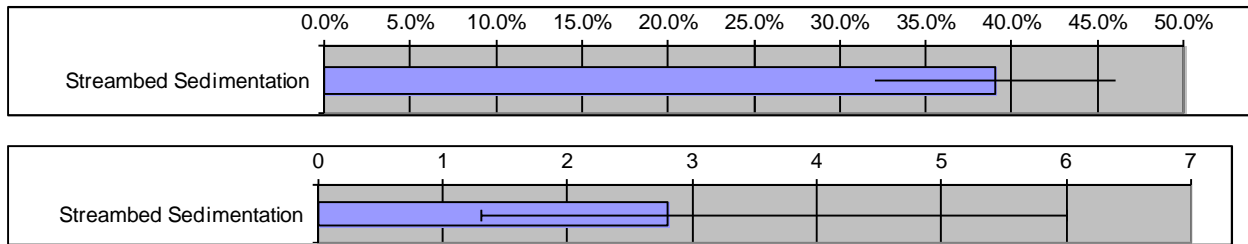


Figure 101. LRBS Relative Extent and Risk Results.

### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 33 sites with LRBS values under -1.5. Sixteen out of 33 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the LRBS is less than -1.5 is 80% (Figure 103). The probability of impairment is 90% when LRBS values fall below -2.0 (Figure 103). Relative risk increases when sites have a LRBS below -1.0 versus sites with a LRBS between -0.5 and 0.5. Stable streams have higher VSCI scores and appear more resilient to other the impact of other stressors (Figure 101). The probability of having a suboptimal VSCI score when the streambed is stable (optimal LRBS) is the lowest with LRBS than any other stressor parameter.

Sites with LRBS above 0.5 may be unnaturally stable (scoured down to hardpan/bedrock or lined with concrete/rip rap). Only 17 sites in the ProbMon database have an LRBS above 0.5. In the mountain ecoregions this could be a natural phenomenon due increased stream power in high gradient streams. However, in the piedmont highly stable streams do not appear natural and biology appears to degrade at these sites (Figure 102). Only 6 sites above 0.5 occur in the piedmont, but in this limited dataset highly stable streams should be viewed as a medium probability for stress in lower gradient bioregions.

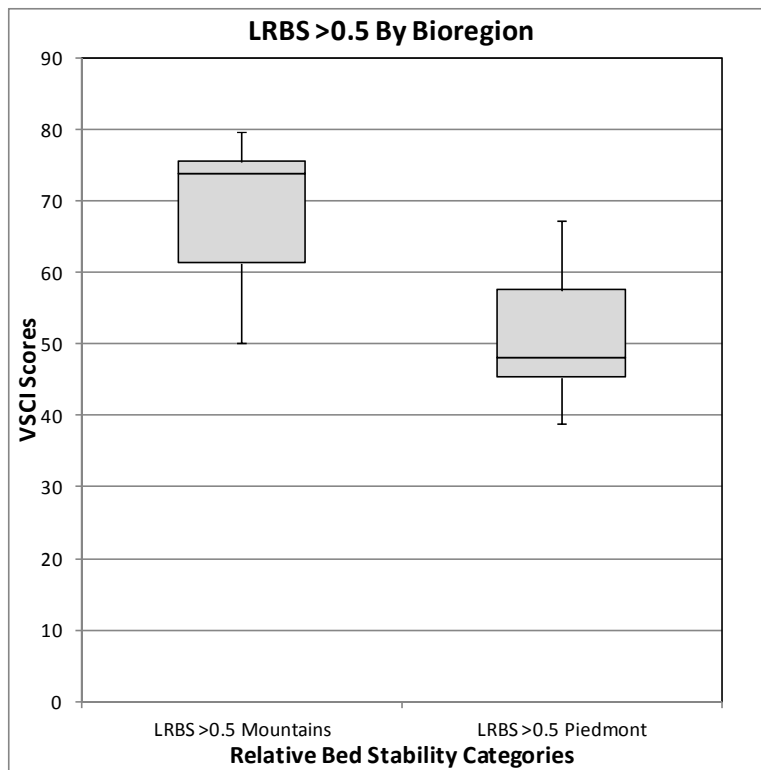


Figure 102. VSCI Scores by Bioregion when LRBS vales are above 0.5.

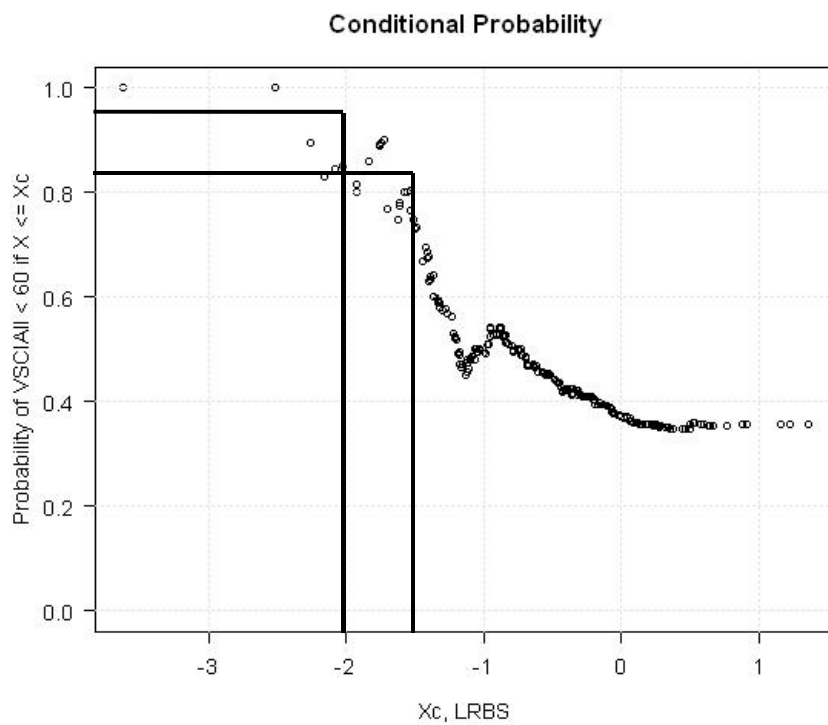


Figure 103. Probability of VSCI less than 60 if LRBS Scores Less than -2.0 and -1.5.

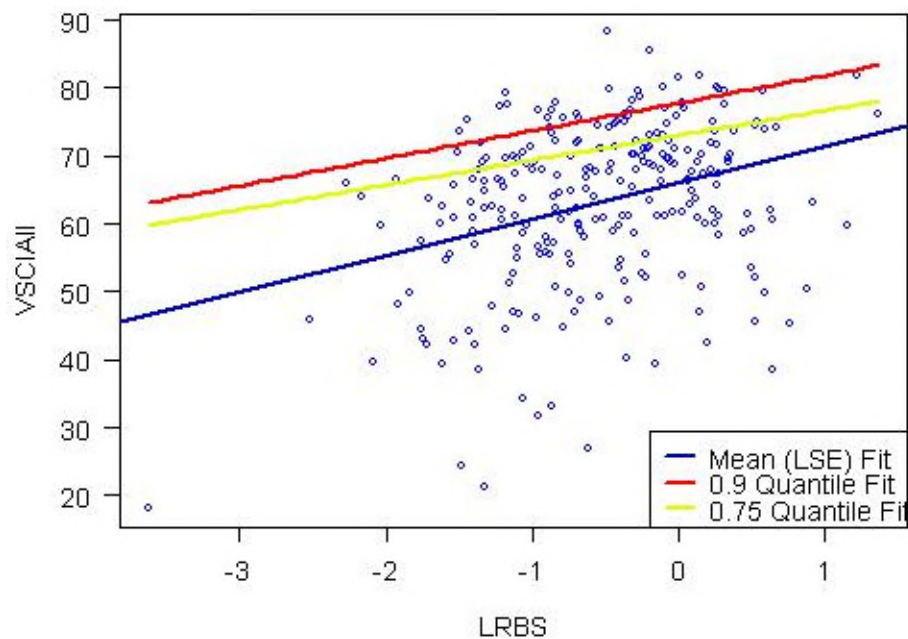


Figure 104. Quantile Regression VSCI versus LRBS Scores.

Quantile regression is shown in Figure 104. The 0.9 quantile (red line) fit regression analysis shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to LRBS scores. The 50<sup>th</sup> percentile of percentile of reference crosses at -1.4, 25<sup>th</sup> percentile intersects at -2.8, and the 10<sup>th</sup> percentile is equal to -4.4. The 50<sup>th</sup> percentile of reference is associated with more protective water chemistry values, while values at the 10<sup>th</sup> percentile tend represent number where the aquatic community is already stressed. Quantile regression results (Figure 104) indicate sites with Total Habitat above -1.4 would be somewhat protected.

### *Relative Bed Stability and Probability of Stress to Aquatic Life*

LRBS scores less than -1.5 increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). When LRBS scores fall below -1.0 the stream bed is considered unstable and the protective function of habitat is reduced.

Table 59. Relative Bed Stability (LRBS) ranges and associated probability of stress to aquatic life (based on VSCI Scores).

Relative Bed Stability (RBS) Quantitative Habitat	
Probability of Stress to Aquatic Life	Relative Bed Stability (unitless)
High	LRBS < -1.5
Medium	-1.5 < LRBS < -1.0
Low	-1.0 < LRBS < -0.5
None	LRBS Between -0.5 and 0.5
Medium	LRBS > 0.5

### *Relative Bed Stability Cumulative Distribution Function curves*

Relative Bed Stability cumulative distribution function (CDF) curves are shown statewide, by major basin, major ecoregion (level III), and by stream order in Figures 105-108. Tables 60-63 correspond to the aforementioned CDF curves.

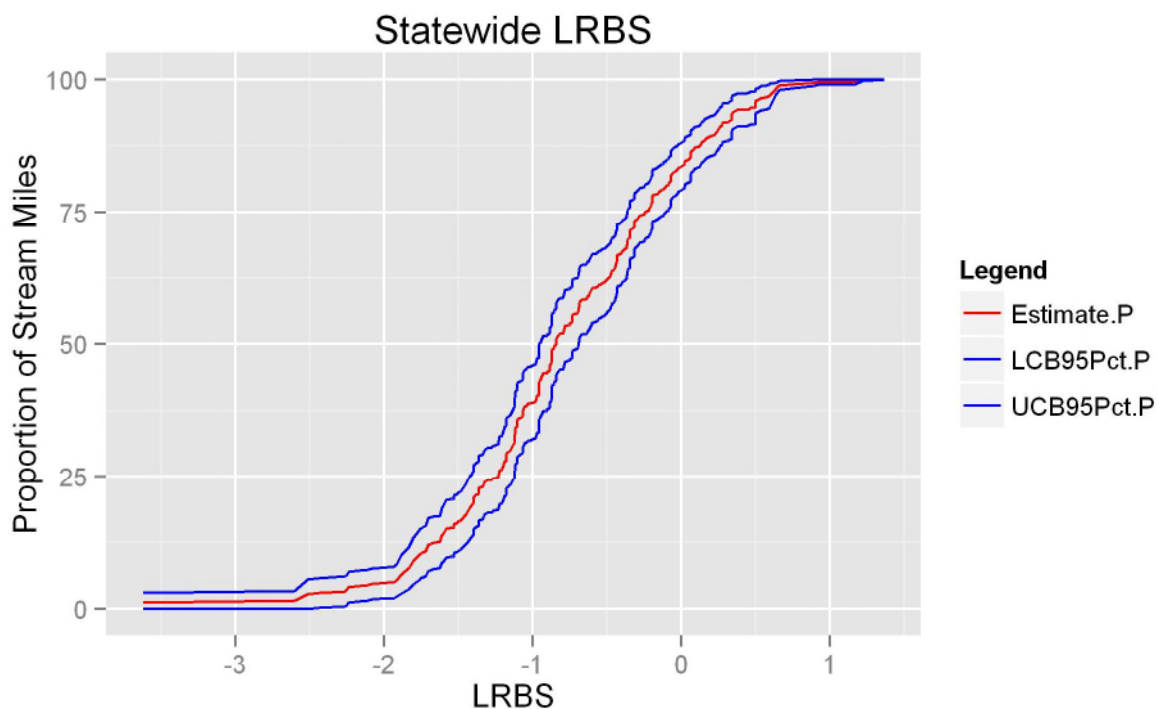


Figure 105. Relative Bed Stability Statewide CDF graph.

Fifty-two percent of Virginia streams have LRBS values less than –0.8 which is considered low probability of stress to aquatic life (Tables 59 and 60).

Table 60. Statewide Relative Bed Stability Estimates.

Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
LRBS	-3.623	1	1.21	0.00	2.98
LRBS	-2.605	2	1.50	0.00	3.34
LRBS	-2.515	3	2.71	0.00	5.46
LRBS	-2.435	4	2.99	0.21	5.78
LRBS	-2.265	5	3.28	0.46	6.10
LRBS	-2.252	6	3.56	0.70	6.43
LRBS	-2.247	7	3.77	0.92	6.63
LRBS	-2.239	8	4.06	1.18	6.94
LRBS	-2.159	9	4.27	1.37	7.17
LRBS	-2.113	10	4.38	1.47	7.29
LRBS	-2.083	11	4.67	1.73	7.61
LRBS	-2.031	12	4.79	1.84	7.74
LRBS	-1.931	13	5.00	2.02	7.97
LRBS	-1.921	14	5.28	2.26	8.30
LRBS	-1.885	15	6.49	2.91	10.07
LRBS	-1.832	16	7.70	3.66	11.74
LRBS	-1.808	17	8.91	4.56	13.26
LRBS	-1.764	18	10.12	5.44	14.80
LRBS	-1.754	19	10.41	5.70	15.11
LRBS	-1.743	20	10.61	5.91	15.32
LRBS	-1.72	21	10.90	6.17	15.63
LRBS	-1.704	22	12.11	7.15	17.07
LRBS	-1.668	23	12.40	7.44	17.35
LRBS	-1.626	24	12.60	7.69	17.52
LRBS	-1.614	25	13.81	8.64	18.99
LRBS	-1.609	26	13.88	8.71	19.06
LRBS	-1.583	27	15.09	9.63	20.55
LRBS	-1.561	28	15.21	9.78	20.64
LRBS	-1.533	29	15.33	9.89	20.77
LRBS	-1.53	31	15.90	10.44	21.36
LRBS	-1.512	32	16.19	10.71	21.66
LRBS	-1.497	33	16.47	10.98	21.97
LRBS	-1.486	34	16.68	11.17	22.19
LRBS	-1.449	35	17.89	12.13	23.65
LRBS	-1.424	36	19.10	13.13	25.07
LRBS	-1.417	37	19.31	13.34	25.28
LRBS	-1.41	38	19.59	13.61	25.58
LRBS	-1.404	39	19.80	13.80	25.80
LRBS	-1.398	40	21.01	14.90	27.12
LRBS	-1.391	41	21.22	15.14	27.30
LRBS	-1.385	42	21.43	15.35	27.51
LRBS	-1.368	43	21.63	15.55	27.72
LRBS	-1.364	44	22.84	16.68	29.01
LRBS	-1.346	45	22.96	16.79	29.14
LRBS	-1.339	46	23.08	16.90	29.26

LRBS	-1.331	48	23.41	17.25	29.57
LRBS	-1.33	49	23.61	17.47	29.76
LRBS	-1.327	50	23.73	17.59	29.88
LRBS	-1.319	51	24.02	17.85	30.19
LRBS	-1.306	52	24.23	18.04	30.41
LRBS	-1.275	53	24.34	18.16	30.53
LRBS	-1.267	54	24.63	18.43	30.83
LRBS	-1.235	55	24.92	18.71	31.13
LRBS	-1.225	56	26.13	19.69	32.56
LRBS	-1.207	57	26.33	19.89	32.78
LRBS	-1.206	58	26.54	20.10	32.99
LRBS	-1.205	59	26.66	20.21	33.11
LRBS	-1.192	60	27.87	21.29	34.45
LRBS	-1.181	61	27.94	21.36	34.52
LRBS	-1.178	62	28.22	21.63	34.82
LRBS	-1.177	63	29.43	22.76	36.11
LRBS	-1.163	64	29.72	23.06	36.39
LRBS	-1.152	65	30.01	23.36	36.65
LRBS	-1.132	66	31.22	24.45	37.98
LRBS	-1.124	67	31.50	24.72	38.28
LRBS	-1.122	68	32.71	25.88	39.55
LRBS	-1.121	69	33.00	26.15	39.85
LRBS	-1.117	70	34.21	27.31	41.10
LRBS	-1.106	71	34.49	27.61	41.38
LRBS	-1.103	72	35.70	28.77	42.64
LRBS	-1.101	73	35.82	28.89	42.75
LRBS	-1.083	74	36.11	29.19	43.02
LRBS	-1.069	75	36.39	29.48	43.31
LRBS	-1.068	76	37.60	30.66	44.54
LRBS	-1.06	77	37.89	30.94	44.84
LRBS	-1.059	78	38.18	31.24	45.11
LRBS	-1.041	79	38.46	31.53	45.40
LRBS	-1.035	80	38.75	31.82	45.68
LRBS	-1.014	81	38.87	31.93	45.80
LRBS	-0.997	82	39.07	32.13	46.01
LRBS	-0.984	83	39.19	32.26	46.12
LRBS	-0.972	84	40.40	33.39	47.41
LRBS	-0.96	85	40.52	33.51	47.53
LRBS	-0.958	86	41.73	34.67	48.79
LRBS	-0.956	87	42.94	35.89	49.99
LRBS	-0.95	88	43.22	36.21	50.24
LRBS	-0.933	89	44.43	37.38	51.48
LRBS	-0.908	90	44.50	37.45	51.55
LRBS	-0.906	91	44.71	37.69	51.74
LRBS	-0.887	92	44.92	37.90	51.93
LRBS	-0.886	93	46.13	39.11	53.15
LRBS	-0.875	94	46.25	39.23	53.26
LRBS	-0.874	95	46.53	39.52	53.55
LRBS	-0.871	96	47.74	40.84	54.65
LRBS	-0.87	97	48.95	42.15	55.76
LRBS	-0.868	98	49.07	42.27	55.87
LRBS	-0.86	99	49.19	42.39	55.99
LRBS	-0.857	100	49.40	42.62	56.17



LRBS	-0.854	101	49.68	42.91	56.46
LRBS	-0.844	102	49.80	43.03	56.57
LRBS	-0.84	103	51.01	44.25	57.77
LRBS	-0.835	105	51.50	44.74	58.27
LRBS	-0.829	106	51.62	44.87	58.38
LRBS	-0.819	107	51.91	45.17	58.65
LRBS	-0.8	108	51.98	45.24	58.72
LRBS	-0.787	109	53.19	46.44	59.94
LRBS	-0.785	110	53.39	46.65	60.14
LRBS	-0.751	111	53.68	46.95	60.41
LRBS	-0.75	112	53.89	47.17	60.60
LRBS	-0.744	113	54.01	47.29	60.72
LRBS	-0.735	114	54.21	47.51	60.92
LRBS	-0.732	115	55.42	48.74	62.11
LRBS	-0.731	116	55.54	48.86	62.22
LRBS	-0.715	117	55.66	48.99	62.33
LRBS	-0.699	118	55.87	49.23	62.51
LRBS	-0.694	119	56.08	49.45	62.71
LRBS	-0.693	120	56.36	49.74	62.99
LRBS	-0.688	121	57.57	50.94	64.20
LRBS	-0.686	122	57.86	51.25	64.46
LRBS	-0.683	123	57.98	51.37	64.58
LRBS	-0.679	124	58.18	51.59	64.78
LRBS	-0.675	125	58.25	51.67	64.84
LRBS	-0.67	126	58.37	51.79	64.95
LRBS	-0.645	127	58.44	51.87	65.01
LRBS	-0.636	128	58.65	52.08	65.22
LRBS	-0.633	129	58.93	52.38	65.49
LRBS	-0.625	130	59.00	52.45	65.56
LRBS	-0.623	131	59.29	52.73	65.85
LRBS	-0.602	132	60.50	54.05	66.95
LRBS	-0.574	133	60.71	54.29	67.13
LRBS	-0.566	134	60.83	54.42	67.24
LRBS	-0.558	135	61.11	54.75	67.48
LRBS	-0.552	136	61.18	54.82	67.55
LRBS	-0.539	137	61.30	54.95	67.65
LRBS	-0.534	138	61.42	55.08	67.76
LRBS	-0.531	139	61.54	55.20	67.87
LRBS	-0.518	140	61.65	55.32	67.99
LRBS	-0.48	141	62.86	56.67	69.06
LRBS	-0.476	143	63.27	57.05	69.48
LRBS	-0.471	144	63.55	57.35	69.76
LRBS	-0.467	145	63.84	57.67	70.01
LRBS	-0.457	146	63.96	57.80	70.12
LRBS	-0.448	147	64.24	58.11	70.38
LRBS	-0.436	148	65.45	59.41	71.50
LRBS	-0.433	149	66.66	60.74	72.59
LRBS	-0.424	150	66.78	60.87	72.70
LRBS	-0.407	151	67.07	61.18	72.95
LRBS	-0.402	152	67.28	61.38	73.17
LRBS	-0.398	153	67.48	61.60	73.37
LRBS	-0.395	154	67.60	61.72	73.48
LRBS	-0.379	155	67.89	62.02	73.76

LRBS	-0.371	156	68.09	62.23	73.96
LRBS	-0.364	157	69.30	63.57	75.04
LRBS	-0.362	158	69.59	63.87	75.32
LRBS	-0.359	159	69.88	64.16	75.59
LRBS	-0.346	160	70.16	64.47	75.85
LRBS	-0.345	162	71.58	66.07	77.09
LRBS	-0.323	163	71.87	66.36	77.38
LRBS	-0.321	164	71.98	66.48	77.49
LRBS	-0.317	165	72.10	66.61	77.60
LRBS	-0.315	166	73.31	68.05	78.57
LRBS	-0.307	167	73.43	68.18	78.68
LRBS	-0.3	168	73.64	68.38	78.89
LRBS	-0.291	169	73.92	68.68	79.17
LRBS	-0.286	170	74.13	68.91	79.35
LRBS	-0.28	171	74.34	69.13	79.55
LRBS	-0.266	172	74.41	69.21	79.61
LRBS	-0.249	173	74.62	69.43	79.81
LRBS	-0.245	174	74.90	69.74	80.07
LRBS	-0.241	175	75.11	69.94	80.28
LRBS	-0.23	176	75.23	70.07	80.39
LRBS	-0.221	177	75.35	70.19	80.51
LRBS	-0.218	178	75.63	70.50	80.76
LRBS	-0.214	179	75.92	70.81	81.03
LRBS	-0.203	181	76.33	71.25	81.42
LRBS	-0.202	182	76.62	71.53	81.71
LRBS	-0.196	183	76.83	71.75	81.91
LRBS	-0.195	185	78.16	73.24	83.07
LRBS	-0.177	186	78.27	73.37	83.18
LRBS	-0.162	187	78.48	73.58	83.38
LRBS	-0.15	188	78.77	73.86	83.68
LRBS	-0.142	189	78.89	73.98	83.79
LRBS	-0.135	190	79.17	74.28	84.07
LRBS	-0.123	191	79.24	74.35	84.13
LRBS	-0.12	192	79.45	74.57	84.33
LRBS	-0.106	194	79.78	74.92	84.63
LRBS	-0.102	195	79.98	75.15	84.81
LRBS	-0.087	196	80.19	75.34	85.05
LRBS	-0.086	197	80.40	75.57	85.23
LRBS	-0.074	199	80.80	76.00	85.60
LRBS	-0.072	200	82.01	77.42	86.61
LRBS	-0.06	201	82.22	77.62	86.82
LRBS	-0.055	202	82.43	77.84	87.02
LRBS	-0.044	203	82.71	78.15	87.28
LRBS	-0.026	204	83.00	78.47	87.53
LRBS	-0.024	205	83.29	78.77	87.80
LRBS	-0.016	206	83.40	78.90	87.91
LRBS	0	207	83.69	79.20	88.19
LRBS	0.02	208	83.98	79.51	88.44
LRBS	0.021	209	84.18	79.74	88.63
LRBS	0.022	210	84.39	79.95	88.83
LRBS	0.023	211	84.68	80.28	89.08
LRBS	0.044	212	84.89	80.48	89.29
LRBS	0.06	213	85.17	80.80	89.54

LRBS	0.064	214	86.38	82.38	90.38
LRBS	0.071	215	86.59	82.62	90.56
LRBS	0.079	216	86.80	82.83	90.77
LRBS	0.085	217	86.92	82.96	90.88
LRBS	0.087	218	87.12	83.19	91.06
LRBS	0.118	219	87.41	83.51	91.31
LRBS	0.127	220	87.70	83.84	91.56
LRBS	0.131	221	87.98	84.15	91.81
LRBS	0.139	222	88.10	84.26	91.94
LRBS	0.14	223	88.22	84.38	92.05
LRBS	0.151	224	88.43	84.60	92.26
LRBS	0.153	225	88.54	84.72	92.36
LRBS	0.154	226	88.66	84.85	92.47
LRBS	0.17	227	88.95	85.17	92.73
LRBS	0.179	228	89.07	85.30	92.84
LRBS	0.199	229	89.35	85.59	93.11
LRBS	0.225	230	89.56	85.82	93.30
LRBS	0.227	231	89.68	85.95	93.41
LRBS	0.231	232	89.89	86.18	93.60
LRBS	0.236	233	90.09	86.39	93.80
LRBS	0.246	234	90.38	86.70	94.06
LRBS	0.25	235	90.67	87.02	94.31
LRBS	0.256	236	90.87	87.22	94.53
LRBS	0.258	237	90.99	87.34	94.64
LRBS	0.264	238	91.20	87.57	94.82
LRBS	0.27	239	91.32	87.70	94.94
LRBS	0.273	240	91.52	87.90	95.15
LRBS	0.274	241	91.73	88.11	95.36
LRBS	0.281	242	91.85	88.24	95.46
LRBS	0.316	243	92.06	88.46	95.65
LRBS	0.317	244	92.18	88.58	95.77
LRBS	0.339	245	92.46	88.84	96.08
LRBS	0.341	246	93.67	90.48	96.86
LRBS	0.346	247	93.74	90.56	96.93
LRBS	0.351	248	93.95	90.79	97.11
LRBS	0.376	249	94.24	91.11	97.36
LRBS	0.446	250	94.35	91.23	97.48
LRBS	0.466	251	94.64	91.56	97.72
LRBS	0.498	252	94.76	91.69	97.83
LRBS	0.5	253	95.97	93.65	98.28
LRBS	0.521	254	96.18	93.89	98.46
LRBS	0.525	255	96.29	94.00	98.58
LRBS	0.53	256	96.36	94.08	98.65
LRBS	0.536	257	96.48	94.21	98.75
LRBS	0.578	258	96.69	94.43	98.95
LRBS	0.594	259	96.90	94.65	99.14
LRBS	0.596	260	97.01	94.78	99.25
LRBS	0.632	261	98.22	97.11	99.34
LRBS	0.645	262	98.51	97.53	99.49
LRBS	0.646	263	98.63	97.67	99.59
LRBS	0.662	264	98.91	98.09	99.74
LRBS	0.762	265	99.12	98.38	99.86
LRBS	0.882	266	99.41	98.82	100.00

LRBS	0.917	267	99.53	98.97	100.00
LRBS	1.158	268	99.60	99.06	100.00
LRBS	1.22	269	99.88	99.68	100.00
LRBS	1.364	270	100.00	100.00	100.00

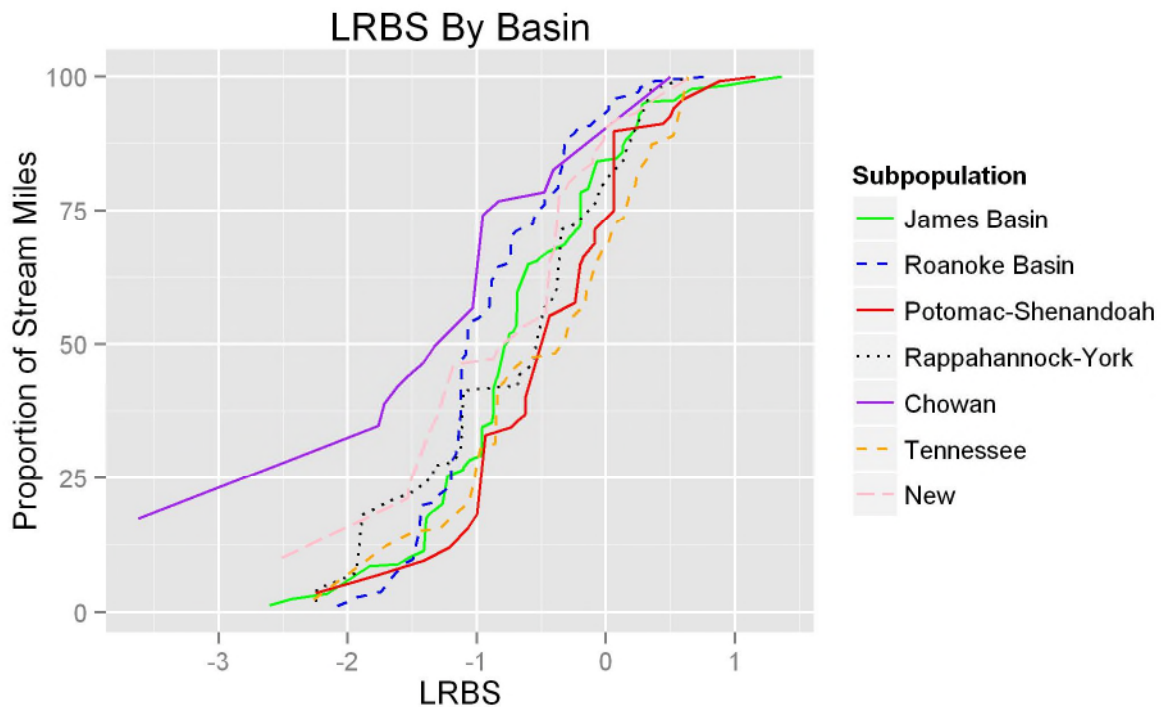


Figure 106. Relative Bed Stability by Major Basin CDF graph.

LRBS by basin is shown in Figure 106 and Table 61. Ten percent of James Basin streams have LRBS values less than -1.5. The Roanoke Basin 53<sup>rd</sup> and Potomac-Shenandoah Basin 15<sup>th</sup> percentile LRBS are -1.068. The Rappahannock-York 57<sup>th</sup> percentile LRBS is -0.48. The Tennessee Basin 50<sup>th</sup> percentile is -0.345 and the New 49<sup>th</sup> percentile LRBS is -0.819.

Table 61. Relative Bed Stability Estimates by Major Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	LRBS	-2.605	1	1.24	0.00	3.29
James Basin	LRBS	-2.435	2	2.47	0.14	4.80
James Basin	LRBS	-2.159	3	3.37	0.54	6.20
James Basin	LRBS	-1.832	4	8.59	0.00	17.24
James Basin	LRBS	-1.609	5	8.89	0.26	17.53
James Basin	LRBS	-1.53	6	10.13	1.43	18.83
James Basin	LRBS	-1.41	7	11.36	2.45	20.28
James Basin	LRBS	-1.398	8	16.59	6.87	26.30
James Basin	LRBS	-1.391	9	17.49	8.19	26.78

James Basin	LRBS	-1.368	10	18.38	8.97	27.80
James Basin	LRBS	-1.331	11	18.89	9.57	28.21
James Basin	LRBS	-1.267	12	20.13	10.60	29.65
James Basin	LRBS	-1.225	13	25.35	13.17	37.53
James Basin	LRBS	-1.106	14	26.59	14.45	38.72
James Basin	LRBS	-1.101	15	27.09	14.94	39.25
James Basin	LRBS	-1.059	16	28.33	16.11	40.55
James Basin	LRBS	-1.014	17	28.84	16.58	41.10
James Basin	LRBS	-0.96	18	29.35	17.08	41.62
James Basin	LRBS	-0.958	19	34.57	21.05	48.10
James Basin	LRBS	-0.887	20	35.47	21.99	48.95
James Basin	LRBS	-0.874	21	36.70	23.19	50.22
James Basin	LRBS	-0.87	22	41.93	28.88	54.97
James Basin	LRBS	-0.854	23	43.16	30.12	56.21
James Basin	LRBS	-0.844	24	43.67	30.67	56.67
James Basin	LRBS	-0.835	25	44.57	31.51	57.62
James Basin	LRBS	-0.787	26	49.79	36.28	63.31
James Basin	LRBS	-0.751	27	51.03	37.58	64.48
James Basin	LRBS	-0.75	28	51.93	38.58	65.27
James Basin	LRBS	-0.715	29	52.44	39.16	65.71
James Basin	LRBS	-0.694	30	53.33	40.14	66.53
James Basin	LRBS	-0.688	31	58.56	45.23	71.88
James Basin	LRBS	-0.686	32	59.79	46.67	72.91
James Basin	LRBS	-0.602	33	65.01	53.21	76.82
James Basin	LRBS	-0.534	34	65.52	53.81	77.24
James Basin	LRBS	-0.518	35	66.03	54.39	77.67
James Basin	LRBS	-0.448	36	67.27	55.88	78.66
James Basin	LRBS	-0.323	37	68.50	57.14	79.87
James Basin	LRBS	-0.291	38	69.74	58.42	81.06
James Basin	LRBS	-0.245	39	70.97	60.01	81.94
James Basin	LRBS	-0.203	40	71.87	61.07	82.68
James Basin	LRBS	-0.196	41	72.77	61.96	83.58
James Basin	LRBS	-0.195	43	78.50	69.25	87.75
James Basin	LRBS	-0.142	44	79.01	69.76	88.26
James Basin	LRBS	-0.072	45	84.23	77.39	91.08
James Basin	LRBS	0.085	46	84.74	78.04	91.44
James Basin	LRBS	0.127	47	85.98	79.84	92.12
James Basin	LRBS	0.131	48	87.21	81.46	92.97
James Basin	LRBS	0.151	49	88.11	82.50	93.72
James Basin	LRBS	0.199	50	89.35	84.07	94.63
James Basin	LRBS	0.231	51	90.24	85.33	95.16
James Basin	LRBS	0.246	52	91.48	87.10	95.87
James Basin	LRBS	0.256	53	92.38	88.02	96.73
James Basin	LRBS	0.258	54	92.89	88.75	97.03
James Basin	LRBS	0.27	55	93.40	89.40	97.39
James Basin	LRBS	0.274	56	94.29	90.36	98.23
James Basin	LRBS	0.281	57	94.80	91.08	98.52
James Basin	LRBS	0.317	58	95.31	91.62	99.01
James Basin	LRBS	0.53	59	95.61	92.00	99.23
James Basin	LRBS	0.578	60	96.51	93.09	99.94
James Basin	LRBS	0.662	61	97.75	95.16	100.00
James Basin	LRBS	0.917	62	98.26	95.87	100.00
James Basin	LRBS	1.22	63	99.49	98.57	100.00

James Basin	LRBS	1.364	64	100.00	100.00	100.00
Roanoke Basin	LRBS	-2.083	1	1.18	0.00	3.29
Roanoke Basin	LRBS	-2.031	2	1.67	0.00	3.94
Roanoke Basin	LRBS	-1.921	3	2.86	0.00	5.95
Roanoke Basin	LRBS	-1.743	4	3.72	0.44	7.00
Roanoke Basin	LRBS	-1.583	5	8.72	0.85	16.60
Roanoke Basin	LRBS	-1.497	6	9.91	1.77	18.04
Roanoke Basin	LRBS	-1.449	7	14.91	3.89	25.93
Roanoke Basin	LRBS	-1.424	8	19.92	7.23	32.61
Roanoke Basin	LRBS	-1.346	9	20.41	7.66	33.15
Roanoke Basin	LRBS	-1.327	10	20.89	8.15	33.64
Roanoke Basin	LRBS	-1.306	11	21.75	8.95	34.56
Roanoke Basin	LRBS	-1.235	12	22.94	10.06	35.82
Roanoke Basin	LRBS	-1.205	13	23.43	10.52	36.34
Roanoke Basin	LRBS	-1.192	14	28.43	14.44	42.43
Roanoke Basin	LRBS	-1.163	15	29.62	15.71	43.53
Roanoke Basin	LRBS	-1.152	16	30.80	17.05	44.55
Roanoke Basin	LRBS	-1.132	17	35.81	21.26	50.36
Roanoke Basin	LRBS	-1.124	18	36.99	22.37	51.62
Roanoke Basin	LRBS	-1.122	19	42.00	27.16	56.84
Roanoke Basin	LRBS	-1.117	20	47.00	32.37	61.64
Roanoke Basin	LRBS	-1.083	21	48.19	33.71	62.67
Roanoke Basin	LRBS	-1.068	22	53.19	39.24	67.14
Roanoke Basin	LRBS	-1.041	23	54.38	40.45	68.31
Roanoke Basin	LRBS	-0.984	24	54.87	41.02	68.72
Roanoke Basin	LRBS	-0.95	25	56.05	42.49	69.61
Roanoke Basin	LRBS	-0.906	26	56.91	43.56	70.26
Roanoke Basin	LRBS	-0.886	27	61.92	49.28	74.55
Roanoke Basin	LRBS	-0.868	28	62.40	49.80	75.01
Roanoke Basin	LRBS	-0.857	29	63.26	50.90	75.63
Roanoke Basin	LRBS	-0.835	30	64.45	52.33	76.57
Roanoke Basin	LRBS	-0.8	31	64.74	52.65	76.83
Roanoke Basin	LRBS	-0.744	32	65.23	53.14	77.31
Roanoke Basin	LRBS	-0.732	33	70.23	59.24	81.22
Roanoke Basin	LRBS	-0.699	34	71.09	60.36	81.82
Roanoke Basin	LRBS	-0.636	35	71.95	61.28	82.63
Roanoke Basin	LRBS	-0.566	36	72.44	61.87	83.01
Roanoke Basin	LRBS	-0.558	37	73.62	63.55	83.70
Roanoke Basin	LRBS	-0.552	38	73.91	63.87	83.95
Roanoke Basin	LRBS	-0.539	39	74.40	64.50	84.30
Roanoke Basin	LRBS	-0.531	40	74.89	65.06	84.72
Roanoke Basin	LRBS	-0.476	41	76.07	65.92	86.22
Roanoke Basin	LRBS	-0.471	42	77.26	67.28	87.23
Roanoke Basin	LRBS	-0.457	43	77.75	67.83	87.66
Roanoke Basin	LRBS	-0.398	44	78.61	68.91	88.31
Roanoke Basin	LRBS	-0.371	45	79.47	69.80	89.13
Roanoke Basin	LRBS	-0.362	46	80.65	71.04	90.26
Roanoke Basin	LRBS	-0.359	47	81.83	72.31	91.35
Roanoke Basin	LRBS	-0.346	48	83.02	73.73	92.31
Roanoke Basin	LRBS	-0.315	49	88.03	82.22	93.83
Roanoke Basin	LRBS	-0.307	50	88.51	82.81	94.22
Roanoke Basin	LRBS	-0.249	51	89.37	83.79	94.96
Roanoke Basin	LRBS	-0.214	52	90.56	85.24	95.88

Roanoke Basin	LRBS	-0.123	53	90.85	85.56	96.13
Roanoke Basin	LRBS	-0.106	54	91.33	86.09	96.58
Roanoke Basin	LRBS	-0.044	55	92.52	87.68	97.36
Roanoke Basin	LRBS	-0.016	56	93.01	88.30	97.72
Roanoke Basin	LRBS	0.021	57	93.87	89.38	98.36
Roanoke Basin	LRBS	0.023	58	95.05	91.15	98.95
Roanoke Basin	LRBS	0.071	59	95.91	92.37	99.45
Roanoke Basin	LRBS	0.25	60	97.10	94.17	100.00
Roanoke Basin	LRBS	0.264	61	97.96	95.44	100.00
Roanoke Basin	LRBS	0.376	62	99.14	97.67	100.00
Roanoke Basin	LRBS	0.762	63	100.00	100.00	100.00
Potomac-Shenandoah	LRBS	-2.252	1	3.52	0.00	9.36
Potomac-Shenandoah	LRBS	-1.754	2	7.04	0.00	15.83
Potomac-Shenandoah	LRBS	-1.404	3	9.60	0.00	19.20
Potomac-Shenandoah	LRBS	-1.207	4	12.15	1.73	22.58
Potomac-Shenandoah	LRBS	-1.069	5	15.67	2.99	28.35
Potomac-Shenandoah	LRBS	-0.997	6	18.23	5.20	31.26
Potomac-Shenandoah	LRBS	-0.933	7	33.11	10.14	56.08
Potomac-Shenandoah	LRBS	-0.731	8	34.56	11.71	57.40
Potomac-Shenandoah	LRBS	-0.67	9	36.01	13.53	58.49
Potomac-Shenandoah	LRBS	-0.625	10	36.87	14.45	59.28
Potomac-Shenandoah	LRBS	-0.623	11	40.39	17.64	63.14
Potomac-Shenandoah	LRBS	-0.436	12	55.26	32.56	77.96
Potomac-Shenandoah	LRBS	-0.241	13	57.82	35.08	80.56
Potomac-Shenandoah	LRBS	-0.218	14	61.34	39.10	83.57
Potomac-Shenandoah	LRBS	-0.202	15	64.86	42.62	87.10
Potomac-Shenandoah	LRBS	-0.177	16	66.31	44.36	88.26
Potomac-Shenandoah	LRBS	-0.087	17	68.87	46.40	91.33
Potomac-Shenandoah	LRBS	-0.086	18	71.42	49.39	93.45
Potomac-Shenandoah	LRBS	0.06	19	74.94	53.28	96.61
Potomac-Shenandoah	LRBS	0.064	20	89.82	81.73	97.91
Potomac-Shenandoah	LRBS	0.446	21	91.27	83.71	98.83
Potomac-Shenandoah	LRBS	0.498	22	92.72	86.13	99.31
Potomac-Shenandoah	LRBS	0.525	23	94.17	87.60	100.00
Potomac-Shenandoah	LRBS	0.596	24	95.62	89.74	100.00
Potomac-Shenandoah	LRBS	0.882	25	99.14	97.49	100.00
Potomac-Shenandoah	LRBS	1.158	26	100.00	100.00	100.00
Rappahannock-York	LRBS	-2.247	1	1.86	0.00	4.99
Rappahannock-York	LRBS	-2.239	2	4.42	0.00	8.95
Rappahannock-York	LRBS	-2.113	3	5.48	0.33	10.62
Rappahannock-York	LRBS	-1.931	4	7.34	0.87	13.80
Rappahannock-York	LRBS	-1.885	5	18.16	0.28	36.04
Rappahannock-York	LRBS	-1.668	6	20.72	2.80	38.64
Rappahannock-York	LRBS	-1.486	7	22.58	4.22	40.95
Rappahannock-York	LRBS	-1.385	8	24.44	5.74	43.15
Rappahannock-York	LRBS	-1.339	9	25.50	6.58	44.41
Rappahannock-York	LRBS	-1.331	10	27.36	8.66	46.06
Rappahannock-York	LRBS	-1.181	11	27.99	9.24	46.73
Rappahannock-York	LRBS	-1.121	12	30.55	10.90	50.19
Rappahannock-York	LRBS	-1.103	13	41.37	21.52	61.23
Rappahannock-York	LRBS	-0.683	14	42.43	22.48	62.37
Rappahannock-York	LRBS	-0.679	15	44.29	24.09	64.48
Rappahannock-York	LRBS	-0.574	16	46.15	25.81	66.49

Rappahannock-York	LRBS	-0.48	17	56.97	37.10	76.85
Rappahannock-York	LRBS	-0.424	18	58.03	38.31	77.75
Rappahannock-York	LRBS	-0.379	19	60.59	40.87	80.32
Rappahannock-York	LRBS	-0.345	20	71.42	53.69	89.14
Rappahannock-York	LRBS	-0.23	21	72.47	54.95	89.99
Rappahannock-York	LRBS	-0.135	22	75.03	57.68	92.39
Rappahannock-York	LRBS	-0.06	23	76.89	59.67	94.12
Rappahannock-York	LRBS	-0.055	24	78.75	61.58	95.93
Rappahannock-York	LRBS	0.02	25	81.32	64.59	98.04
Rappahannock-York	LRBS	0.118	26	83.88	67.66	100.00
Rappahannock-York	LRBS	0.153	27	84.93	68.81	100.00
Rappahannock-York	LRBS	0.154	28	85.99	70.00	100.00
Rappahannock-York	LRBS	0.341	29	96.81	91.96	100.00
Rappahannock-York	LRBS	0.346	30	97.44	92.82	100.00
Rappahannock-York	LRBS	0.645	31	100.00	100.00	100.00
Chowan	LRBS	-3.623	1	17.40	0.00	44.11
Chowan	LRBS	-1.764	2	34.80	2.14	67.46
Chowan	LRBS	-1.72	3	38.92	5.92	71.91
Chowan	LRBS	-1.626	4	41.91	9.90	73.91
Chowan	LRBS	-1.561	5	43.60	12.27	74.93
Chowan	LRBS	-1.417	6	46.59	15.14	78.04
Chowan	LRBS	-1.33	7	49.58	18.66	80.50
Chowan	LRBS	-1.206	8	52.57	21.02	84.12
Chowan	LRBS	-1.035	9	56.69	24.55	88.82
Chowan	LRBS	-0.956	10	74.09	46.08	100.00
Chowan	LRBS	-0.908	11	75.09	46.93	100.00
Chowan	LRBS	-0.829	12	76.79	48.84	100.00
Chowan	LRBS	-0.476	13	78.48	50.44	100.00
Chowan	LRBS	-0.407	14	82.60	55.24	100.00
Chowan	LRBS	0.5	15	100.00	100.00	100.00
Tennessee	LRBS	-2.265	1	2.37	0.00	6.14
Tennessee	LRBS	-1.704	2	12.40	0.00	26.20
Tennessee	LRBS	-1.512	3	14.77	0.67	28.86
Tennessee	LRBS	-1.275	4	15.74	1.58	29.90
Tennessee	LRBS	-1.178	5	18.12	3.54	32.69
Tennessee	LRBS	-1.06	6	20.49	5.72	35.25
Tennessee	LRBS	-0.972	7	30.51	11.74	49.29
Tennessee	LRBS	-0.86	8	31.49	12.76	50.22
Tennessee	LRBS	-0.84	9	41.51	22.00	61.03
Tennessee	LRBS	-0.785	10	43.24	24.12	62.35
Tennessee	LRBS	-0.735	11	44.96	26.10	63.82
Tennessee	LRBS	-0.633	12	47.33	28.92	65.74
Tennessee	LRBS	-0.395	13	48.31	30.01	66.61
Tennessee	LRBS	-0.345	14	50.03	31.82	68.24
Tennessee	LRBS	-0.321	15	51.01	32.97	69.04
Tennessee	LRBS	-0.3	16	52.73	34.75	70.71
Tennessee	LRBS	-0.28	17	54.45	36.84	72.07
Tennessee	LRBS	-0.266	18	55.03	37.60	72.47
Tennessee	LRBS	-0.221	19	56.01	38.55	73.46
Tennessee	LRBS	-0.162	20	57.73	40.44	75.02
Tennessee	LRBS	-0.15	21	60.10	42.75	77.45
Tennessee	LRBS	-0.12	22	61.82	44.92	78.73
Tennessee	LRBS	-0.074	24	65.17	49.06	81.29



Tennessee	LRBS	-0.026	25	67.54	52.13	82.96
Tennessee	LRBS	0.022	26	69.27	54.00	84.53
Tennessee	LRBS	0.044	27	70.99	55.59	86.38
Tennessee	LRBS	0.079	28	72.71	57.32	88.10
Tennessee	LRBS	0.139	29	73.69	58.18	89.20
Tennessee	LRBS	0.14	30	74.67	59.24	90.09
Tennessee	LRBS	0.17	31	77.04	61.92	92.16
Tennessee	LRBS	0.179	32	78.01	63.01	93.02
Tennessee	LRBS	0.225	33	79.74	65.00	94.47
Tennessee	LRBS	0.236	34	81.46	66.67	96.25
Tennessee	LRBS	0.273	35	83.18	68.25	98.11
Tennessee	LRBS	0.339	36	85.55	70.08	100.00
Tennessee	LRBS	0.351	37	87.28	71.94	100.00
Tennessee	LRBS	0.521	38	89.00	73.78	100.00
Tennessee	LRBS	0.536	39	89.98	74.82	100.00
Tennessee	LRBS	0.632	40	100.00	100.00	100.00
New	LRBS	-2.515	1	10.13	0.00	26.43
New	LRBS	-1.614	2	20.26	0.33	40.20
New	LRBS	-1.533	3	21.25	1.23	41.27
New	LRBS	-1.53	4	23.65	3.59	43.71
New	LRBS	-1.364	5	33.78	12.72	54.84
New	LRBS	-1.319	6	36.18	14.61	57.75
New	LRBS	-1.177	7	46.31	24.93	67.68
New	LRBS	-0.875	8	47.30	26.16	68.43
New	LRBS	-0.819	9	49.69	29.08	70.30
New	LRBS	-0.693	10	52.09	31.57	72.61
New	LRBS	-0.675	11	52.67	32.33	73.02
New	LRBS	-0.645	12	53.26	33.07	73.45
New	LRBS	-0.467	13	55.66	36.40	74.92
New	LRBS	-0.433	14	65.79	48.94	82.63
New	LRBS	-0.402	15	67.53	50.31	84.75
New	LRBS	-0.364	16	77.66	65.39	89.93
New	LRBS	-0.317	17	78.65	66.77	90.52
New	LRBS	-0.286	18	80.39	69.40	91.38
New	LRBS	-0.203	19	82.13	71.50	92.76
New	LRBS	-0.106	20	83.87	73.87	93.88
New	LRBS	-0.102	21	85.61	76.70	94.53
New	LRBS	-0.024	22	88.01	80.01	96.01
New	LRBS	0	23	90.41	82.82	97.99
New	LRBS	0.087	24	92.15	85.59	98.70
New	LRBS	0.227	25	93.13	86.98	99.28
New	LRBS	0.316	26	94.87	89.44	100.00
New	LRBS	0.466	27	97.27	94.10	100.00
New	LRBS	0.594	28	99.01	97.31	100.00
New	LRBS	0.646	29	100.00	100.00	100.00

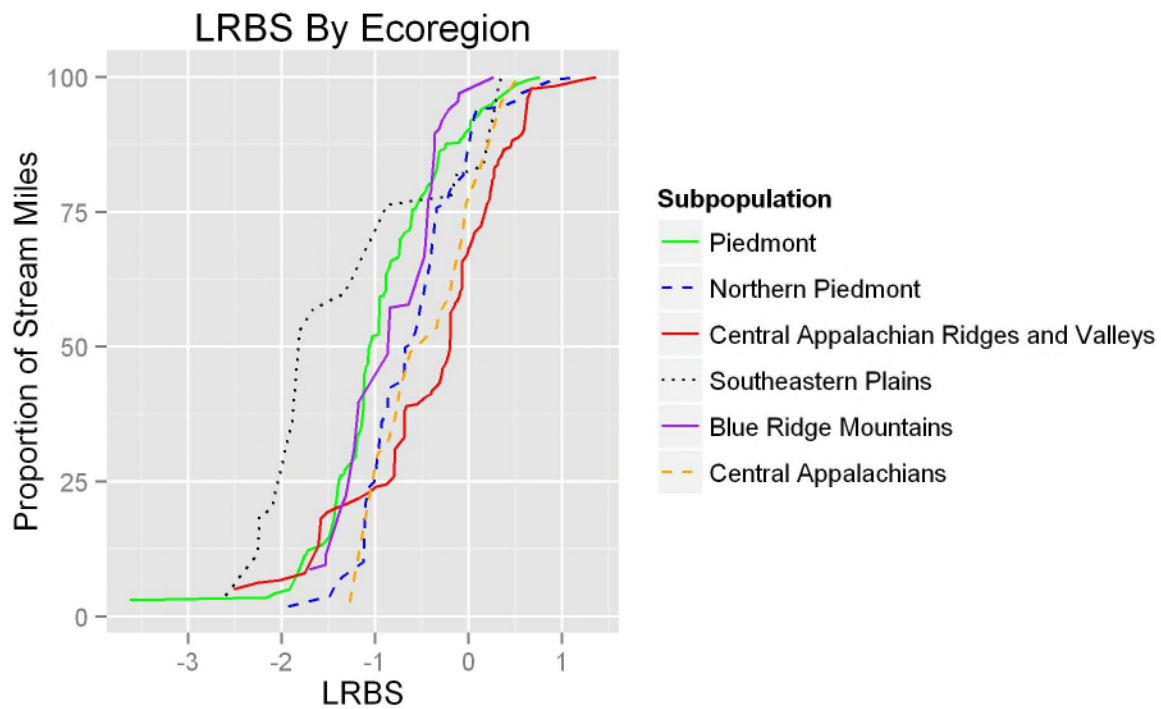


Figure 107. Relative Bed Stability by Major Ecoregion (Level III) CDF graph.

Figure 107 shows LRBS by ecoregion. Table 62 corresponds to the CDF curves shown in Figure 107. The 53<sup>rd</sup> percentile of Southeastern Plains streams is -1.80. By contrast, Central Appalachian Ridges and Valley streams are -0.20 at the 50<sup>th</sup> percentile.

Table 62. Relative Bed Stability Population Estimates by Major Ecoregion (Level III).

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	LRBS	-3.623	1	3.05	0.00	7.48
Piedmont	LRBS	-2.159	2	3.57	0.00	8.10
Piedmont	LRBS	-2.083	3	4.29	0.00	8.96
Piedmont	LRBS	-1.921	4	5.01	0.17	9.85
Piedmont	LRBS	-1.832	5	8.06	1.39	14.72
Piedmont	LRBS	-1.764	6	11.10	3.13	19.07
Piedmont	LRBS	-1.743	7	11.62	3.65	19.60
Piedmont	LRBS	-1.72	8	12.34	4.28	20.41
Piedmont	LRBS	-1.626	9	12.87	4.94	20.80
Piedmont	LRBS	-1.609	10	13.04	5.11	20.98
Piedmont	LRBS	-1.561	11	13.34	5.51	21.17
Piedmont	LRBS	-1.53	12	14.06	6.16	21.96
Piedmont	LRBS	-1.497	13	14.78	6.78	22.78
Piedmont	LRBS	-1.449	14	17.83	8.72	26.93
Piedmont	LRBS	-1.424	15	20.87	10.95	30.79
Piedmont	LRBS	-1.417	16	21.40	11.47	31.32

Piedmont	LRBS	-1.398	17	24.44	14.28	34.60
Piedmont	LRBS	-1.391	18	24.96	14.93	35.00
Piedmont	LRBS	-1.385	19	25.49	15.46	35.51
Piedmont	LRBS	-1.368	20	26.01	15.97	36.05
Piedmont	LRBS	-1.346	21	26.31	16.23	36.38
Piedmont	LRBS	-1.331	22	26.61	16.56	36.66
Piedmont	LRBS	-1.33	23	27.13	17.14	37.12
Piedmont	LRBS	-1.306	24	27.65	17.61	37.70
Piedmont	LRBS	-1.267	25	28.37	18.28	38.47
Piedmont	LRBS	-1.235	26	29.09	18.95	39.24
Piedmont	LRBS	-1.207	27	29.62	19.43	39.80
Piedmont	LRBS	-1.206	28	30.14	19.95	40.33
Piedmont	LRBS	-1.205	29	30.44	20.22	40.65
Piedmont	LRBS	-1.192	30	33.48	22.81	44.15
Piedmont	LRBS	-1.181	31	33.66	22.98	44.33
Piedmont	LRBS	-1.163	32	34.38	23.73	45.03
Piedmont	LRBS	-1.152	33	35.10	24.51	45.69
Piedmont	LRBS	-1.132	34	38.14	27.16	49.13
Piedmont	LRBS	-1.124	35	38.86	27.83	49.90
Piedmont	LRBS	-1.122	36	41.91	30.74	53.08
Piedmont	LRBS	-1.117	37	44.96	33.78	56.13
Piedmont	LRBS	-1.106	38	45.68	34.53	56.82
Piedmont	LRBS	-1.101	39	45.97	34.83	57.12
Piedmont	LRBS	-1.083	40	46.69	35.61	57.78
Piedmont	LRBS	-1.068	41	49.74	38.77	60.71
Piedmont	LRBS	-1.059	42	50.46	39.54	61.38
Piedmont	LRBS	-1.041	43	51.18	40.25	62.11
Piedmont	LRBS	-1.035	44	51.90	40.98	62.83
Piedmont	LRBS	-0.984	45	52.20	41.30	63.10
Piedmont	LRBS	-0.96	46	52.49	41.58	63.41
Piedmont	LRBS	-0.958	47	55.54	44.68	66.40
Piedmont	LRBS	-0.956	48	58.59	48.00	69.17
Piedmont	LRBS	-0.95	49	59.31	48.84	69.77
Piedmont	LRBS	-0.908	50	59.48	49.01	69.95
Piedmont	LRBS	-0.906	51	60.01	49.61	70.40
Piedmont	LRBS	-0.887	52	60.53	50.17	70.88
Piedmont	LRBS	-0.886	53	63.57	53.52	73.63
Piedmont	LRBS	-0.868	54	63.87	53.83	73.92
Piedmont	LRBS	-0.857	55	64.39	54.44	74.35
Piedmont	LRBS	-0.835	57	65.64	55.62	75.65
Piedmont	LRBS	-0.829	58	65.93	55.95	75.92
Piedmont	LRBS	-0.751	59	66.66	56.70	76.61
Piedmont	LRBS	-0.744	60	66.95	56.99	76.91
Piedmont	LRBS	-0.732	61	70.00	60.43	79.57
Piedmont	LRBS	-0.715	62	70.29	60.76	79.83
Piedmont	LRBS	-0.699	63	70.82	61.39	80.25
Piedmont	LRBS	-0.683	64	71.11	61.66	80.57
Piedmont	LRBS	-0.636	65	71.64	62.19	81.09
Piedmont	LRBS	-0.623	66	72.36	62.94	81.78
Piedmont	LRBS	-0.602	67	75.40	66.86	83.95
Piedmont	LRBS	-0.566	68	75.70	67.19	84.21
Piedmont	LRBS	-0.558	69	76.42	68.08	84.76
Piedmont	LRBS	-0.539	70	76.72	68.41	85.02

Piedmont	LRBS	-0.534	71	77.01	68.73	85.30
Piedmont	LRBS	-0.531	72	77.31	69.06	85.57
Piedmont	LRBS	-0.518	73	77.61	69.36	85.85
Piedmont	LRBS	-0.476	75	78.63	70.27	86.98
Piedmont	LRBS	-0.457	76	78.92	70.60	87.24
Piedmont	LRBS	-0.448	77	79.64	71.43	87.86
Piedmont	LRBS	-0.407	78	80.36	72.26	88.47
Piedmont	LRBS	-0.379	79	81.08	73.02	89.15
Piedmont	LRBS	-0.371	80	81.61	73.56	89.65
Piedmont	LRBS	-0.359	81	82.33	74.31	90.34
Piedmont	LRBS	-0.346	82	83.05	75.13	90.97
Piedmont	LRBS	-0.315	83	86.09	79.49	92.70
Piedmont	LRBS	-0.307	84	86.39	79.82	92.96
Piedmont	LRBS	-0.249	85	86.91	80.38	93.45
Piedmont	LRBS	-0.245	86	87.63	81.23	94.04
Piedmont	LRBS	-0.106	87	87.93	81.54	94.33
Piedmont	LRBS	-0.087	88	88.45	82.09	94.81
Piedmont	LRBS	-0.055	89	88.98	82.61	95.34
Piedmont	LRBS	-0.044	90	89.70	83.45	95.95
Piedmont	LRBS	-0.016	91	90.00	83.79	96.20
Piedmont	LRBS	0.02	92	90.72	84.61	96.82
Piedmont	LRBS	0.021	93	91.24	85.19	97.28
Piedmont	LRBS	0.023	94	91.96	86.06	97.86
Piedmont	LRBS	0.071	95	92.48	86.67	98.29
Piedmont	LRBS	0.118	96	93.20	87.49	98.91
Piedmont	LRBS	0.127	97	93.92	88.36	99.49
Piedmont	LRBS	0.154	98	94.22	88.69	99.75
Piedmont	LRBS	0.25	99	94.94	89.53	100.00
Piedmont	LRBS	0.258	100	95.24	89.86	100.00
Piedmont	LRBS	0.281	101	95.53	90.18	100.00
Piedmont	LRBS	0.5	102	98.58	96.99	100.00
Piedmont	LRBS	0.53	103	98.76	97.21	100.00
Piedmont	LRBS	0.645	104	99.48	98.59	100.00
Piedmont	LRBS	0.762	105	100.00	100.00	100.00
Northern Piedmont	LRBS	-1.931	1	1.91	0.00	5.29
Northern Piedmont	LRBS	-1.486	2	3.82	0.00	8.77
Northern Piedmont	LRBS	-1.41	3	6.44	0.00	13.34
Northern Piedmont	LRBS	-1.339	4	7.52	0.36	14.69
Northern Piedmont	LRBS	-1.121	5	10.15	1.80	18.50
Northern Piedmont	LRBS	-1.103	6	21.25	6.34	36.17
Northern Piedmont	LRBS	-1.069	7	23.88	8.86	38.90
Northern Piedmont	LRBS	-1.014	8	24.96	9.73	40.20
Northern Piedmont	LRBS	-0.933	9	36.06	16.80	55.33
Northern Piedmont	LRBS	-0.874	10	38.69	19.25	58.13
Northern Piedmont	LRBS	-0.854	11	41.32	21.82	60.81
Northern Piedmont	LRBS	-0.844	12	42.40	22.98	61.82
Northern Piedmont	LRBS	-0.731	13	43.48	24.17	62.80
Northern Piedmont	LRBS	-0.694	14	45.39	26.10	64.68
Northern Piedmont	LRBS	-0.686	15	48.02	29.03	67.00
Northern Piedmont	LRBS	-0.679	16	49.92	30.87	68.98
Northern Piedmont	LRBS	-0.625	17	50.57	31.52	69.62
Northern Piedmont	LRBS	-0.574	18	52.47	33.31	71.63
Northern Piedmont	LRBS	-0.436	19	63.58	44.77	82.38

Northern Piedmont	LRBS	-0.424	20	64.66	45.93	83.39
Northern Piedmont	LRBS	-0.345	21	75.76	60.86	90.66
Northern Piedmont	LRBS	-0.23	22	76.84	62.15	91.54
Northern Piedmont	LRBS	-0.203	23	78.75	64.36	93.14
Northern Piedmont	LRBS	-0.177	24	79.83	65.66	94.01
Northern Piedmont	LRBS	-0.06	25	81.74	67.97	95.51
Northern Piedmont	LRBS	0.064	26	92.84	87.19	98.49
Northern Piedmont	LRBS	0.085	27	93.93	88.86	99.00
Northern Piedmont	LRBS	0.346	28	94.57	89.84	99.30
Northern Piedmont	LRBS	0.498	29	95.65	91.57	99.73
Northern Piedmont	LRBS	0.525	30	96.73	92.48	100.00
Northern Piedmont	LRBS	0.882	31	99.36	98.20	100.00
Northern Piedmont	LRBS	1.158	32	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	LRBS	-2.515	1	5.08	0.00	13.10
Central Appalachian Ridges and Valleys	LRBS	-2.265	2	6.29	0.00	14.46
Central Appalachian Ridges and Valleys	LRBS	-2.031	3	6.78	0.00	14.99
Central Appalachian Ridges and Valleys	LRBS	-1.754	4	7.98	0.00	16.40
Central Appalachian Ridges and Valleys	LRBS	-1.614	5	13.07	2.30	23.83
Central Appalachian Ridges and Valleys	LRBS	-1.583	6	18.15	5.74	30.56
Central Appalachian Ridges and Valleys	LRBS	-1.512	7	19.35	6.90	31.80
Central Appalachian Ridges and Valleys	LRBS	-1.404	8	20.23	7.80	32.65
Central Appalachian Ridges and Valleys	LRBS	-1.327	9	20.72	8.31	33.13
Central Appalachian Ridges and Valleys	LRBS	-1.178	10	21.92	9.40	34.44
Central Appalachian Ridges and Valleys	LRBS	-1.06	11	23.13	10.59	35.66
Central Appalachian Ridges and Valleys	LRBS	-0.997	12	24.00	11.51	36.49
Central Appalachian Ridges and Valleys	LRBS	-0.875	13	24.50	12.13	36.86
Central Appalachian Ridges and Valleys	LRBS	-0.819	14	25.70	13.51	37.88
Central Appalachian Ridges and Valleys	LRBS	-0.8	15	25.99	13.81	38.17
Central Appalachian Ridges and Valleys	LRBS	-0.787	16	31.07	17.79	44.35
Central Appalachian Ridges and Valleys	LRBS	-0.75	17	31.95	18.62	45.27
Central Appalachian Ridges and Valleys	LRBS	-0.693	18	33.15	19.93	46.37
Central Appalachian Ridges and Valleys	LRBS	-0.688	19	38.23	24.20	52.27
Central Appalachian Ridges and Valleys	LRBS	-0.675	20	38.53	24.58	52.47
Central Appalachian Ridges and Valleys	LRBS	-0.67	21	39.02	25.11	52.94
Central Appalachian Ridges and Valleys	LRBS	-0.552	22	39.32	25.44	53.19
Central Appalachian Ridges and Valleys	LRBS	-0.471	23	40.52	26.72	54.32
Central Appalachian Ridges and Valleys	LRBS	-0.398	24	41.39	27.75	55.04
Central Appalachian Ridges and Valleys	LRBS	-0.395	25	41.89	28.26	55.52
Central Appalachian Ridges and Valleys	LRBS	-0.323	26	43.09	29.63	56.55
Central Appalachian Ridges and Valleys	LRBS	-0.3	27	43.96	30.50	57.43
Central Appalachian Ridges and Valleys	LRBS	-0.291	28	45.17	31.79	58.54
Central Appalachian Ridges and Valleys	LRBS	-0.28	29	46.04	32.79	59.29
Central Appalachian Ridges and Valleys	LRBS	-0.266	30	46.33	33.10	59.57
Central Appalachian Ridges and Valleys	LRBS	-0.241	31	47.21	33.97	60.44
Central Appalachian Ridges and Valleys	LRBS	-0.218	32	48.41	35.26	61.56
Central Appalachian Ridges and Valleys	LRBS	-0.203	33	49.28	36.27	62.30
Central Appalachian Ridges and Valleys	LRBS	-0.202	34	50.49	37.45	63.52
Central Appalachian Ridges and Valleys	LRBS	-0.196	35	51.36	38.38	64.34
Central Appalachian Ridges and Valleys	LRBS	-0.195	36	56.44	43.87	69.01
Central Appalachian Ridges and Valleys	LRBS	-0.15	37	57.64	45.04	70.24
Central Appalachian Ridges and Valleys	LRBS	-0.142	38	58.14	45.54	70.74
Central Appalachian Ridges and Valleys	LRBS	-0.123	39	58.43	45.87	71.00
Central Appalachian Ridges and Valleys	LRBS	-0.106	40	59.31	46.90	71.71

Central Appalachian Ridges and Valleys	LRBS	-0.086	41	60.18	47.92	72.44
Central Appalachian Ridges and Valleys	LRBS	-0.074	42	60.68	48.44	72.91
Central Appalachian Ridges and Valleys	LRBS	-0.072	43	65.76	54.36	77.16
Central Appalachian Ridges and Valleys	LRBS	-0.024	44	66.96	55.74	78.18
Central Appalachian Ridges and Valleys	LRBS	0	45	68.16	57.02	79.31
Central Appalachian Ridges and Valleys	LRBS	0.022	46	69.04	57.96	80.11
Central Appalachian Ridges and Valleys	LRBS	0.044	47	69.91	58.89	80.93
Central Appalachian Ridges and Valleys	LRBS	0.06	48	71.11	60.45	81.78
Central Appalachian Ridges and Valleys	LRBS	0.131	49	72.32	61.87	82.76
Central Appalachian Ridges and Valleys	LRBS	0.14	50	72.81	62.39	83.23
Central Appalachian Ridges and Valleys	LRBS	0.151	51	73.68	63.34	84.03
Central Appalachian Ridges and Valleys	LRBS	0.17	52	74.89	64.73	85.05
Central Appalachian Ridges and Valleys	LRBS	0.179	53	75.38	65.29	85.48
Central Appalachian Ridges and Valleys	LRBS	0.199	54	76.58	66.54	86.63
Central Appalachian Ridges and Valleys	LRBS	0.225	55	77.46	67.57	87.35
Central Appalachian Ridges and Valleys	LRBS	0.227	56	77.95	68.15	87.76
Central Appalachian Ridges and Valleys	LRBS	0.231	57	78.83	69.20	88.45
Central Appalachian Ridges and Valleys	LRBS	0.246	58	80.03	70.66	89.40
Central Appalachian Ridges and Valleys	LRBS	0.256	59	80.90	71.49	90.31
Central Appalachian Ridges and Valleys	LRBS	0.27	60	81.40	72.04	90.75
Central Appalachian Ridges and Valleys	LRBS	0.273	61	82.27	72.84	91.71
Central Appalachian Ridges and Valleys	LRBS	0.274	62	83.15	73.72	92.57
Central Appalachian Ridges and Valleys	LRBS	0.316	63	84.02	74.71	93.32
Central Appalachian Ridges and Valleys	LRBS	0.317	64	84.51	75.23	93.80
Central Appalachian Ridges and Valleys	LRBS	0.351	65	85.39	76.20	94.57
Central Appalachian Ridges and Valleys	LRBS	0.376	66	86.59	77.59	95.59
Central Appalachian Ridges and Valleys	LRBS	0.446	67	87.09	78.11	96.06
Central Appalachian Ridges and Valleys	LRBS	0.466	68	88.29	79.58	96.99
Central Appalachian Ridges and Valleys	LRBS	0.536	69	88.78	80.13	97.44
Central Appalachian Ridges and Valleys	LRBS	0.578	70	89.66	81.05	98.26
Central Appalachian Ridges and Valleys	LRBS	0.594	71	90.53	81.99	99.07
Central Appalachian Ridges and Valleys	LRBS	0.596	72	91.03	82.53	99.52
Central Appalachian Ridges and Valleys	LRBS	0.632	73	96.11	92.66	99.56
Central Appalachian Ridges and Valleys	LRBS	0.646	74	96.60	93.31	99.90
Central Appalachian Ridges and Valleys	LRBS	0.662	75	97.81	95.32	100.00
Central Appalachian Ridges and Valleys	LRBS	0.917	76	98.30	96.00	100.00
Central Appalachian Ridges and Valleys	LRBS	1.22	77	99.50	98.65	100.00
Central Appalachian Ridges and Valleys	LRBS	1.364	78	100.00	100.00	100.00
Southeastern Plains	LRBS	-2.605	1	3.91	0.00	10.78
Southeastern Plains	LRBS	-2.435	2	7.81	0.00	16.80
Southeastern Plains	LRBS	-2.252	3	11.72	0.00	23.82
Southeastern Plains	LRBS	-2.247	4	14.56	2.16	26.96
Southeastern Plains	LRBS	-2.239	5	18.46	3.63	33.30
Southeastern Plains	LRBS	-2.113	6	20.07	4.14	36.00
Southeastern Plains	LRBS	-1.885	7	36.59	8.00	65.17
Southeastern Plains	LRBS	-1.808	8	53.10	21.82	84.39
Southeastern Plains	LRBS	-1.668	9	57.01	25.79	88.23
Southeastern Plains	LRBS	-1.331	10	59.85	28.59	91.10
Southeastern Plains	LRBS	-0.871	11	76.36	51.51	100.00
Southeastern Plains	LRBS	-0.195	12	77.97	53.22	100.00
Southeastern Plains	LRBS	-0.135	13	81.88	57.34	100.00
Southeastern Plains	LRBS	0.153	14	83.49	58.78	100.00
Southeastern Plains	LRBS	0.341	15	100.00	100.00	100.00

Blue Ridge Mountains	LRBS	-1.704	1	8.72	0.00	22.40
Blue Ridge Mountains	LRBS	-1.533	2	9.57	0.00	23.36
Blue Ridge Mountains	LRBS	-1.53	3	11.63	0.00	25.83
Blue Ridge Mountains	LRBS	-1.364	4	20.36	3.21	37.50
Blue Ridge Mountains	LRBS	-1.319	5	22.42	4.82	40.01
Blue Ridge Mountains	LRBS	-1.225	6	31.14	8.94	53.34
Blue Ridge Mountains	LRBS	-1.177	7	39.86	16.67	63.05
Blue Ridge Mountains	LRBS	-0.87	8	48.58	25.51	71.65
Blue Ridge Mountains	LRBS	-0.84	9	57.30	36.17	78.43
Blue Ridge Mountains	LRBS	-0.645	10	57.81	36.75	78.86
Blue Ridge Mountains	LRBS	-0.48	11	66.53	49.16	83.89
Blue Ridge Mountains	LRBS	-0.467	12	68.59	51.89	85.29
Blue Ridge Mountains	LRBS	-0.433	13	77.31	63.32	91.31
Blue Ridge Mountains	LRBS	-0.402	14	78.81	64.29	93.33
Blue Ridge Mountains	LRBS	-0.364	15	87.53	78.39	96.67
Blue Ridge Mountains	LRBS	-0.362	16	89.59	82.13	97.06
Blue Ridge Mountains	LRBS	-0.317	17	90.44	83.23	97.66
Blue Ridge Mountains	LRBS	-0.286	18	91.94	85.55	98.34
Blue Ridge Mountains	LRBS	-0.214	19	94.01	88.27	99.75
Blue Ridge Mountains	LRBS	-0.12	20	95.50	90.84	100.00
Blue Ridge Mountains	LRBS	-0.102	21	97.00	93.26	100.00
Blue Ridge Mountains	LRBS	0.087	22	98.50	95.94	100.00
Blue Ridge Mountains	LRBS	0.264	23	100.00	100.00	100.00
Central Appalachians	LRBS	-1.275	1	2.68	0.00	7.58
Central Appalachians	LRBS	-0.972	2	30.18	0.00	64.60
Central Appalachians	LRBS	-0.86	3	32.86	0.00	66.59
Central Appalachians	LRBS	-0.785	4	37.59	6.05	69.12
Central Appalachians	LRBS	-0.735	5	42.31	12.24	72.38
Central Appalachians	LRBS	-0.633	6	48.82	21.42	76.21
Central Appalachians	LRBS	-0.345	7	53.54	28.05	79.03
Central Appalachians	LRBS	-0.321	8	56.22	31.99	80.45
Central Appalachians	LRBS	-0.221	9	58.90	34.72	83.09
Central Appalachians	LRBS	-0.162	10	63.63	40.47	86.79
Central Appalachians	LRBS	-0.074	11	70.13	50.29	89.97
Central Appalachians	LRBS	-0.026	12	76.64	62.15	91.13
Central Appalachians	LRBS	0.079	13	81.36	66.29	96.44
Central Appalachians	LRBS	0.139	14	84.04	68.91	99.18
Central Appalachians	LRBS	0.236	15	88.77	74.80	100.00
Central Appalachians	LRBS	0.339	16	95.28	87.17	100.00
Central Appalachians	LRBS	0.521	17	100.00	100.00	100.00

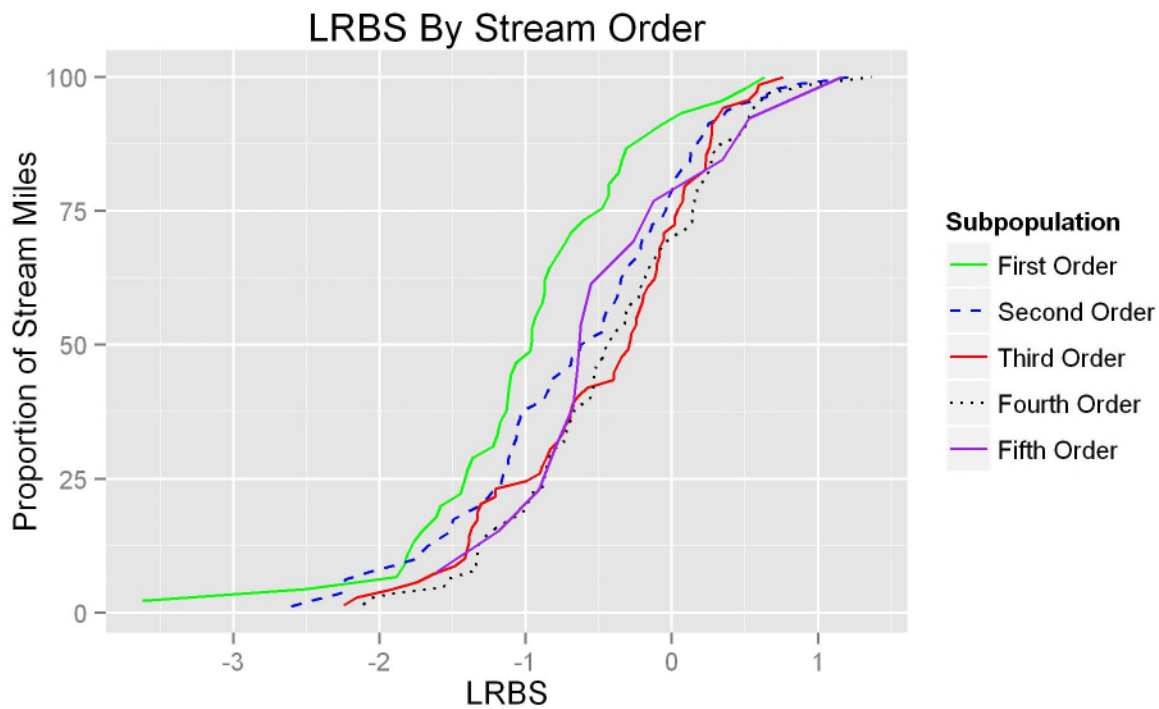


Figure 108. Relative **Bed Stability by Stream Order** CDF graph.

LRBS CDF curves by stream order are displayed in Figure 108. Table 63 contains percentiles and estimates for Figure 108. Fifty-one percent of first order streams have LRBS scores below -0.96. The 50<sup>th</sup> percentile for second order streams is -0.62 and -0.29 for third order streams. The 50<sup>th</sup> percentile for fourth order streams is similar to third order at -0.22. The sample size of fifth order streams is relatively small and the 53<sup>rd</sup> percentile is -0.63.

Table 63. Relative Bed Stability Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	LRBS	-3.623	1	2.22	0.00	6.15
First Order	LRBS	-2.515	2	4.44	0.00	9.94
First Order	LRBS	-1.885	3	6.67	0.00	13.39
First Order	LRBS	-1.832	4	8.89	1.29	16.49
First Order	LRBS	-1.808	5	11.11	2.99	19.23
First Order	LRBS	-1.764	6	13.33	4.78	21.89
First Order	LRBS	-1.704	7	15.56	6.44	24.67
First Order	LRBS	-1.614	8	17.78	8.52	27.04
First Order	LRBS	-1.583	9	20.00	10.02	29.98
First Order	LRBS	-1.449	10	22.22	11.53	32.92
First Order	LRBS	-1.424	11	24.44	13.32	35.57
First Order	LRBS	-1.398	12	26.67	15.56	37.78
First Order	LRBS	-1.364	13	28.89	17.58	40.19



First Order	LRBS	-1.225	14	31.11	19.21	43.01
First Order	LRBS	-1.192	15	33.33	21.16	45.51
First Order	LRBS	-1.177	16	35.56	23.61	47.50
First Order	LRBS	-1.132	17	37.78	25.49	50.07
First Order	LRBS	-1.122	18	40.00	27.75	52.25
First Order	LRBS	-1.117	19	42.22	30.07	54.37
First Order	LRBS	-1.103	20	44.44	31.73	57.16
First Order	LRBS	-1.068	21	46.67	34.34	59.00
First Order	LRBS	-0.972	22	48.89	36.36	61.42
First Order	LRBS	-0.958	23	51.11	38.59	63.63
First Order	LRBS	-0.956	24	53.33	41.07	65.60
First Order	LRBS	-0.933	25	55.56	43.06	68.05
First Order	LRBS	-0.886	26	57.78	45.36	70.20
First Order	LRBS	-0.871	27	60.00	47.74	72.26
First Order	LRBS	-0.87	28	62.22	50.14	74.30
First Order	LRBS	-0.84	29	64.44	52.73	76.15
First Order	LRBS	-0.787	30	66.67	54.56	78.77
First Order	LRBS	-0.732	31	68.89	57.24	80.54
First Order	LRBS	-0.688	32	71.11	59.55	82.67
First Order	LRBS	-0.602	33	73.33	62.30	84.37
First Order	LRBS	-0.48	34	75.56	64.60	86.51
First Order	LRBS	-0.436	35	77.78	67.10	88.45
First Order	LRBS	-0.433	36	80.00	69.47	90.53
First Order	LRBS	-0.364	37	82.22	72.29	92.15
First Order	LRBS	-0.345	38	84.44	74.96	93.93
First Order	LRBS	-0.315	39	86.67	78.02	95.31
First Order	LRBS	-0.195	40	88.89	80.77	97.00
First Order	LRBS	-0.072	41	91.11	83.84	98.38
First Order	LRBS	0.064	42	93.33	86.86	99.80
First Order	LRBS	0.341	43	95.56	90.35	100.00
First Order	LRBS	0.5	44	97.78	94.23	100.00
First Order	LRBS	0.632	45	100.00	100.00	100.00
Second Order	LRBS	-2.605	1	1.25	0.00	3.46
Second Order	LRBS	-2.435	2	2.50	0.00	5.14
Second Order	LRBS	-2.265	3	3.75	0.39	7.11
Second Order	LRBS	-2.252	4	5.00	1.23	8.77
Second Order	LRBS	-2.239	5	6.25	2.65	9.85
Second Order	LRBS	-2.083	6	7.50	3.30	11.70
Second Order	LRBS	-1.921	7	8.75	4.12	13.38
Second Order	LRBS	-1.754	8	10.00	4.87	15.13
Second Order	LRBS	-1.72	9	11.25	5.73	16.77
Second Order	LRBS	-1.668	10	12.50	7.12	17.88
Second Order	LRBS	-1.53	12	15.00	9.12	20.88
Second Order	LRBS	-1.512	13	16.25	10.07	22.43
Second Order	LRBS	-1.497	14	17.50	10.96	24.04
Second Order	LRBS	-1.41	15	18.75	11.95	25.55
Second Order	LRBS	-1.319	16	20.00	13.03	26.97
Second Order	LRBS	-1.267	17	21.25	13.98	28.52
Second Order	LRBS	-1.235	18	22.50	15.12	29.88
Second Order	LRBS	-1.178	19	23.75	16.11	31.39
Second Order	LRBS	-1.163	20	25.00	17.14	32.86
Second Order	LRBS	-1.152	21	26.25	18.34	34.16
Second Order	LRBS	-1.124	22	27.50	19.30	35.70

Second Order	LRBS	-1.121	23	28.75	20.50	37.00
Second Order	LRBS	-1.106	24	30.00	21.87	38.13
Second Order	LRBS	-1.083	25	31.25	23.24	39.26
Second Order	LRBS	-1.069	26	32.50	24.25	40.75
Second Order	LRBS	-1.06	27	33.75	25.48	42.02
Second Order	LRBS	-1.059	28	35.00	26.66	43.34
Second Order	LRBS	-1.041	29	36.25	28.03	44.47
Second Order	LRBS	-1.035	30	37.50	29.31	45.69
Second Order	LRBS	-0.95	31	38.75	30.65	46.85
Second Order	LRBS	-0.874	32	40.00	31.86	48.14
Second Order	LRBS	-0.854	33	41.25	33.13	49.37
Second Order	LRBS	-0.835	34	42.50	34.58	50.42
Second Order	LRBS	-0.819	35	43.75	35.61	51.89
Second Order	LRBS	-0.751	36	45.00	36.78	53.22
Second Order	LRBS	-0.693	37	46.25	37.76	54.74
Second Order	LRBS	-0.686	38	47.50	39.21	55.79
Second Order	LRBS	-0.633	39	48.75	40.29	57.21
Second Order	LRBS	-0.623	40	50.00	41.43	58.57
Second Order	LRBS	-0.558	41	51.25	42.66	59.84
Second Order	LRBS	-0.476	42	52.50	43.91	61.09
Second Order	LRBS	-0.471	43	53.75	45.05	62.45
Second Order	LRBS	-0.467	44	55.00	46.38	63.62
Second Order	LRBS	-0.448	45	56.25	47.78	64.72
Second Order	LRBS	-0.407	46	57.50	49.32	65.68
Second Order	LRBS	-0.379	47	58.75	50.36	67.14
Second Order	LRBS	-0.362	48	60.00	51.47	68.53
Second Order	LRBS	-0.359	49	61.25	52.62	69.88
Second Order	LRBS	-0.346	50	62.50	54.05	70.95
Second Order	LRBS	-0.323	51	63.75	55.04	72.46
Second Order	LRBS	-0.291	52	65.00	56.33	73.67
Second Order	LRBS	-0.245	53	66.25	57.80	74.70
Second Order	LRBS	-0.218	54	67.50	59.17	75.83
Second Order	LRBS	-0.214	55	68.75	60.67	76.83
Second Order	LRBS	-0.202	56	70.00	61.95	78.05
Second Order	LRBS	-0.15	57	71.25	63.28	79.22
Second Order	LRBS	-0.135	58	72.50	64.54	80.46
Second Order	LRBS	-0.074	59	73.75	65.78	81.72
Second Order	LRBS	-0.044	60	75.00	67.16	82.84
Second Order	LRBS	-0.026	61	76.25	68.62	83.88
Second Order	LRBS	-0.024	62	77.50	69.88	85.12
Second Order	LRBS	0	63	78.75	71.36	86.14
Second Order	LRBS	0.02	64	80.00	72.86	87.14
Second Order	LRBS	0.023	65	81.25	74.41	88.09
Second Order	LRBS	0.06	66	82.50	75.97	89.03
Second Order	LRBS	0.118	67	83.75	77.33	90.17
Second Order	LRBS	0.127	68	85.00	78.80	91.20
Second Order	LRBS	0.131	69	86.25	80.41	92.09
Second Order	LRBS	0.17	70	87.50	81.94	93.06
Second Order	LRBS	0.199	71	88.75	83.11	94.39
Second Order	LRBS	0.246	72	90.00	84.30	95.70
Second Order	LRBS	0.25	73	91.25	85.90	96.60
Second Order	LRBS	0.339	74	92.50	87.61	97.39
Second Order	LRBS	0.376	75	93.75	89.32	98.18

Second Order	LRBS	0.466	76	95.00	91.14	98.86
Second Order	LRBS	0.645	77	96.25	92.97	99.53
Second Order	LRBS	0.662	78	97.50	94.51	100.00
Second Order	LRBS	0.882	79	98.75	96.61	100.00
Second Order	LRBS	1.22	80	100.00	100.00	100.00
Third Order	LRBS	-2.247	1	1.45	0.00	3.80
Third Order	LRBS	-2.159	2	2.90	0.00	6.26
Third Order	LRBS	-1.931	3	4.35	0.18	8.52
Third Order	LRBS	-1.743	4	5.80	0.94	10.66
Third Order	LRBS	-1.626	5	7.25	1.93	12.56
Third Order	LRBS	-1.486	6	8.70	2.96	14.44
Third Order	LRBS	-1.417	7	10.14	4.35	15.94
Third Order	LRBS	-1.404	8	11.59	5.42	17.77
Third Order	LRBS	-1.391	9	13.04	6.76	19.33
Third Order	LRBS	-1.385	10	14.49	8.06	20.92
Third Order	LRBS	-1.368	11	15.94	9.37	22.52
Third Order	LRBS	-1.331	12	17.39	11.17	23.61
Third Order	LRBS	-1.33	13	18.84	12.97	24.71
Third Order	LRBS	-1.306	14	20.29	14.04	26.54
Third Order	LRBS	-1.207	15	21.74	15.29	28.19
Third Order	LRBS	-1.206	16	23.19	17.04	29.34
Third Order	LRBS	-0.997	17	24.64	18.56	30.71
Third Order	LRBS	-0.906	18	26.09	19.86	32.31
Third Order	LRBS	-0.887	19	27.54	21.27	33.80
Third Order	LRBS	-0.857	20	28.99	22.51	35.46
Third Order	LRBS	-0.835	21	30.43	24.33	36.54
Third Order	LRBS	-0.785	22	31.88	25.31	38.45
Third Order	LRBS	-0.75	23	33.33	26.30	40.37
Third Order	LRBS	-0.735	24	34.78	27.52	42.05
Third Order	LRBS	-0.699	25	36.23	29.14	43.32
Third Order	LRBS	-0.694	26	37.68	30.39	44.98
Third Order	LRBS	-0.679	27	39.13	31.70	46.56
Third Order	LRBS	-0.636	28	40.58	32.80	48.36
Third Order	LRBS	-0.574	29	42.03	34.41	49.65
Third Order	LRBS	-0.402	30	43.48	35.46	51.50
Third Order	LRBS	-0.398	31	44.93	36.55	53.30
Third Order	LRBS	-0.371	32	46.38	37.89	54.86
Third Order	LRBS	-0.345	33	47.83	39.01	56.64
Third Order	LRBS	-0.3	34	49.28	40.16	58.39
Third Order	LRBS	-0.286	35	50.72	41.41	60.04
Third Order	LRBS	-0.28	36	52.17	42.58	61.77
Third Order	LRBS	-0.249	37	53.62	44.13	63.11
Third Order	LRBS	-0.241	38	55.07	45.67	64.47
Third Order	LRBS	-0.203	40	57.97	48.74	67.20
Third Order	LRBS	-0.196	41	59.42	50.17	68.67
Third Order	LRBS	-0.162	42	60.87	51.68	70.06
Third Order	LRBS	-0.12	43	62.32	53.10	71.54
Third Order	LRBS	-0.106	44	63.77	54.71	72.83
Third Order	LRBS	-0.102	45	65.22	56.17	74.26
Third Order	LRBS	-0.087	46	66.67	57.78	75.56
Third Order	LRBS	-0.086	47	68.12	59.56	76.67
Third Order	LRBS	-0.06	48	69.57	61.26	77.87
Third Order	LRBS	-0.055	49	71.01	63.11	78.92

Third Order	LRBS	0.021	50	72.46	64.70	80.23
Third Order	LRBS	0.022	51	73.91	66.30	81.53
Third Order	LRBS	0.044	52	75.36	67.50	83.22
Third Order	LRBS	0.071	53	76.81	69.35	84.28
Third Order	LRBS	0.079	54	78.26	70.80	85.72
Third Order	LRBS	0.087	55	79.71	72.58	86.84
Third Order	LRBS	0.151	56	81.16	73.94	88.38
Third Order	LRBS	0.225	57	82.61	75.79	89.43
Third Order	LRBS	0.231	58	84.06	77.42	90.70
Third Order	LRBS	0.236	59	85.51	79.06	91.95
Third Order	LRBS	0.256	60	86.96	80.43	93.48
Third Order	LRBS	0.264	61	88.41	82.31	94.50
Third Order	LRBS	0.273	62	89.86	84.19	95.52
Third Order	LRBS	0.274	63	91.30	85.80	96.81
Third Order	LRBS	0.316	64	92.75	87.41	98.10
Third Order	LRBS	0.351	65	94.20	89.40	99.01
Third Order	LRBS	0.521	66	95.65	91.48	99.83
Third Order	LRBS	0.578	67	97.10	93.74	100.00
Third Order	LRBS	0.594	68	98.55	96.18	100.00
Third Order	LRBS	0.762	69	100.00	100.00	100.00
Fourth Order	LRBS	-2.113	1	1.59	0.00	4.32
Fourth Order	LRBS	-2.031	2	3.17	0.00	6.99
Fourth Order	LRBS	-1.561	3	4.76	0.18	9.34
Fourth Order	LRBS	-1.533	4	6.35	1.09	11.61
Fourth Order	LRBS	-1.346	5	7.94	2.07	13.81
Fourth Order	LRBS	-1.339	6	9.52	3.06	15.99
Fourth Order	LRBS	-1.331	7	11.11	4.24	17.98
Fourth Order	LRBS	-1.327	8	12.70	5.63	19.77
Fourth Order	LRBS	-1.275	9	14.29	6.71	21.86
Fourth Order	LRBS	-1.205	10	15.87	7.95	23.80
Fourth Order	LRBS	-1.101	11	17.46	9.20	25.72
Fourth Order	LRBS	-1.014	12	19.05	10.36	27.74
Fourth Order	LRBS	-0.984	13	20.63	11.64	29.63
Fourth Order	LRBS	-0.96	14	22.22	13.07	31.38
Fourth Order	LRBS	-0.875	15	23.81	14.52	33.10
Fourth Order	LRBS	-0.868	16	25.40	15.88	34.92
Fourth Order	LRBS	-0.86	17	26.98	17.35	36.62
Fourth Order	LRBS	-0.844	18	28.57	18.59	38.55
Fourth Order	LRBS	-0.829	19	30.16	20.21	40.11
Fourth Order	LRBS	-0.744	20	31.75	21.64	41.85
Fourth Order	LRBS	-0.731	21	33.33	22.96	43.70
Fourth Order	LRBS	-0.715	22	34.92	24.61	45.23
Fourth Order	LRBS	-0.683	23	36.51	26.05	46.97
Fourth Order	LRBS	-0.67	24	38.10	27.51	48.68
Fourth Order	LRBS	-0.566	25	39.68	29.09	50.27
Fourth Order	LRBS	-0.539	26	41.27	30.81	51.73
Fourth Order	LRBS	-0.534	27	42.86	32.39	53.32
Fourth Order	LRBS	-0.531	28	44.44	34.16	54.73
Fourth Order	LRBS	-0.518	29	46.03	35.55	56.51
Fourth Order	LRBS	-0.476	30	47.62	37.49	57.75
Fourth Order	LRBS	-0.457	31	49.21	39.14	59.27
Fourth Order	LRBS	-0.424	32	50.79	40.62	60.96
Fourth Order	LRBS	-0.395	33	52.38	41.86	62.90

Fourth Order	LRBS	-0.321	34	53.97	43.31	64.62
Fourth Order	LRBS	-0.317	35	55.56	44.91	66.20
Fourth Order	LRBS	-0.307	36	57.14	46.77	67.52
Fourth Order	LRBS	-0.23	37	58.73	48.55	68.91
Fourth Order	LRBS	-0.221	38	60.32	50.31	70.32
Fourth Order	LRBS	-0.195	39	61.90	52.06	71.75
Fourth Order	LRBS	-0.177	40	63.49	53.76	73.23
Fourth Order	LRBS	-0.142	41	65.08	55.14	75.02
Fourth Order	LRBS	-0.106	42	66.67	57.07	76.26
Fourth Order	LRBS	-0.074	43	68.25	58.53	77.98
Fourth Order	LRBS	-0.016	44	69.84	60.47	79.21
Fourth Order	LRBS	0.085	45	71.43	62.05	80.81
Fourth Order	LRBS	0.139	46	73.02	64.00	82.03
Fourth Order	LRBS	0.14	47	74.60	65.68	83.53
Fourth Order	LRBS	0.153	48	76.19	67.59	84.79
Fourth Order	LRBS	0.154	49	77.78	69.51	86.04
Fourth Order	LRBS	0.179	50	79.37	71.40	87.33
Fourth Order	LRBS	0.227	51	80.95	73.03	88.87
Fourth Order	LRBS	0.258	52	82.54	75.05	90.03
Fourth Order	LRBS	0.27	53	84.13	76.83	91.43
Fourth Order	LRBS	0.281	54	85.71	78.77	92.66
Fourth Order	LRBS	0.317	55	87.30	80.47	94.13
Fourth Order	LRBS	0.446	56	88.89	82.12	95.65
Fourth Order	LRBS	0.498	57	90.48	84.11	96.84
Fourth Order	LRBS	0.525	58	92.06	86.24	97.89
Fourth Order	LRBS	0.536	59	93.65	88.51	98.79
Fourth Order	LRBS	0.596	60	95.24	90.81	99.66
Fourth Order	LRBS	0.646	61	96.83	93.20	100.00
Fourth Order	LRBS	0.917	62	98.41	95.86	100.00
Fourth Order	LRBS	1.364	63	100.00	100.00	100.00
Fifth Order	LRBS	-1.609	1	7.69	0.00	20.63
Fifth Order	LRBS	-1.181	2	15.38	0.00	32.02
Fifth Order	LRBS	-0.908	3	23.08	7.11	39.05
Fifth Order	LRBS	-0.8	4	30.77	10.05	51.48
Fifth Order	LRBS	-0.675	5	38.46	14.97	61.96
Fifth Order	LRBS	-0.645	6	46.15	22.08	70.23
Fifth Order	LRBS	-0.625	7	53.85	28.24	79.46
Fifth Order	LRBS	-0.552	8	61.54	36.79	86.28
Fifth Order	LRBS	-0.266	9	69.23	47.28	91.19
Fifth Order	LRBS	-0.123	10	76.92	57.85	95.99
Fifth Order	LRBS	0.346	11	84.62	66.77	100.00
Fifth Order	LRBS	0.53	12	92.31	79.61	100.00
Fifth Order	LRBS	1.158	13	100.00	100.00	100.00

## Appendix M. Dissolved Metals Cumulative Criterion Unit Statistical Analyses

### *Stressor Linkage to Aquatic Health*

High levels of dissolved metals have been linked to diminished aquatic health in Virginia streams (VDEQ, 2012) as measured by the VSCI. Metals CCU levels above 2 increase the likelihood of having a low VSCI score. Figure 109 shows a scatterplot of VSCI vs. Metals CCU. The case for this increased probability of stress to the aquatic community with increasing cumulative metals as measured by Metals Cumulative Criterion Unit (CCU) is presented in this appendix.

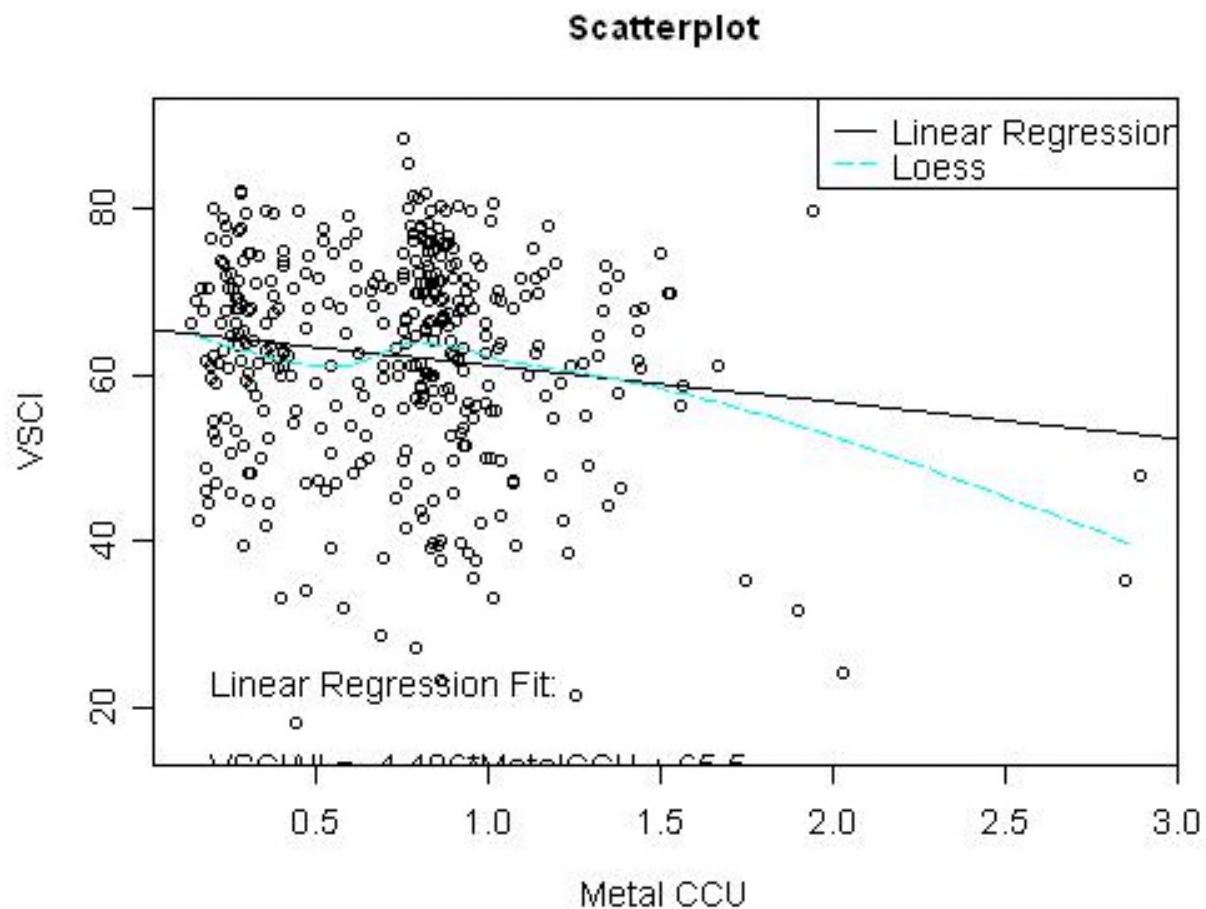


Figure 109. Stressor Gradient Scatterplot Comparing Increasing Dissolved Metal values to Declining VSCI Scores

### *Metals CCU Relative Risk Results*

An optimal Metal CCU score is considered to be below 1, this Metal CCU score represents all dissolved metals used collectively in the index are well below water quality criteria. VDEQ estimates 83% of Virginia streams have a Metal CCU below 1 (Table 64). A Metal CCU over 2 is considered suboptimal based on recommendations in water quality literature (Clements, 2000). Less than 2% of Virginia streams have a Metals CCU above 2 (Table 64). VDEQ relative risk calculations found that a VSCI score is 4.3 times more likely to be below 50 when the Metals CCU is above 2 than when the Metals CCU is below 1 (Figure 111). In Figure 110 declining median values are observed when Metal CCUs are above 1.5. Metals above 1.5 and 2.0 were combined in order to create a box plot due to low n values.

Table 64. Relative Risk Categories.

Stressor Parameter	Optimal	Suboptimal
Metals CCU	<1	>2

Figure 110. VSCI Scores by Metals CCU Categories

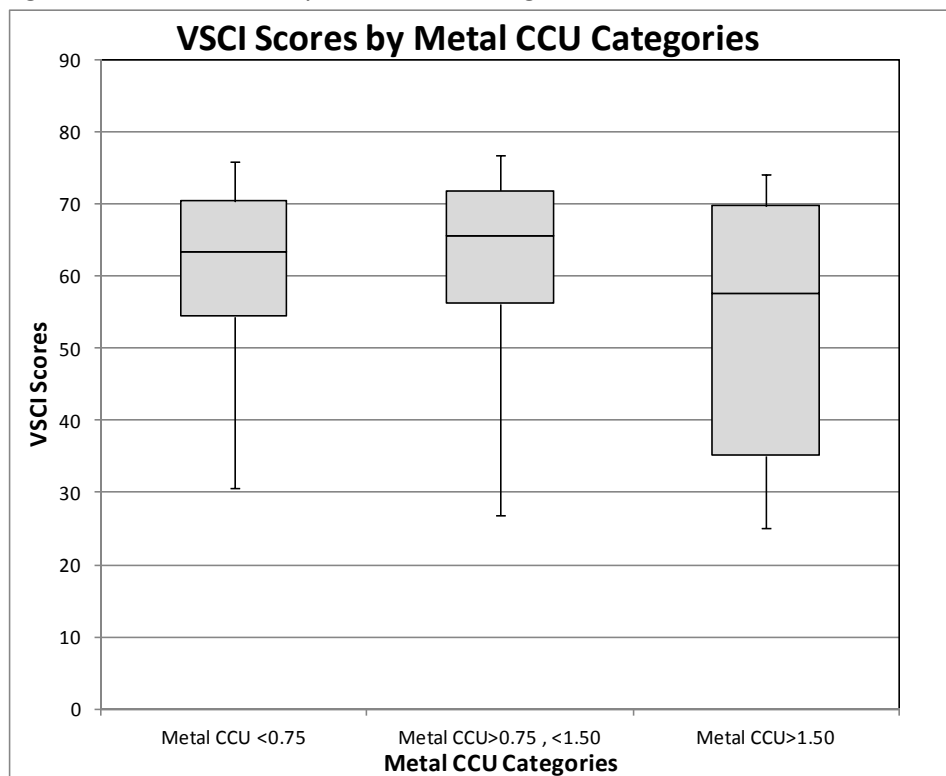
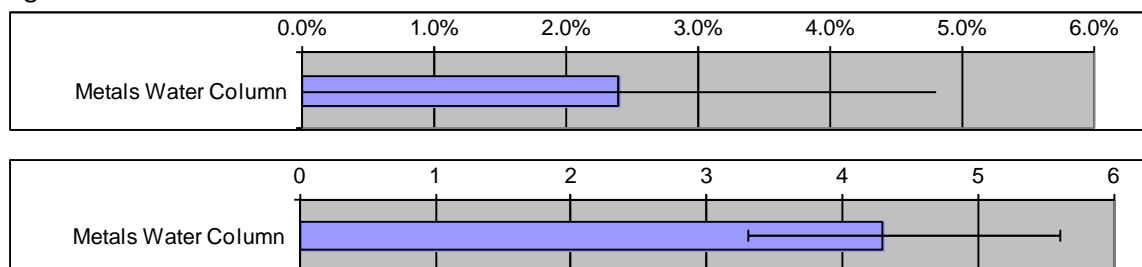


Figure 111. Metals CCU Extent and Risk Results.



### *Probability of VSCI Not Meeting Aquatic Life Use Determination*

The dataset used in this analysis has 12 sites with Metals CCU values above 1.5. This is a positive sign that widespread heavy metal contamination is not widespread in Virginia. Seven out of 12 sites have VSCI scores less than 60. The probability of having VSCI score less than 60 when the Metals CCU increases significantly from Metals CCU score of 1.5 to 2.0 (Figure 112). Quantile regression results (Figure 113) indicate sites with Metals CCU below 2.3 are somewhat protected.

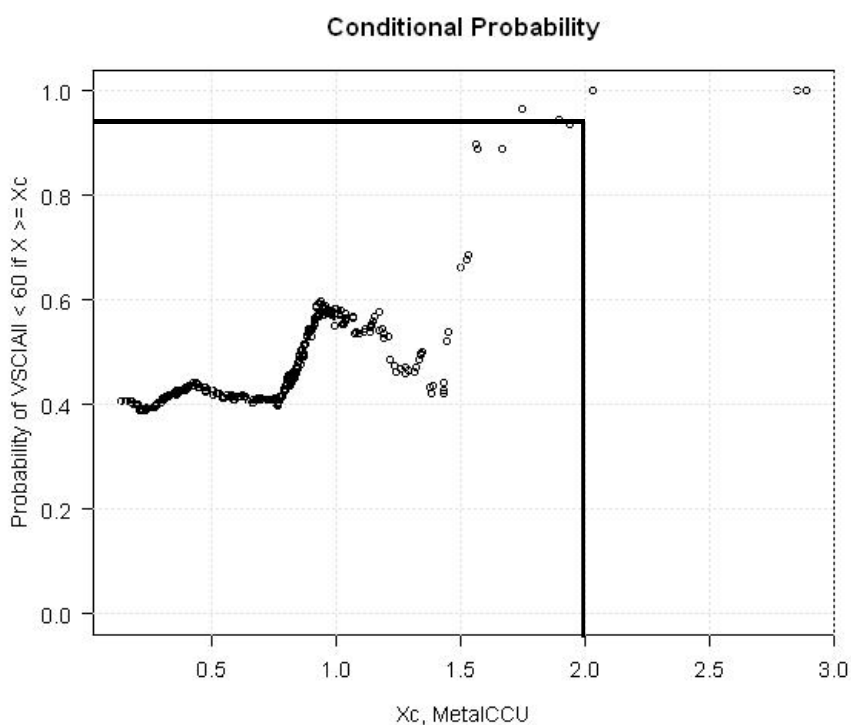


Figure 112. Probability of VSCI less than 60 if Metals CCU Scores Above 2.



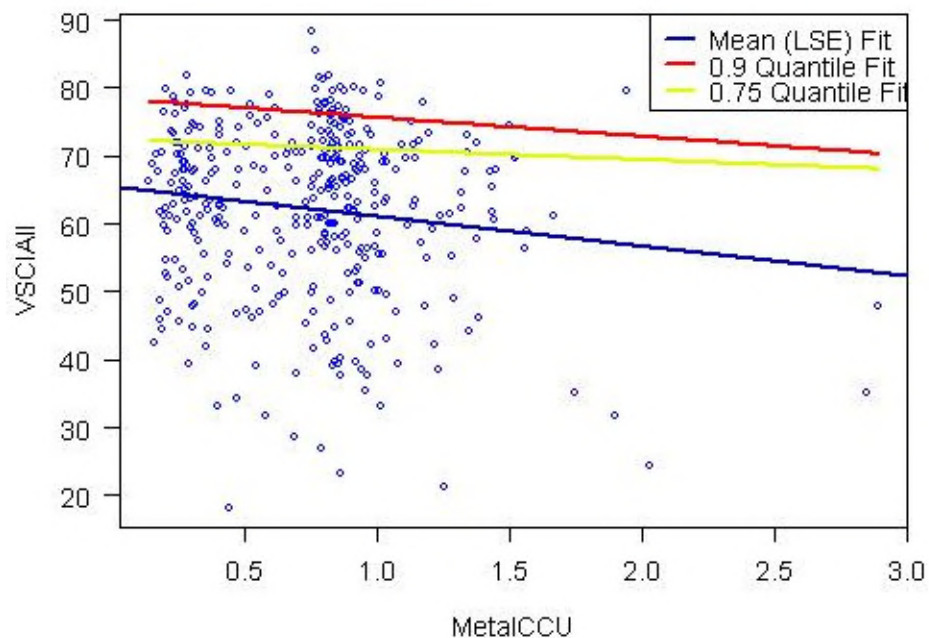


Figure 113. Quantile Regression VSCI versus Metal CCU Scores

Quantile regression is shown in Figure 113. The 0.9 quantile (red line) fit regression analysis shows the 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to Metals CCU scores. Quantile regression techniques are used to fit a regression to the 90<sup>th</sup> quantile in order to remove the effects of other stressor variables to biological metrics. The 50<sup>th</sup> (VSCI=72), 25<sup>th</sup> (VSCI=66), and 10<sup>th</sup> percentile (VSCI=60) of reference VSCI scores are compared to Metal CCU scores. The 50<sup>th</sup> percentile of percentile of reference crosses at 2.3, 25th percentile intersects at 4.5 mg/L, and the 10<sup>th</sup> percentile is equal to 6.6. The 50<sup>th</sup> percentile of reference is associated with more protective water chemistry values, while values at the 10<sup>th</sup> percentile tend represent number where the aquatic community is already stressed.

### *Metal CCU and Probability of Stress to Aquatic Life*

High levels of dissolved metals have been linked to decreases of the aquatic health in Virginia streams (VDEQ, 2012). Aquatic health is measured by VDEQ with a multimetric biomonitoring tool known as the Virginia Stream Condition Index (VSCI). Metals CCU levels above 2 increase the likelihood of having a low VSCI score (VSCI score less than 60 indicates an aquatic life use impairment). This probability increases significantly once the Metal CCU increases above 1.5.

Table 65. Dissolved metals cumulative criterion unit and associated probability of stress to aquatic life.

Dissolved Metals Cumulative Criterion Unit (CCU)	
Probability of Stress to Aquatic Life	Metals CCU (unitless)
High	> 2.0
Medium	> 1.5, < 2.0
Low	> 0.75, < 1.5
No	< 0.75

### *Metal CCU Cumulative Distribution Function curves*

Metal CCU cumulative distribution function (CDF) are shown statewide, by major basin, major ecoregion (level III), and by stream order in Figures 113-116 and Tables 66-69.

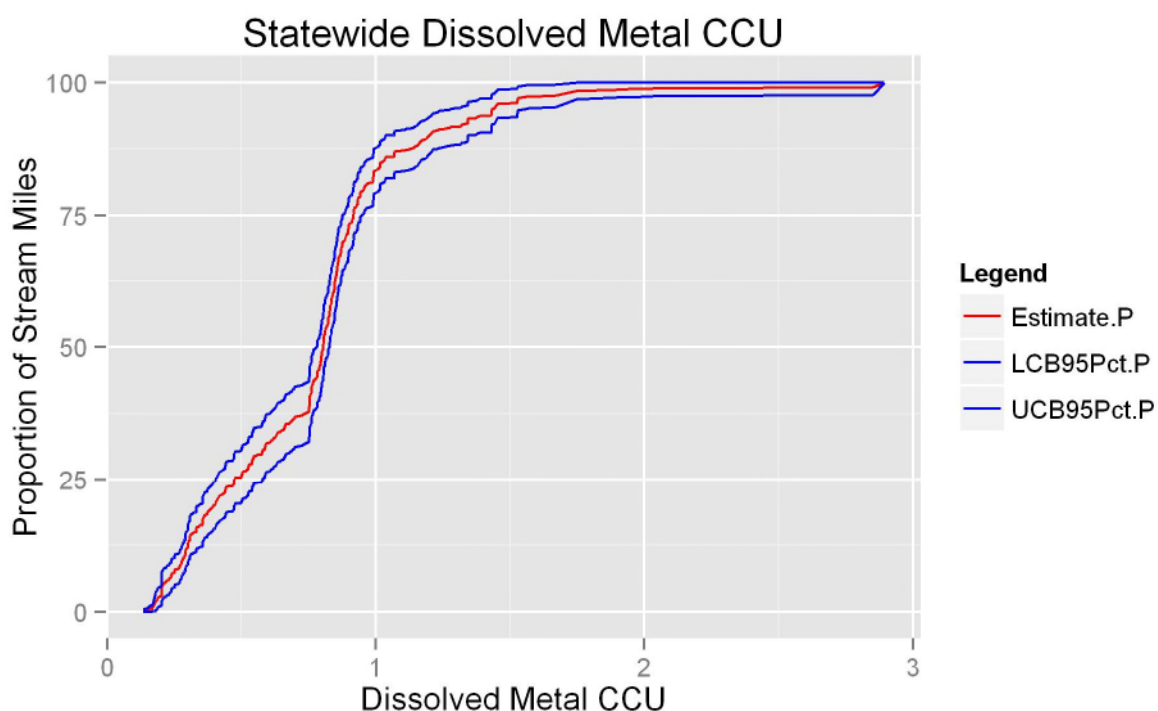


Figure 113. Metal CCU Statewide CDF graph

Figure 113 shows Metals CCU distribution statewide. From Table 66 it is apparent that 98.8% of stream miles have Metals CCU scores below 2.03. High probability of stress to aquatic life occurs at Metal CCU scores greater than 2.0 (Table 65).

Table 66. Statewide Metal CCU Estimates.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Virginia	Metals CCU	0.13	1	0.16	0.00	0.43
Virginia	Metals CCU	0.15	2	0.31	0.00	0.69
Virginia	Metals CCU	0.16	3	0.53	0.01	1.05
Virginia	Metals CCU	0.17	4	0.68	0.10	1.26
Virginia	Metals CCU	0.17	5	0.90	0.22	1.58
Virginia	Metals CCU	0.18	6	1.81	0.11	3.50
Virginia	Metals CCU	0.18	7	1.90	0.20	3.60
Virginia	Metals CCU	0.18	8	2.05	0.33	3.78
Virginia	Metals CCU	0.19	9	2.27	0.51	4.03
Virginia	Metals CCU	0.19	10	2.48	0.69	4.28
Virginia	Metals CCU	0.19	11	2.70	0.88	4.52
Virginia	Metals CCU	0.19	12	2.79	0.97	4.60
Virginia	Metals CCU	0.20	13	2.88	1.06	4.69
Virginia	Metals CCU	0.20	14	2.96	1.15	4.78
Virginia	Metals CCU	0.20	15	3.87	1.54	6.21
Virginia	Metals CCU	0.20	16	4.03	1.69	6.37
Virginia	Metals CCU	0.20	17	4.94	2.22	7.65
Virginia	Metals CCU	0.21	18	5.09	2.37	7.82
Virginia	Metals CCU	0.21	19	5.25	2.53	7.97
Virginia	Metals CCU	0.21	20	5.41	2.68	8.13
Virginia	Metals CCU	0.22	21	5.50	2.76	8.23
Virginia	Metals CCU	0.22	22	5.71	2.96	8.46
Virginia	Metals CCU	0.22	23	5.93	3.15	8.70
Virginia	Metals CCU	0.23	24	5.98	3.20	8.75
Virginia	Metals CCU	0.23	25	6.19	3.41	8.98
Virginia	Metals CCU	0.23	26	6.25	3.46	9.04
Virginia	Metals CCU	0.24	27	6.46	3.69	9.23
Virginia	Metals CCU	0.24	28	6.55	3.78	9.32
Virginia	Metals CCU	0.24	29	6.71	3.92	9.49
Virginia	Metals CCU	0.24	30	6.92	4.15	9.69
Virginia	Metals CCU	0.24	31	7.08	4.29	9.86
Virginia	Metals CCU	0.24	32	7.23	4.45	10.02
Virginia	Metals CCU	0.25	33	7.29	4.51	10.06
Virginia	Metals CCU	0.25	34	7.37	4.59	10.16
Virginia	Metals CCU	0.25	35	7.59	4.78	10.40
Virginia	Metals CCU	0.25	36	7.75	4.92	10.57
Virginia	Metals CCU	0.25	37	7.90	5.07	10.74
Virginia	Metals CCU	0.26	38	7.99	5.16	10.82
Virginia	Metals CCU	0.26	39	8.04	5.22	10.87
Virginia	Metals CCU	0.27	40	8.13	5.31	10.96
Virginia	Metals CCU	0.27	41	8.22	5.40	11.04
Virginia	Metals CCU	0.27	42	8.38	5.54	11.21
Virginia	Metals CCU	0.27	43	8.59	5.74	11.45
Virginia	Metals CCU	0.27	44	8.75	5.90	11.59
Virginia	Metals CCU	0.27	45	8.84	5.99	11.68
Virginia	Metals CCU	0.27	46	8.99	6.15	11.84
Virginia	Metals CCU	0.28	47	9.21	6.35	12.07
Virginia	Metals CCU	0.28	48	9.42	6.54	12.31
Virginia	Metals CCU	0.28	49	9.51	6.64	12.38
Virginia	Metals CCU	0.28	50	9.60	6.73	12.47
Virginia	Metals CCU	0.28	51	9.69	6.82	12.56

Virginia	Metals CCU	0.28	52	9.90	7.01	12.80
Virginia	Metals CCU	0.28	53	10.06	7.16	12.96
Virginia	Metals CCU	0.29	54	10.22	7.30	13.13
Virginia	Metals CCU	0.29	55	10.30	7.39	13.22
Virginia	Metals CCU	0.29	56	10.52	7.59	13.45
Virginia	Metals CCU	0.29	57	10.68	7.73	13.62
Virginia	Metals CCU	0.29	58	11.59	8.34	14.83
Virginia	Metals CCU	0.29	59	11.80	8.56	15.04
Virginia	Metals CCU	0.30	60	11.89	8.66	15.11
Virginia	Metals CCU	0.30	61	12.10	8.86	15.35
Virginia	Metals CCU	0.30	62	12.19	8.95	15.43
Virginia	Metals CCU	0.30	63	13.10	9.57	16.63
Virginia	Metals CCU	0.30	64	13.26	9.71	16.80
Virginia	Metals CCU	0.31	65	13.35	9.80	16.90
Virginia	Metals CCU	0.31	66	13.44	9.88	16.99
Virginia	Metals CCU	0.31	67	14.34	10.60	18.09
Virginia	Metals CCU	0.31	68	14.40	10.65	18.14
Virginia	Metals CCU	0.31	69	14.45	10.71	18.19
Virginia	Metals CCU	0.31	70	14.54	10.80	18.28
Virginia	Metals CCU	0.32	71	14.69	10.94	18.45
Virginia	Metals CCU	0.32	72	14.91	11.13	18.69
Virginia	Metals CCU	0.33	73	14.96	11.19	18.73
Virginia	Metals CCU	0.33	74	15.05	11.29	18.82
Virginia	Metals CCU	0.33	75	15.96	11.95	19.97
Virginia	Metals CCU	0.34	76	16.05	12.04	20.06
Virginia	Metals CCU	0.34	77	16.26	12.23	20.30
Virginia	Metals CCU	0.35	78	16.32	12.28	20.35
Virginia	Metals CCU	0.36	79	16.47	12.43	20.51
Virginia	Metals CCU	0.36	80	17.38	13.13	21.63
Virginia	Metals CCU	0.36	81	17.60	13.33	21.86
Virginia	Metals CCU	0.36	82	17.68	13.42	21.95
Virginia	Metals CCU	0.36	83	17.90	13.64	22.16
Virginia	Metals CCU	0.36	84	18.06	13.79	22.33
Virginia	Metals CCU	0.37	85	18.27	13.99	22.55
Virginia	Metals CCU	0.37	86	18.32	14.04	22.60
Virginia	Metals CCU	0.37	87	18.38	14.09	22.66
Virginia	Metals CCU	0.37	88	18.53	14.25	22.82
Virginia	Metals CCU	0.37	89	18.75	14.45	23.04
Virginia	Metals CCU	0.39	90	19.66	15.18	24.14
Virginia	Metals CCU	0.39	91	19.75	15.27	24.22
Virginia	Metals CCU	0.39	92	19.96	15.51	24.42
Virginia	Metals CCU	0.40	93	20.05	15.59	24.51
Virginia	Metals CCU	0.40	94	20.14	15.68	24.60
Virginia	Metals CCU	0.40	95	20.29	15.83	24.75
Virginia	Metals CCU	0.40	96	20.45	15.98	24.92
Virginia	Metals CCU	0.40	97	20.61	16.14	25.07
Virginia	Metals CCU	0.41	98	20.82	16.34	25.31
Virginia	Metals CCU	0.41	99	20.91	16.42	25.40
Virginia	Metals CCU	0.42	100	21.82	17.17	26.46
Virginia	Metals CCU	0.42	101	22.03	17.37	26.70
Virginia	Metals CCU	0.43	102	22.25	17.57	26.93
Virginia	Metals CCU	0.44	103	22.41	17.73	27.09
Virginia	Metals CCU	0.44	104	23.31	18.49	28.14

Virginia	Metals CCU	0.44	105	23.53	18.69	28.37
Virginia	Metals CCU	0.45	106	23.62	18.78	28.46
Virginia	Metals CCU	0.47	107	23.71	18.87	28.55
Virginia	Metals CCU	0.47	108	23.86	19.02	28.71
Virginia	Metals CCU	0.47	109	24.08	19.22	28.94
Virginia	Metals CCU	0.47	110	24.99	19.99	29.98
Virginia	Metals CCU	0.48	111	25.20	20.20	30.20
Virginia	Metals CCU	0.48	112	25.36	20.35	30.36
Virginia	Metals CCU	0.50	113	25.41	20.41	30.41
Virginia	Metals CCU	0.51	114	26.32	21.21	31.43
Virginia	Metals CCU	0.51	115	26.54	21.41	31.66
Virginia	Metals CCU	0.52	116	26.62	21.50	31.75
Virginia	Metals CCU	0.52	117	26.78	21.66	31.90
Virginia	Metals CCU	0.52	118	26.94	21.81	32.06
Virginia	Metals CCU	0.53	119	27.85	22.65	33.04
Virginia	Metals CCU	0.54	120	27.93	22.75	33.12
Virginia	Metals CCU	0.54	121	28.15	22.96	33.34
Virginia	Metals CCU	0.54	122	28.36	23.16	33.57
Virginia	Metals CCU	0.54	123	28.58	23.36	33.79
Virginia	Metals CCU	0.55	124	29.49	24.21	34.77
Virginia	Metals CCU	0.56	125	29.58	24.30	34.85
Virginia	Metals CCU	0.56	126	29.67	24.39	34.94
Virginia	Metals CCU	0.57	127	29.72	24.45	34.99
Virginia	Metals CCU	0.58	128	30.63	25.25	36.01
Virginia	Metals CCU	0.58	129	30.72	25.35	36.09
Virginia	Metals CCU	0.59	130	31.63	26.17	37.09
Virginia	Metals CCU	0.59	131	31.84	26.38	37.30
Virginia	Metals CCU	0.60	132	31.93	26.48	37.38
Virginia	Metals CCU	0.61	133	32.14	26.70	37.59
Virginia	Metals CCU	0.61	134	32.36	26.90	37.82
Virginia	Metals CCU	0.61	135	32.52	27.07	37.96
Virginia	Metals CCU	0.62	136	32.67	27.22	38.12
Virginia	Metals CCU	0.62	137	32.72	27.27	38.18
Virginia	Metals CCU	0.62	138	32.94	27.48	38.40
Virginia	Metals CCU	0.63	139	33.03	27.58	38.48
Virginia	Metals CCU	0.64	140	33.94	28.39	39.48
Virginia	Metals CCU	0.65	141	34.09	28.54	39.64
Virginia	Metals CCU	0.65	142	34.31	28.75	39.86
Virginia	Metals CCU	0.66	143	34.46	28.90	40.03
Virginia	Metals CCU	0.66	144	35.37	29.76	40.99
Virginia	Metals CCU	0.66	145	35.46	29.84	41.08
Virginia	Metals CCU	0.68	146	35.68	30.07	41.29
Virginia	Metals CCU	0.68	147	35.89	30.27	41.51
Virginia	Metals CCU	0.69	148	36.11	30.47	41.74
Virginia	Metals CCU	0.69	149	36.26	30.64	41.89
Virginia	Metals CCU	0.70	150	36.48	30.83	42.12
Virginia	Metals CCU	0.70	151	36.57	30.92	42.22
Virginia	Metals CCU	0.70	152	36.66	31.00	42.31
Virginia	Metals CCU	0.70	153	36.87	31.21	42.53
Virginia	Metals CCU	0.72	154	37.09	31.43	42.74
Virginia	Metals CCU	0.73	155	37.17	31.52	42.83
Virginia	Metals CCU	0.73	156	37.33	31.68	42.98
Virginia	Metals CCU	0.74	157	37.55	31.89	43.20

Virginia	Metals CCU	0.74	158	37.60	31.94	43.26
Virginia	Metals CCU	0.75	159	37.81	32.15	43.48
Virginia	Metals CCU	0.75	160	38.72	33.14	44.31
Virginia	Metals CCU	0.75	164	40.85	35.15	46.54
Virginia	Metals CCU	0.76	165	40.90	35.20	46.59
Virginia	Metals CCU	0.76	166	40.95	35.26	46.64
Virginia	Metals CCU	0.76	167	41.11	35.41	46.81
Virginia	Metals CCU	0.76	168	41.32	35.61	47.04
Virginia	Metals CCU	0.76	169	41.54	35.81	47.27
Virginia	Metals CCU	0.76	170	41.75	36.02	47.48
Virginia	Metals CCU	0.76	171	42.66	36.92	48.40
Virginia	Metals CCU	0.76	172	42.88	37.16	48.59
Virginia	Metals CCU	0.77	173	43.78	38.05	49.52
Virginia	Metals CCU	0.77	174	43.87	38.14	49.61
Virginia	Metals CCU	0.77	175	43.93	38.19	49.66
Virginia	Metals CCU	0.78	176	44.14	38.42	49.86
Virginia	Metals CCU	0.78	177	44.36	38.63	50.08
Virginia	Metals CCU	0.78	179	45.42	39.60	51.24
Virginia	Metals CCU	0.79	180	45.64	39.81	51.46
Virginia	Metals CCU	0.79	181	45.73	39.90	51.55
Virginia	Metals CCU	0.79	184	46.21	40.37	52.05
Virginia	Metals CCU	0.79	185	46.42	40.58	52.26
Virginia	Metals CCU	0.79	186	46.51	40.66	52.36
Virginia	Metals CCU	0.80	187	47.42	41.56	53.29
Virginia	Metals CCU	0.80	188	48.33	42.46	54.20
Virginia	Metals CCU	0.80	189	49.24	43.37	55.11
Virginia	Metals CCU	0.80	190	49.45	43.59	55.32
Virginia	Metals CCU	0.80	191	50.36	44.47	56.25
Virginia	Metals CCU	0.80	192	50.45	44.56	56.34
Virginia	Metals CCU	0.81	193	50.67	44.76	56.57
Virginia	Metals CCU	0.81	194	50.88	44.97	56.80
Virginia	Metals CCU	0.81	195	51.79	45.89	57.69
Virginia	Metals CCU	0.81	196	52.01	46.13	57.89
Virginia	Metals CCU	0.81	197	52.22	46.35	58.09
Virginia	Metals CCU	0.81	198	52.31	46.45	58.17
Virginia	Metals CCU	0.81	199	53.22	47.36	59.08
Virginia	Metals CCU	0.81	200	53.38	47.52	59.23
Virginia	Metals CCU	0.82	201	53.59	47.75	59.43
Virginia	Metals CCU	0.82	202	53.81	47.97	59.64
Virginia	Metals CCU	0.82	203	53.86	48.02	59.70
Virginia	Metals CCU	0.82	204	53.95	48.11	59.78
Virginia	Metals CCU	0.82	205	54.10	48.27	59.94
Virginia	Metals CCU	0.82	206	54.32	48.48	60.16
Virginia	Metals CCU	0.82	207	54.37	48.53	60.21
Virginia	Metals CCU	0.82	208	55.28	49.40	61.16
Virginia	Metals CCU	0.82	211	55.67	49.79	61.56
Virginia	Metals CCU	0.83	212	55.83	49.94	61.72
Virginia	Metals CCU	0.83	213	55.92	50.03	61.80
Virginia	Metals CCU	0.83	214	56.83	50.95	62.70
Virginia	Metals CCU	0.83	215	56.91	51.04	62.79
Virginia	Metals CCU	0.83	216	57.00	51.13	62.88
Virginia	Metals CCU	0.83	217	57.91	52.10	63.72
Virginia	Metals CCU	0.83	218	58.13	52.32	63.94

Virginia	Metals CCU	0.83	219	58.22	52.41	64.02
Virginia	Metals CCU	0.83	220	58.43	52.63	64.23
Virginia	Metals CCU	0.84	221	59.34	53.52	65.16
Virginia	Metals CCU	0.84	222	59.43	53.61	65.25
Virginia	Metals CCU	0.84	223	59.48	53.66	65.31
Virginia	Metals CCU	0.84	224	59.53	53.71	65.36
Virginia	Metals CCU	0.84	225	59.69	53.86	65.52
Virginia	Metals CCU	0.84	226	59.85	54.01	65.68
Virginia	Metals CCU	0.84	227	60.06	54.23	65.89
Virginia	Metals CCU	0.84	228	60.15	54.32	65.98
Virginia	Metals CCU	0.84	229	60.37	54.53	66.20
Virginia	Metals CCU	0.85	230	61.27	55.47	67.08
Virginia	Metals CCU	0.85	231	61.36	55.57	67.16
Virginia	Metals CCU	0.85	232	62.27	56.49	68.05
Virginia	Metals CCU	0.85	233	62.49	56.73	68.25
Virginia	Metals CCU	0.85	234	63.40	57.66	69.14
Virginia	Metals CCU	0.86	235	64.31	58.69	69.92
Virginia	Metals CCU	0.86	236	65.21	59.64	70.79
Virginia	Metals CCU	0.86	237	65.37	59.78	70.96
Virginia	Metals CCU	0.86	238	65.46	59.87	71.04
Virginia	Metals CCU	0.86	239	65.55	59.96	71.14
Virginia	Metals CCU	0.86	240	65.76	60.18	71.35
Virginia	Metals CCU	0.86	241	65.98	60.40	71.56
Virginia	Metals CCU	0.86	242	66.89	61.38	72.39
Virginia	Metals CCU	0.86	243	67.10	61.60	72.60
Virginia	Metals CCU	0.87	244	67.26	61.77	72.75
Virginia	Metals CCU	0.87	245	67.42	61.93	72.90
Virginia	Metals CCU	0.87	246	67.63	62.14	73.12
Virginia	Metals CCU	0.87	247	68.54	63.14	73.94
Virginia	Metals CCU	0.87	248	68.63	63.23	74.02
Virginia	Metals CCU	0.87	249	68.68	63.28	74.08
Virginia	Metals CCU	0.87	250	68.84	63.45	74.23
Virginia	Metals CCU	0.88	251	69.75	64.45	75.04
Virginia	Metals CCU	0.88	252	69.83	64.54	75.13
Virginia	Metals CCU	0.88	253	70.05	64.77	75.33
Virginia	Metals CCU	0.88	254	70.10	64.82	75.38
Virginia	Metals CCU	0.89	255	70.19	64.91	75.47
Virginia	Metals CCU	0.89	256	70.35	65.06	75.63
Virginia	Metals CCU	0.89	257	70.50	65.23	75.78
Virginia	Metals CCU	0.89	258	70.66	65.38	75.94
Virginia	Metals CCU	0.89	259	70.82	65.54	76.09
Virginia	Metals CCU	0.89	260	71.03	65.76	76.30
Virginia	Metals CCU	0.89	261	71.19	65.89	76.48
Virginia	Metals CCU	0.89	262	71.28	65.97	76.58
Virginia	Metals CCU	0.89	263	71.36	66.06	76.67
Virginia	Metals CCU	0.90	264	71.42	66.11	76.73
Virginia	Metals CCU	0.90	265	72.33	67.13	77.53
Virginia	Metals CCU	0.90	266	73.23	68.11	78.36
Virginia	Metals CCU	0.90	267	73.32	68.19	78.45
Virginia	Metals CCU	0.91	268	73.54	68.42	78.66
Virginia	Metals CCU	0.91	269	73.75	68.64	78.87
Virginia	Metals CCU	0.91	270	73.91	68.80	79.02
Virginia	Metals CCU	0.91	271	74.12	69.01	79.24

Virginia	Metals CCU	0.91	272	74.28	69.18	79.38
Virginia	Metals CCU	0.92	273	75.19	70.13	80.25
Virginia	Metals CCU	0.92	274	75.41	70.36	80.46
Virginia	Metals CCU	0.92	275	76.31	71.41	81.22
Virginia	Metals CCU	0.92	276	76.47	71.58	81.36
Virginia	Metals CCU	0.93	277	76.50	71.60	81.39
Virginia	Metals CCU	0.93	278	76.71	71.79	81.63
Virginia	Metals CCU	0.93	279	76.93	72.03	81.82
Virginia	Metals CCU	0.93	280	76.98	72.08	81.88
Virginia	Metals CCU	0.93	281	77.89	73.14	82.64
Virginia	Metals CCU	0.93	282	77.98	73.23	82.72
Virginia	Metals CCU	0.93	283	78.13	73.39	82.87
Virginia	Metals CCU	0.94	284	78.29	73.56	83.01
Virginia	Metals CCU	0.94	285	78.45	73.72	83.17
Virginia	Metals CCU	0.94	286	79.35	74.79	83.92
Virginia	Metals CCU	0.94	287	79.44	74.88	84.01
Virginia	Metals CCU	0.95	288	79.60	75.04	84.15
Virginia	Metals CCU	0.95	289	79.81	75.27	84.36
Virginia	Metals CCU	0.96	290	79.97	75.44	84.50
Virginia	Metals CCU	0.96	291	80.19	75.67	84.70
Virginia	Metals CCU	0.96	292	80.34	75.83	84.85
Virginia	Metals CCU	0.96	293	80.56	76.06	85.05
Virginia	Metals CCU	0.96	294	80.71	76.22	85.20
Virginia	Metals CCU	0.97	295	80.93	76.39	85.47
Virginia	Metals CCU	0.98	296	81.08	76.54	85.63
Virginia	Metals CCU	0.98	297	81.11	76.57	85.65
Virginia	Metals CCU	0.99	298	81.27	76.71	85.82
Virginia	Metals CCU	0.99	299	81.42	76.88	85.97
Virginia	Metals CCU	0.99	300	82.33	77.93	86.73
Virginia	Metals CCU	0.99	301	83.24	78.99	87.49
Virginia	Metals CCU	0.99	302	83.29	79.04	87.55
Virginia	Metals CCU	1.00	303	83.45	79.20	87.70
Virginia	Metals CCU	1.00	304	83.66	79.41	87.91
Virginia	Metals CCU	1.01	305	83.69	79.44	87.94
Virginia	Metals CCU	1.01	306	83.78	79.53	88.02
Virginia	Metals CCU	1.01	307	83.99	79.77	88.22
Virginia	Metals CCU	1.02	308	84.90	80.86	88.95
Virginia	Metals CCU	1.02	309	84.99	80.95	89.03
Virginia	Metals CCU	1.02	310	85.04	81.00	89.09
Virginia	Metals CCU	1.03	311	85.13	81.09	89.17
Virginia	Metals CCU	1.03	312	85.29	81.25	89.33
Virginia	Metals CCU	1.03	313	85.44	81.41	89.48
Virginia	Metals CCU	1.03	314	85.60	81.55	89.65
Virginia	Metals CCU	1.04	315	85.82	81.76	89.87
Virginia	Metals CCU	1.04	316	85.97	81.93	90.01
Virginia	Metals CCU	1.07	317	86.06	82.02	90.10
Virginia	Metals CCU	1.07	318	86.97	83.10	90.84
Virginia	Metals CCU	1.07	319	87.02	83.15	90.89
Virginia	Metals CCU	1.08	320	87.07	83.21	90.94
Virginia	Metals CCU	1.09	321	87.16	83.30	91.03
Virginia	Metals CCU	1.11	322	87.25	83.38	91.12
Virginia	Metals CCU	1.11	323	87.34	83.47	91.22
Virginia	Metals CCU	1.13	324	87.50	83.63	91.36



Virginia	Metals CCU	1.14	325	87.59	83.72	91.45
Virginia	Metals CCU	1.14	326	87.64	83.77	91.51
Virginia	Metals CCU	1.14	327	87.79	83.93	91.66
Virginia	Metals CCU	1.15	328	87.95	84.09	91.81
Virginia	Metals CCU	1.16	329	88.17	84.32	92.01
Virginia	Metals CCU	1.17	330	89.07	85.44	92.71
Virginia	Metals CCU	1.17	331	89.13	85.49	92.76
Virginia	Metals CCU	1.18	332	89.34	85.73	92.96
Virginia	Metals CCU	1.19	333	89.56	85.96	93.16
Virginia	Metals CCU	1.19	334	89.65	86.05	93.24
Virginia	Metals CCU	1.21	335	90.55	87.13	93.98
Virginia	Metals CCU	1.21	336	90.77	87.35	94.19
Virginia	Metals CCU	1.23	337	90.98	87.52	94.45
Virginia	Metals CCU	1.24	338	91.14	87.68	94.60
Virginia	Metals CCU	1.26	339	91.30	87.84	94.75
Virginia	Metals CCU	1.28	340	91.51	88.08	94.94
Virginia	Metals CCU	1.28	341	91.60	88.17	95.03
Virginia	Metals CCU	1.29	342	91.65	88.22	95.09
Virginia	Metals CCU	1.32	343	91.81	88.38	95.24
Virginia	Metals CCU	1.32	344	92.02	88.61	95.44
Virginia	Metals CCU	1.33	345	92.18	88.78	95.58
Virginia	Metals CCU	1.34	346	92.23	88.83	95.63
Virginia	Metals CCU	1.34	347	92.29	88.89	95.69
Virginia	Metals CCU	1.34	348	93.20	90.03	96.36
Virginia	Metals CCU	1.37	349	93.35	90.15	96.55
Virginia	Metals CCU	1.38	350	93.57	90.38	96.76
Virginia	Metals CCU	1.39	351	93.72	90.52	96.93
Virginia	Metals CCU	1.43	352	93.81	90.61	97.02
Virginia	Metals CCU	1.43	353	94.03	90.84	97.22
Virginia	Metals CCU	1.43	354	94.94	92.11	97.76
Virginia	Metals CCU	1.44	355	95.09	92.28	97.91
Virginia	Metals CCU	1.45	356	96.00	93.35	98.65
Virginia	Metals CCU	1.50	357	96.09	93.44	98.73
Virginia	Metals CCU	1.52	358	96.14	93.49	98.79
Virginia	Metals CCU	1.53	359	97.05	94.84	99.27
Virginia	Metals CCU	1.56	360	97.27	95.08	99.46
Virginia	Metals CCU	1.57	361	97.29	95.09	99.49
Virginia	Metals CCU	1.67	362	97.51	95.34	99.68
Virginia	Metals CCU	1.75	363	98.42	96.89	99.94
Virginia	Metals CCU	1.90	364	98.63	97.15	100.00
Virginia	Metals CCU	1.94	365	98.72	97.24	100.00
Virginia	Metals CCU	2.03	366	98.88	97.42	100.00
Virginia	Metals CCU	2.85	367	99.09	97.68	100.00
Virginia	Metals CCU	2.89	368	100.00	100.00	100.00

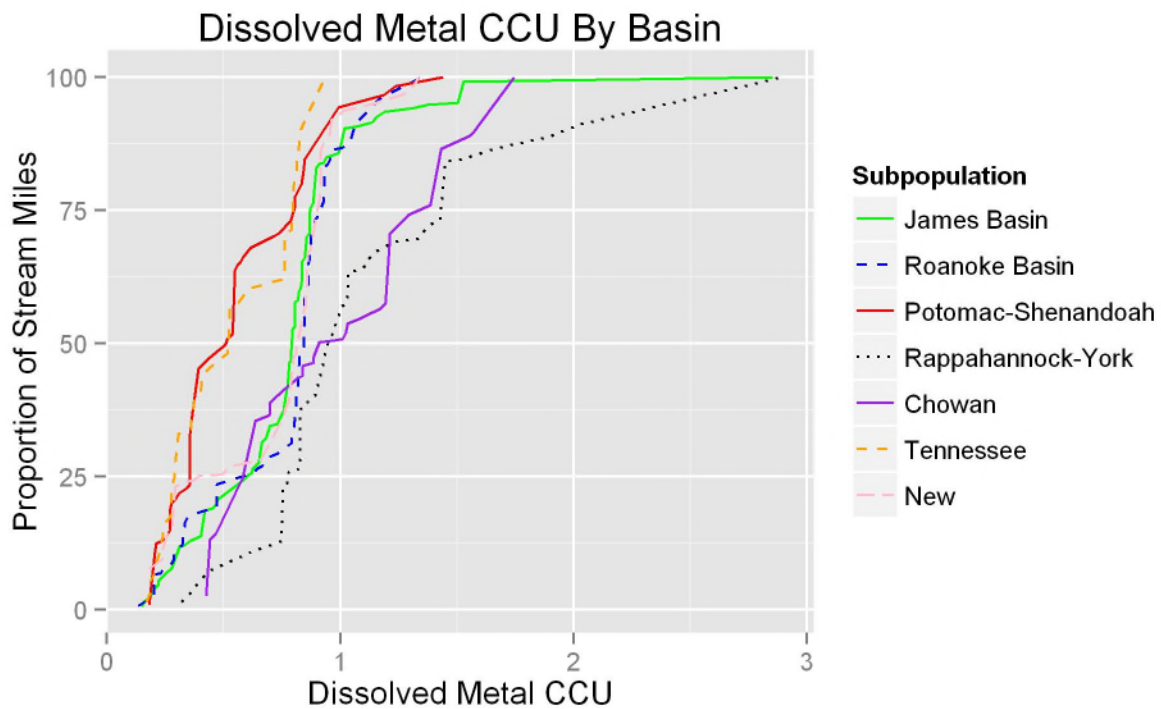


Figure 114. Metal CCU by Major Basin CDF graph.

Figure 114 shows Metal CCU CDF curves by major river basin. The estimates and percentiles are listed in Table 67. All basins except the James and Rappahannock-York have Metals CCU scores less than 2.0. Ninety-nine percent of James Basin stream miles have Metals CCU scores below 1.53. Ninety-one percent of Rappahannock-York Basin stream miles are less than 2.03 Metals CCU.

Table 67. Metal CCU Estimates by Basin.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
James Basin	Metals CCU	0.15	1	0.67	0.00	1.81
James Basin	Metals CCU	0.16	2	1.58	0.00	3.25
James Basin	Metals CCU	0.18	3	2.25	0.16	4.34
James Basin	Metals CCU	0.19	4	3.17	0.69	5.65
James Basin	Metals CCU	0.19	5	3.54	1.08	6.01
James Basin	Metals CCU	0.21	6	4.21	1.85	6.57
James Basin	Metals CCU	0.22	7	4.59	2.10	7.08
James Basin	Metals CCU	0.22	8	5.51	2.54	8.47
James Basin	Metals CCU	0.24	9	6.17	2.96	9.39
James Basin	Metals CCU	0.25	10	6.84	3.45	10.22
James Basin	Metals CCU	0.28	11	7.76	4.19	11.32
James Basin	Metals CCU	0.31	12	11.63	5.15	18.11
James Basin	Metals CCU	0.31	13	11.86	5.35	18.37

James Basin	Metals CCU	0.33	14	12.08	5.65	18.51
James Basin	Metals CCU	0.36	15	13.00	6.37	19.62
James Basin	Metals CCU	0.37	16	13.22	6.57	19.88
James Basin	Metals CCU	0.40	17	13.89	7.15	20.62
James Basin	Metals CCU	0.41	18	14.81	7.84	21.77
James Basin	Metals CCU	0.42	19	18.68	9.85	27.52
James Basin	Metals CCU	0.45	20	19.06	10.23	27.89
James Basin	Metals CCU	0.47	21	19.73	10.87	28.58
James Basin	Metals CCU	0.48	22	20.64	11.72	29.57
James Basin	Metals CCU	0.59	23	24.52	14.40	34.65
James Basin	Metals CCU	0.61	24	25.44	15.19	35.69
James Basin	Metals CCU	0.62	25	25.66	15.40	35.93
James Basin	Metals CCU	0.62	26	26.58	16.23	36.93
James Basin	Metals CCU	0.65	27	27.50	17.07	37.92
James Basin	Metals CCU	0.66	28	31.37	20.31	42.44
James Basin	Metals CCU	0.68	29	32.29	21.14	43.44
James Basin	Metals CCU	0.69	30	33.21	21.97	44.45
James Basin	Metals CCU	0.70	31	34.13	22.81	45.44
James Basin	Metals CCU	0.70	32	34.50	23.13	45.87
James Basin	Metals CCU	0.73	33	34.88	23.50	46.27
James Basin	Metals CCU	0.74	34	35.80	24.30	47.30
James Basin	Metals CCU	0.75	36	37.09	25.52	48.66
James Basin	Metals CCU	0.76	37	37.32	25.77	48.87
James Basin	Metals CCU	0.76	38	37.54	25.99	49.10
James Basin	Metals CCU	0.77	39	41.42	29.62	53.21
James Basin	Metals CCU	0.77	40	41.80	30.00	53.59
James Basin	Metals CCU	0.78	42	46.34	33.74	58.94
James Basin	Metals CCU	0.79	43	46.72	34.11	59.33
James Basin	Metals CCU	0.79	45	47.86	35.29	60.43
James Basin	Metals CCU	0.79	46	48.78	36.21	61.34
James Basin	Metals CCU	0.80	47	52.65	40.19	65.12
James Basin	Metals CCU	0.80	48	53.03	40.57	65.49
James Basin	Metals CCU	0.81	49	53.95	41.44	66.46
James Basin	Metals CCU	0.81	50	57.83	45.65	70.00
James Basin	Metals CCU	0.82	51	58.20	46.08	70.32
James Basin	Metals CCU	0.82	52	58.87	46.79	70.95
James Basin	Metals CCU	0.82	53	59.79	47.62	71.96
James Basin	Metals CCU	0.83	54	60.17	48.01	72.32
James Basin	Metals CCU	0.83	55	61.08	48.88	73.28
James Basin	Metals CCU	0.83	56	61.46	49.27	73.65
James Basin	Metals CCU	0.84	57	65.34	52.92	77.75
James Basin	Metals CCU	0.84	58	65.72	53.29	78.14
James Basin	Metals CCU	0.85	59	66.09	53.70	78.49
James Basin	Metals CCU	0.86	60	69.97	58.70	81.24
James Basin	Metals CCU	0.87	61	70.89	59.59	82.18
James Basin	Metals CCU	0.87	62	74.77	64.54	84.99
James Basin	Metals CCU	0.87	63	75.43	65.29	85.57
James Basin	Metals CCU	0.88	64	76.35	66.37	86.32
James Basin	Metals CCU	0.89	65	77.01	67.07	86.96
James Basin	Metals CCU	0.89	66	77.68	67.80	87.56
James Basin	Metals CCU	0.89	67	78.35	68.44	88.26
James Basin	Metals CCU	0.89	68	79.01	69.12	88.90
James Basin	Metals CCU	0.90	69	82.89	74.07	91.71

James Basin	Metals CCU	0.91	70	83.81	75.02	92.60
James Basin	Metals CCU	0.93	71	83.92	75.09	92.74
James Basin	Metals CCU	0.93	72	84.29	75.51	93.07
James Basin	Metals CCU	0.94	73	84.96	76.23	93.69
James Basin	Metals CCU	0.99	74	85.63	76.96	94.29
James Basin	Metals CCU	0.99	75	85.85	77.16	94.54
James Basin	Metals CCU	1.00	76	86.52	77.90	95.14
James Basin	Metals CCU	1.02	77	90.39	83.93	96.86
James Basin	Metals CCU	1.07	78	90.77	84.30	97.24
James Basin	Metals CCU	1.13	79	91.44	85.05	97.83
James Basin	Metals CCU	1.14	80	91.66	85.17	98.15
James Basin	Metals CCU	1.16	81	92.58	86.26	98.89
James Basin	Metals CCU	1.19	82	93.50	87.35	99.64
James Basin	Metals CCU	1.32	83	94.16	88.11	100.00
James Basin	Metals CCU	1.37	84	94.83	88.50	100.00
James Basin	Metals CCU	1.50	85	95.21	88.90	100.00
James Basin	Metals CCU	1.53	86	99.08	97.57	100.00
James Basin	Metals CCU	2.85	87	100.00	100.00	100.00
Roanoke Basin	Metals CCU	0.13	1	0.71	0.00	1.94
Roanoke Basin	Metals CCU	0.17	2	1.68	0.00	3.36
Roanoke Basin	Metals CCU	0.20	3	2.08	0.25	3.90
Roanoke Basin	Metals CCU	0.20	4	2.48	0.59	4.37
Roanoke Basin	Metals CCU	0.20	5	6.58	0.80	12.37
Roanoke Basin	Metals CCU	0.23	6	6.82	1.03	12.61
Roanoke Basin	Metals CCU	0.24	7	7.53	1.61	13.45
Roanoke Basin	Metals CCU	0.25	8	7.76	1.99	13.54
Roanoke Basin	Metals CCU	0.26	9	8.00	2.23	13.78
Roanoke Basin	Metals CCU	0.28	10	8.97	2.98	14.97
Roanoke Basin	Metals CCU	0.29	11	9.68	3.55	15.81
Roanoke Basin	Metals CCU	0.29	12	10.65	4.37	16.93
Roanoke Basin	Metals CCU	0.31	13	11.05	4.71	17.40
Roanoke Basin	Metals CCU	0.31	14	11.29	5.08	17.50
Roanoke Basin	Metals CCU	0.32	15	12.26	5.83	18.69
Roanoke Basin	Metals CCU	0.33	16	16.37	7.35	25.39
Roanoke Basin	Metals CCU	0.34	17	17.34	8.11	26.56
Roanoke Basin	Metals CCU	0.37	18	18.04	8.79	27.29
Roanoke Basin	Metals CCU	0.40	19	18.44	9.15	27.74
Roanoke Basin	Metals CCU	0.47	20	19.41	9.91	28.92
Roanoke Basin	Metals CCU	0.47	21	23.52	12.75	34.29
Roanoke Basin	Metals CCU	0.54	22	24.49	13.62	35.36
Roanoke Basin	Metals CCU	0.61	23	25.46	14.74	36.19
Roanoke Basin	Metals CCU	0.63	24	25.86	15.10	36.63
Roanoke Basin	Metals CCU	0.65	25	26.57	15.74	37.40
Roanoke Basin	Metals CCU	0.66	26	26.97	16.12	37.82
Roanoke Basin	Metals CCU	0.68	27	27.94	17.15	38.74
Roanoke Basin	Metals CCU	0.69	28	28.65	17.81	39.49
Roanoke Basin	Metals CCU	0.73	29	29.35	18.68	40.02
Roanoke Basin	Metals CCU	0.76	30	30.32	19.50	41.15
Roanoke Basin	Metals CCU	0.79	31	31.30	20.30	42.29
Roanoke Basin	Metals CCU	0.80	32	35.40	23.55	47.26
Roanoke Basin	Metals CCU	0.81	33	36.37	24.40	48.35
Roanoke Basin	Metals CCU	0.81	34	40.48	28.00	52.96
Roanoke Basin	Metals CCU	0.82	35	41.45	28.98	53.93

Roanoke Basin	Metals CCU	0.82	36	41.69	29.18	54.20
Roanoke Basin	Metals CCU	0.82	37	45.80	32.68	58.92
Roanoke Basin	Metals CCU	0.82	40	47.57	34.48	60.66
Roanoke Basin	Metals CCU	0.83	41	47.97	34.88	61.06
Roanoke Basin	Metals CCU	0.84	42	48.37	35.28	61.45
Roanoke Basin	Metals CCU	0.84	43	48.61	35.51	61.71
Roanoke Basin	Metals CCU	0.84	44	49.31	36.19	62.43
Roanoke Basin	Metals CCU	0.84	45	50.28	37.11	63.45
Roanoke Basin	Metals CCU	0.85	46	54.39	41.25	67.53
Roanoke Basin	Metals CCU	0.85	47	58.50	45.38	71.61
Roanoke Basin	Metals CCU	0.86	48	59.20	46.09	72.31
Roanoke Basin	Metals CCU	0.86	49	60.17	47.20	73.14
Roanoke Basin	Metals CCU	0.86	50	64.28	51.84	76.72
Roanoke Basin	Metals CCU	0.86	51	65.25	52.88	77.62
Roanoke Basin	Metals CCU	0.87	52	65.96	53.68	78.24
Roanoke Basin	Metals CCU	0.87	53	66.66	54.38	78.94
Roanoke Basin	Metals CCU	0.87	54	67.06	54.79	79.34
Roanoke Basin	Metals CCU	0.88	55	71.17	59.73	82.60
Roanoke Basin	Metals CCU	0.88	56	71.57	60.14	83.00
Roanoke Basin	Metals CCU	0.89	57	72.54	61.22	83.86
Roanoke Basin	Metals CCU	0.89	58	73.25	61.61	84.89
Roanoke Basin	Metals CCU	0.90	59	73.65	62.02	85.27
Roanoke Basin	Metals CCU	0.91	60	74.62	63.05	86.19
Roanoke Basin	Metals CCU	0.92	61	75.59	64.00	87.18
Roanoke Basin	Metals CCU	0.93	62	76.56	64.60	88.52
Roanoke Basin	Metals CCU	0.93	63	77.53	65.73	89.34
Roanoke Basin	Metals CCU	0.93	64	77.77	65.91	89.63
Roanoke Basin	Metals CCU	0.93	65	81.88	71.35	92.40
Roanoke Basin	Metals CCU	0.93	66	82.58	72.10	93.06
Roanoke Basin	Metals CCU	0.94	67	83.29	72.92	93.66
Roanoke Basin	Metals CCU	0.94	68	83.69	73.33	94.04
Roanoke Basin	Metals CCU	0.96	69	84.66	74.45	94.87
Roanoke Basin	Metals CCU	0.96	70	85.37	75.12	95.61
Roanoke Basin	Metals CCU	0.96	71	86.34	76.16	96.51
Roanoke Basin	Metals CCU	1.01	72	86.74	76.58	96.89
Roanoke Basin	Metals CCU	1.04	73	87.44	77.17	97.71
Roanoke Basin	Metals CCU	1.07	74	91.55	82.57	100.00
Roanoke Basin	Metals CCU	1.08	75	91.79	82.81	100.00
Roanoke Basin	Metals CCU	1.17	76	95.89	89.33	100.00
Roanoke Basin	Metals CCU	1.34	77	100.00	100.00	100.00
Potomac-Shenandoah	Metals CCU	0.18	1	0.95	0.00	2.60
Potomac-Shenandoah	Metals CCU	0.20	2	10.70	0.00	26.66
Potomac-Shenandoah	Metals CCU	0.21	3	12.38	0.00	28.36
Potomac-Shenandoah	Metals CCU	0.25	4	13.33	0.00	29.35
Potomac-Shenandoah	Metals CCU	0.27	5	15.00	0.00	31.17
Potomac-Shenandoah	Metals CCU	0.27	6	17.31	0.85	33.78
Potomac-Shenandoah	Metals CCU	0.27	7	18.99	2.69	35.29
Potomac-Shenandoah	Metals CCU	0.28	8	19.94	3.92	35.96
Potomac-Shenandoah	Metals CCU	0.30	9	20.89	5.15	36.63
Potomac-Shenandoah	Metals CCU	0.31	10	21.84	6.07	37.61
Potomac-Shenandoah	Metals CCU	0.34	11	22.79	7.04	38.54
Potomac-Shenandoah	Metals CCU	0.35	12	23.35	7.55	39.15
Potomac-Shenandoah	Metals CCU	0.36	13	33.10	13.54	52.67

Potomac-Shenandoah	Metals CCU	0.36	14	35.41	15.97	54.85
Potomac-Shenandoah	Metals CCU	0.39	15	45.16	24.47	65.86
Potomac-Shenandoah	Metals CCU	0.44	16	47.47	27.54	67.40
Potomac-Shenandoah	Metals CCU	0.51	17	49.78	29.70	69.85
Potomac-Shenandoah	Metals CCU	0.52	18	50.73	30.55	70.91
Potomac-Shenandoah	Metals CCU	0.54	19	51.68	31.68	71.68
Potomac-Shenandoah	Metals CCU	0.54	20	53.99	34.08	73.89
Potomac-Shenandoah	Metals CCU	0.55	21	63.74	45.54	81.94
Potomac-Shenandoah	Metals CCU	0.56	22	64.69	46.68	82.70
Potomac-Shenandoah	Metals CCU	0.57	23	65.25	47.41	83.09
Potomac-Shenandoah	Metals CCU	0.58	24	66.20	48.66	83.74
Potomac-Shenandoah	Metals CCU	0.61	25	67.88	50.77	84.99
Potomac-Shenandoah	Metals CCU	0.72	26	70.18	53.77	86.60
Potomac-Shenandoah	Metals CCU	0.74	27	70.75	54.34	87.15
Potomac-Shenandoah	Metals CCU	0.79	28	73.06	56.94	89.17
Potomac-Shenandoah	Metals CCU	0.80	29	75.36	59.47	91.26
Potomac-Shenandoah	Metals CCU	0.81	30	77.67	62.29	93.04
Potomac-Shenandoah	Metals CCU	0.83	31	79.98	65.08	94.87
Potomac-Shenandoah	Metals CCU	0.84	32	82.28	67.33	97.23
Potomac-Shenandoah	Metals CCU	0.85	33	84.59	70.07	99.11
Potomac-Shenandoah	Metals CCU	0.99	34	94.34	89.13	99.56
Potomac-Shenandoah	Metals CCU	1.18	35	96.65	92.83	100.00
Potomac-Shenandoah	Metals CCU	1.24	36	98.32	95.39	100.00
Potomac-Shenandoah	Metals CCU	1.44	37	100.00	100.00	100.00
Rappahannock-York	Metals CCU	0.32	1	1.52	0.00	3.90
Rappahannock-York	Metals CCU	0.36	2	3.04	0.00	6.60
Rappahannock-York	Metals CCU	0.39	3	5.13	0.88	9.38
Rappahannock-York	Metals CCU	0.43	4	7.22	1.77	12.68
Rappahannock-York	Metals CCU	0.54	5	9.32	2.70	15.93
Rappahannock-York	Metals CCU	0.62	6	10.84	4.41	17.26
Rappahannock-York	Metals CCU	0.75	7	12.93	5.87	19.99
Rappahannock-York	Metals CCU	0.75	8	21.78	8.75	34.80
Rappahannock-York	Metals CCU	0.76	9	23.30	9.78	36.82
Rappahannock-York	Metals CCU	0.77	10	23.81	10.23	37.38
Rappahannock-York	Metals CCU	0.78	11	25.90	13.09	38.71
Rappahannock-York	Metals CCU	0.82	12	26.41	13.58	39.24
Rappahannock-York	Metals CCU	0.83	13	27.93	15.13	40.73
Rappahannock-York	Metals CCU	0.83	14	28.79	16.23	41.36
Rappahannock-York	Metals CCU	0.83	15	37.64	23.66	51.62
Rappahannock-York	Metals CCU	0.86	16	38.50	24.69	52.31
Rappahannock-York	Metals CCU	0.86	17	39.36	25.51	53.22
Rappahannock-York	Metals CCU	0.89	18	40.22	26.28	54.17
Rappahannock-York	Metals CCU	0.90	19	40.74	26.80	54.67
Rappahannock-York	Metals CCU	0.94	20	49.58	35.91	63.26
Rappahannock-York	Metals CCU	0.97	21	51.67	37.00	66.34
Rappahannock-York	Metals CCU	0.98	22	53.19	38.47	67.92
Rappahannock-York	Metals CCU	0.99	23	54.71	39.89	69.54
Rappahannock-York	Metals CCU	1.00	24	56.81	41.92	71.69
Rappahannock-York	Metals CCU	1.02	25	57.32	42.53	72.11
Rappahannock-York	Metals CCU	1.03	26	58.18	43.44	72.92
Rappahannock-York	Metals CCU	1.03	27	59.70	45.09	74.31
Rappahannock-York	Metals CCU	1.03	28	61.22	46.34	76.10
Rappahannock-York	Metals CCU	1.04	29	63.31	48.47	78.16

Rappahannock-York	Metals CCU	1.07	30	63.82	49.00	78.65
Rappahannock-York	Metals CCU	1.11	31	64.69	49.81	79.56
Rappahannock-York	Metals CCU	1.11	32	65.55	50.55	80.55
Rappahannock-York	Metals CCU	1.14	33	67.07	52.23	81.91
Rappahannock-York	Metals CCU	1.23	34	69.16	53.53	84.79
Rappahannock-York	Metals CCU	1.34	35	69.67	54.03	85.32
Rappahannock-York	Metals CCU	1.34	36	70.18	54.56	85.80
Rappahannock-York	Metals CCU	1.38	37	72.28	56.62	87.93
Rappahannock-York	Metals CCU	1.43	38	73.14	57.49	88.79
Rappahannock-York	Metals CCU	1.43	39	75.23	59.79	90.67
Rappahannock-York	Metals CCU	1.45	40	84.08	70.01	98.14
Rappahannock-York	Metals CCU	1.52	41	84.59	70.50	98.67
Rappahannock-York	Metals CCU	1.67	42	86.68	72.93	100.00
Rappahannock-York	Metals CCU	1.90	43	88.77	75.33	100.00
Rappahannock-York	Metals CCU	1.94	44	89.63	76.17	100.00
Rappahannock-York	Metals CCU	2.03	45	91.15	77.85	100.00
Rappahannock-York	Metals CCU	2.89	46	100.00	100.00	100.00
Chowan	Metals CCU	0.42	1	2.52	0.00	6.97
Chowan	Metals CCU	0.44	2	13.15	0.00	29.92
Chowan	Metals CCU	0.47	3	14.18	0.00	31.11
Chowan	Metals CCU	0.58	4	24.82	5.22	44.42
Chowan	Metals CCU	0.64	5	35.45	12.26	58.63
Chowan	Metals CCU	0.70	6	36.49	13.25	59.72
Chowan	Metals CCU	0.70	7	39.00	15.57	62.43
Chowan	Metals CCU	0.76	8	41.52	17.73	65.31
Chowan	Metals CCU	0.81	9	43.34	19.93	66.76
Chowan	Metals CCU	0.84	10	43.96	20.48	67.43
Chowan	Metals CCU	0.84	11	45.78	22.06	69.51
Chowan	Metals CCU	0.88	12	46.40	22.63	70.17
Chowan	Metals CCU	0.89	13	47.43	23.58	71.29
Chowan	Metals CCU	0.89	14	48.47	24.41	72.54
Chowan	Metals CCU	0.91	15	50.30	26.20	74.39
Chowan	Metals CCU	0.98	16	50.59	26.48	74.71
Chowan	Metals CCU	1.01	17	50.89	26.76	75.01
Chowan	Metals CCU	1.02	18	51.92	27.95	75.89
Chowan	Metals CCU	1.03	19	53.75	29.59	77.91
Chowan	Metals CCU	1.09	20	54.79	30.55	79.03
Chowan	Metals CCU	1.14	21	55.82	31.51	80.14
Chowan	Metals CCU	1.17	22	56.44	32.08	80.79
Chowan	Metals CCU	1.19	23	57.47	33.27	81.68
Chowan	Metals CCU	1.21	24	68.11	46.26	89.95
Chowan	Metals CCU	1.21	25	70.62	48.65	92.59
Chowan	Metals CCU	1.26	26	72.45	50.50	94.40
Chowan	Metals CCU	1.28	27	73.48	51.50	95.47
Chowan	Metals CCU	1.29	28	74.10	51.92	96.28
Chowan	Metals CCU	1.39	29	75.93	53.33	98.52
Chowan	Metals CCU	1.43	30	86.56	69.58	100.00
Chowan	Metals CCU	1.56	31	89.07	72.25	100.00
Chowan	Metals CCU	1.57	32	89.37	72.39	100.00
Chowan	Metals CCU	1.75	33	100.00	100.00	100.00
Tennessee	Metals CCU	0.17	1	1.44	0.00	3.79
Tennessee	Metals CCU	0.19	2	3.43	0.00	7.59
Tennessee	Metals CCU	0.19	3	5.41	0.10	10.73

Tennessee	Metals CCU	0.20	4	6.86	1.23	12.49
Tennessee	Metals CCU	0.21	5	8.30	2.09	14.50
Tennessee	Metals CCU	0.22	6	10.28	3.21	17.36
Tennessee	Metals CCU	0.23	7	12.27	4.66	19.88
Tennessee	Metals CCU	0.23	8	12.76	4.98	20.53
Tennessee	Metals CCU	0.24	9	13.57	5.59	21.56
Tennessee	Metals CCU	0.24	10	15.02	7.01	23.02
Tennessee	Metals CCU	0.25	11	16.46	7.85	25.07
Tennessee	Metals CCU	0.27	12	17.28	8.76	25.79
Tennessee	Metals CCU	0.27	13	18.09	9.52	26.67
Tennessee	Metals CCU	0.27	14	19.54	10.70	28.37
Tennessee	Metals CCU	0.28	15	21.52	11.57	31.48
Tennessee	Metals CCU	0.28	16	22.34	12.13	32.56
Tennessee	Metals CCU	0.28	17	23.78	13.22	34.35
Tennessee	Metals CCU	0.29	18	24.60	13.83	35.37
Tennessee	Metals CCU	0.29	19	26.04	14.61	37.47
Tennessee	Metals CCU	0.29	20	28.03	16.45	39.61
Tennessee	Metals CCU	0.30	21	30.01	17.59	42.44
Tennessee	Metals CCU	0.30	22	30.83	18.37	43.30
Tennessee	Metals CCU	0.30	23	32.28	19.06	45.49
Tennessee	Metals CCU	0.31	24	33.09	19.61	46.57
Tennessee	Metals CCU	0.36	25	33.91	20.32	47.51
Tennessee	Metals CCU	0.36	26	35.35	21.32	49.39
Tennessee	Metals CCU	0.37	27	37.34	22.59	52.09
Tennessee	Metals CCU	0.37	28	39.33	24.03	54.62
Tennessee	Metals CCU	0.40	29	40.14	24.62	55.67
Tennessee	Metals CCU	0.40	30	41.59	25.83	57.34
Tennessee	Metals CCU	0.40	31	43.03	26.91	59.15
Tennessee	Metals CCU	0.41	32	43.85	27.48	60.21
Tennessee	Metals CCU	0.44	33	45.29	28.61	61.97
Tennessee	Metals CCU	0.48	34	46.73	29.60	63.87
Tennessee	Metals CCU	0.52	35	48.17	30.74	65.61
Tennessee	Metals CCU	0.53	36	56.57	37.93	75.21
Tennessee	Metals CCU	0.56	37	57.39	38.61	76.16
Tennessee	Metals CCU	0.59	38	59.37	40.46	78.29
Tennessee	Metals CCU	0.60	39	60.19	41.22	79.16
Tennessee	Metals CCU	0.76	40	62.18	42.88	81.47
Tennessee	Metals CCU	0.76	41	70.57	51.53	89.61
Tennessee	Metals CCU	0.79	42	71.39	51.99	90.78
Tennessee	Metals CCU	0.80	43	79.78	61.77	97.80
Tennessee	Metals CCU	0.81	44	81.77	63.81	99.73
Tennessee	Metals CCU	0.83	45	90.16	76.86	100.00
Tennessee	Metals CCU	0.92	46	98.56	96.17	100.00
Tennessee	Metals CCU	0.95	47	100.00	100.00	100.00
New	Metals CCU	0.18	1	7.71	0.00	20.30
New	Metals CCU	0.24	2	9.53	0.00	22.34
New	Metals CCU	0.24	3	11.36	0.00	24.20
New	Metals CCU	0.25	4	13.18	0.00	26.47
New	Metals CCU	0.26	5	13.93	0.72	27.15
New	Metals CCU	0.27	6	14.68	1.48	27.88
New	Metals CCU	0.28	7	15.43	2.31	28.56
New	Metals CCU	0.29	8	23.14	6.37	39.91
New	Metals CCU	0.33	9	23.90	7.23	40.56



New	Metals CCU	0.37	10	24.34	7.65	41.03
New	Metals CCU	0.39	11	25.09	8.35	41.84
New	Metals CCU	0.50	12	25.54	8.78	42.30
New	Metals CCU	0.52	13	26.86	10.14	43.59
New	Metals CCU	0.66	14	28.19	11.34	45.03
New	Metals CCU	0.75	15	35.90	18.13	53.66
New	Metals CCU	0.76	16	37.72	20.69	54.75
New	Metals CCU	0.78	17	39.54	22.46	56.63
New	Metals CCU	0.80	18	47.25	30.15	64.36
New	Metals CCU	0.81	19	48.00	31.23	64.77
New	Metals CCU	0.82	20	49.83	33.42	66.24
New	Metals CCU	0.85	21	57.54	41.13	73.95
New	Metals CCU	0.86	22	65.25	49.73	80.76
New	Metals CCU	0.86	23	67.07	51.90	82.24
New	Metals CCU	0.87	24	67.52	52.25	82.78
New	Metals CCU	0.90	25	75.22	61.85	88.60
New	Metals CCU	0.91	26	77.05	63.89	90.21
New	Metals CCU	0.91	27	78.37	65.55	91.20
New	Metals CCU	0.92	28	86.08	76.87	95.30
New	Metals CCU	0.92	29	87.41	78.81	96.01
New	Metals CCU	0.95	30	89.23	81.28	97.18
New	Metals CCU	0.96	31	90.56	83.28	97.83
New	Metals CCU	0.96	32	91.88	85.16	98.60
New	Metals CCU	1.01	33	93.70	88.13	99.28
New	Metals CCU	1.15	34	95.03	89.84	100.00
New	Metals CCU	1.28	35	96.85	92.87	100.00
New	Metals CCU	1.32	36	98.68	96.39	100.00
New	Metals CCU	1.33	37	100.00	100.00	100.00

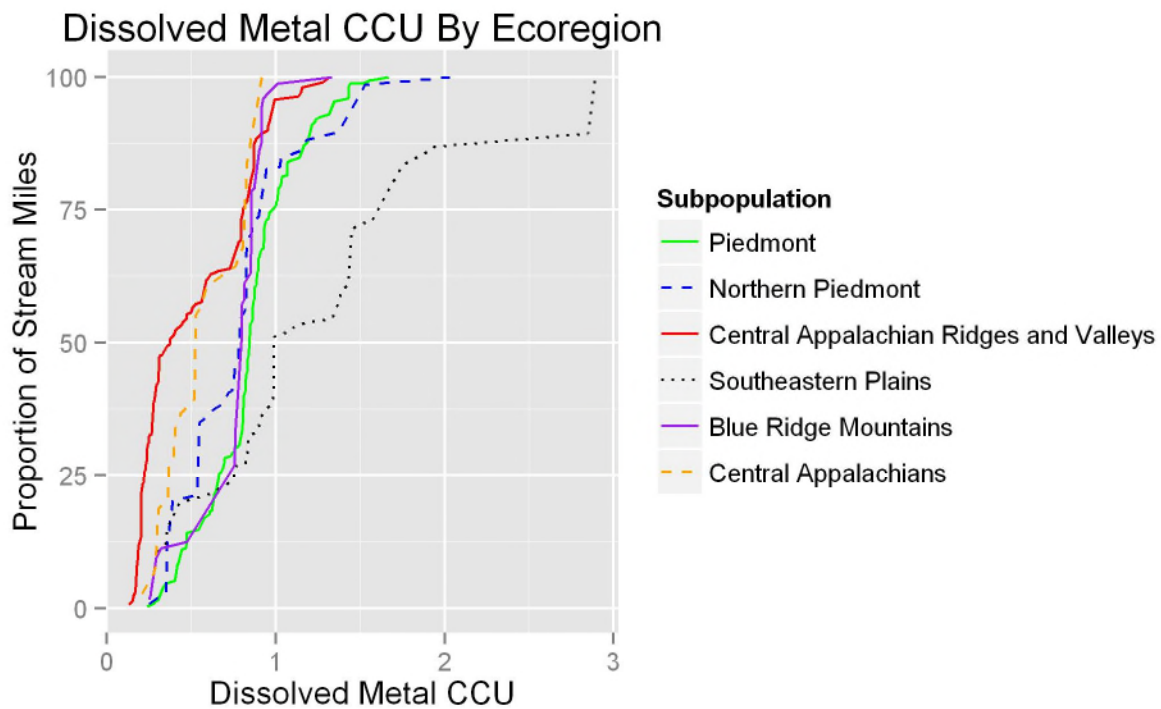


Figure 115. Metal CCU by Major Ecoregion (Level III) CDF graph.

Figure 115 shows Metal CCU CDF curves by Level III ecoregion. Table 68 corresponds to Figure 115. All ecoregions except Northern Piedmont and Southeastern Plains are estimated to have Metal CCU scores less than 2.0. The 98.5<sup>th</sup> percentile of Northern Piedmont stream miles is 1.53. The Southeastern Plains ecoregion 87<sup>th</sup> percentile is 1.94.

Table 68. Metal CCU Population Estimates by Major Ecoregion.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
Piedmont	Metals CCU	0.24	1	0.41	0.00	1.11
Piedmont	Metals CCU	0.28	2	0.97	0.00	2.16
Piedmont	Metals CCU	0.29	3	1.38	0.02	2.74
Piedmont	Metals CCU	0.31	4	1.61	0.19	3.03
Piedmont	Metals CCU	0.33	5	3.98	0.00	8.22
Piedmont	Metals CCU	0.34	6	4.55	0.19	8.90
Piedmont	Metals CCU	0.37	7	4.95	0.63	9.28
Piedmont	Metals CCU	0.40	8	5.19	0.85	9.52
Piedmont	Metals CCU	0.41	9	5.75	1.30	10.20
Piedmont	Metals CCU	0.42	10	8.12	2.44	13.80
Piedmont	Metals CCU	0.42	11	8.68	2.91	14.46
Piedmont	Metals CCU	0.44	12	11.06	4.40	17.72
Piedmont	Metals CCU	0.47	13	11.29	4.62	17.97
Piedmont	Metals CCU	0.47	14	11.85	5.10	18.60
Piedmont	Metals CCU	0.47	15	14.23	6.72	21.74

Piedmont	Metals CCU	0.54	16	14.79	7.24	22.34
Piedmont	Metals CCU	0.58	17	17.16	9.03	25.30
Piedmont	Metals CCU	0.61	18	17.73	9.66	25.79
Piedmont	Metals CCU	0.61	19	18.29	10.16	26.42
Piedmont	Metals CCU	0.62	20	18.43	10.29	26.56
Piedmont	Metals CCU	0.62	21	18.99	10.84	27.14
Piedmont	Metals CCU	0.63	22	19.22	11.12	27.31
Piedmont	Metals CCU	0.64	23	21.59	12.89	30.29
Piedmont	Metals CCU	0.65	24	22.00	13.28	30.72
Piedmont	Metals CCU	0.65	25	22.56	13.84	31.29
Piedmont	Metals CCU	0.66	26	24.94	15.86	34.02
Piedmont	Metals CCU	0.66	27	25.17	16.09	34.25
Piedmont	Metals CCU	0.68	28	25.73	16.70	34.76
Piedmont	Metals CCU	0.69	29	26.29	17.23	35.36
Piedmont	Metals CCU	0.69	30	26.70	17.68	35.72
Piedmont	Metals CCU	0.70	31	27.26	18.19	36.34
Piedmont	Metals CCU	0.70	32	27.49	18.40	36.59
Piedmont	Metals CCU	0.70	33	27.73	18.62	36.83
Piedmont	Metals CCU	0.70	34	28.29	19.15	37.43
Piedmont	Metals CCU	0.73	35	28.70	19.62	37.77
Piedmont	Metals CCU	0.74	36	29.26	20.15	38.37
Piedmont	Metals CCU	0.76	37	29.39	20.29	38.50
Piedmont	Metals CCU	0.76	38	29.53	20.42	38.64
Piedmont	Metals CCU	0.76	39	30.09	20.94	39.25
Piedmont	Metals CCU	0.77	40	30.33	21.17	39.48
Piedmont	Metals CCU	0.79	41	30.89	21.69	40.09
Piedmont	Metals CCU	0.79	43	31.59	22.34	40.83
Piedmont	Metals CCU	0.80	44	33.96	24.42	43.51
Piedmont	Metals CCU	0.80	45	34.19	24.64	43.74
Piedmont	Metals CCU	0.81	46	34.75	25.15	44.36
Piedmont	Metals CCU	0.81	47	35.32	25.67	44.96
Piedmont	Metals CCU	0.81	48	37.69	27.94	47.44
Piedmont	Metals CCU	0.81	49	40.07	30.17	49.96
Piedmont	Metals CCU	0.81	50	40.47	30.63	50.32
Piedmont	Metals CCU	0.82	51	40.61	30.75	50.47
Piedmont	Metals CCU	0.82	52	40.84	31.01	50.67
Piedmont	Metals CCU	0.82	53	43.22	33.12	53.31
Piedmont	Metals CCU	0.82	56	44.24	34.18	54.31
Piedmont	Metals CCU	0.83	57	44.47	34.41	54.54
Piedmont	Metals CCU	0.83	58	44.71	34.66	54.75
Piedmont	Metals CCU	0.84	59	47.08	36.86	57.30
Piedmont	Metals CCU	0.84	60	47.31	37.09	57.53
Piedmont	Metals CCU	0.84	61	47.45	37.23	57.67
Piedmont	Metals CCU	0.84	62	47.59	37.36	57.81
Piedmont	Metals CCU	0.84	63	47.99	37.77	58.21
Piedmont	Metals CCU	0.84	64	48.23	38.00	58.45
Piedmont	Metals CCU	0.84	65	48.79	38.56	59.01
Piedmont	Metals CCU	0.85	66	51.16	40.99	61.34
Piedmont	Metals CCU	0.85	67	53.54	43.38	63.69
Piedmont	Metals CCU	0.86	68	54.10	44.03	64.17
Piedmont	Metals CCU	0.86	69	56.47	46.54	66.41
Piedmont	Metals CCU	0.86	70	57.04	47.14	66.93
Piedmont	Metals CCU	0.87	71	57.44	47.61	67.28

Piedmont	Metals CCU	0.87	72	57.85	48.03	67.68
Piedmont	Metals CCU	0.87	73	58.08	48.27	67.90
Piedmont	Metals CCU	0.88	74	60.46	50.91	70.01
Piedmont	Metals CCU	0.88	75	60.69	51.15	70.23
Piedmont	Metals CCU	0.88	76	60.83	51.29	70.36
Piedmont	Metals CCU	0.89	77	61.06	51.52	70.60
Piedmont	Metals CCU	0.89	78	61.47	51.94	70.99
Piedmont	Metals CCU	0.89	79	61.88	52.34	71.41
Piedmont	Metals CCU	0.89	80	62.28	52.78	71.79
Piedmont	Metals CCU	0.89	81	62.85	53.39	72.30
Piedmont	Metals CCU	0.89	82	63.25	53.69	72.81
Piedmont	Metals CCU	0.89	83	63.48	53.91	73.06
Piedmont	Metals CCU	0.90	84	65.86	56.57	75.15
Piedmont	Metals CCU	0.90	85	66.09	56.81	75.37
Piedmont	Metals CCU	0.91	86	66.65	57.43	75.88
Piedmont	Metals CCU	0.91	87	67.06	57.86	76.27
Piedmont	Metals CCU	0.92	88	67.62	58.45	76.79
Piedmont	Metals CCU	0.93	89	67.69	58.51	76.87
Piedmont	Metals CCU	0.93	90	68.25	59.00	77.50
Piedmont	Metals CCU	0.93	91	68.81	59.65	77.98
Piedmont	Metals CCU	0.93	92	68.95	59.77	78.13
Piedmont	Metals CCU	0.93	93	71.32	62.62	80.03
Piedmont	Metals CCU	0.93	94	71.56	62.88	80.23
Piedmont	Metals CCU	0.93	95	71.96	63.32	80.61
Piedmont	Metals CCU	0.94	96	72.37	63.79	80.95
Piedmont	Metals CCU	0.94	97	72.78	64.22	81.34
Piedmont	Metals CCU	0.94	98	73.01	64.46	81.56
Piedmont	Metals CCU	0.96	99	73.57	65.11	82.03
Piedmont	Metals CCU	0.96	100	73.98	65.53	82.43
Piedmont	Metals CCU	0.96	101	74.54	66.14	82.95
Piedmont	Metals CCU	0.98	102	74.95	66.54	83.37
Piedmont	Metals CCU	0.99	103	75.36	66.97	83.75
Piedmont	Metals CCU	0.99	104	75.50	67.12	83.87
Piedmont	Metals CCU	1.00	105	75.90	67.55	84.26
Piedmont	Metals CCU	1.00	106	76.47	68.10	84.83
Piedmont	Metals CCU	1.01	107	76.70	68.35	85.04
Piedmont	Metals CCU	1.02	108	79.07	71.24	86.91
Piedmont	Metals CCU	1.02	109	79.30	71.49	87.12
Piedmont	Metals CCU	1.03	110	79.54	71.74	87.33
Piedmont	Metals CCU	1.03	111	79.94	72.15	87.73
Piedmont	Metals CCU	1.03	112	80.35	72.53	88.17
Piedmont	Metals CCU	1.04	113	80.91	73.10	88.73
Piedmont	Metals CCU	1.04	114	81.32	73.55	89.10
Piedmont	Metals CCU	1.07	115	81.55	73.78	89.33
Piedmont	Metals CCU	1.07	116	83.93	76.73	91.13
Piedmont	Metals CCU	1.08	117	84.07	76.88	91.25
Piedmont	Metals CCU	1.09	118	84.30	77.11	91.48
Piedmont	Metals CCU	1.11	119	84.53	77.34	91.72
Piedmont	Metals CCU	1.14	120	84.76	77.57	91.95
Piedmont	Metals CCU	1.14	121	84.90	77.72	92.07
Piedmont	Metals CCU	1.17	122	87.27	80.88	93.66
Piedmont	Metals CCU	1.19	123	87.83	81.51	94.16
Piedmont	Metals CCU	1.19	124	88.07	81.76	94.37

Piedmont	Metals CCU	1.21	125	90.44	84.83	96.05
Piedmont	Metals CCU	1.21	126	91.00	85.43	96.58
Piedmont	Metals CCU	1.23	127	91.56	86.02	97.10
Piedmont	Metals CCU	1.24	128	91.97	86.45	97.49
Piedmont	Metals CCU	1.26	129	92.38	86.90	97.86
Piedmont	Metals CCU	1.28	130	92.61	87.14	98.08
Piedmont	Metals CCU	1.32	131	93.02	87.59	98.44
Piedmont	Metals CCU	1.34	132	95.39	91.11	99.68
Piedmont	Metals CCU	1.43	133	95.96	91.74	100.00
Piedmont	Metals CCU	1.43	134	98.33	96.90	99.76
Piedmont	Metals CCU	1.44	135	98.74	97.49	99.99
Piedmont	Metals CCU	1.52	136	98.88	97.60	100.00
Piedmont	Metals CCU	1.56	137	99.44	98.53	100.00
Piedmont	Metals CCU	1.67	138	100.00	100.00	100.00
Northern Piedmont	Metals CCU	0.25	1	0.85	0.00	2.31
Northern Piedmont	Metals CCU	0.32	2	2.36	0.00	5.46
Northern Piedmont	Metals CCU	0.35	3	2.87	0.00	6.04
Northern Piedmont	Metals CCU	0.36	4	11.64	0.00	23.42
Northern Piedmont	Metals CCU	0.39	5	20.40	3.63	37.18
Northern Piedmont	Metals CCU	0.52	6	21.26	4.52	38.00
Northern Piedmont	Metals CCU	0.54	7	22.11	5.65	38.58
Northern Piedmont	Metals CCU	0.54	8	24.19	7.75	40.62
Northern Piedmont	Metals CCU	0.54	9	26.26	9.54	42.98
Northern Piedmont	Metals CCU	0.55	10	35.03	17.52	52.54
Northern Piedmont	Metals CCU	0.57	11	35.54	18.25	52.82
Northern Piedmont	Metals CCU	0.58	12	36.39	19.49	53.29
Northern Piedmont	Metals CCU	0.68	13	38.46	21.43	55.50
Northern Piedmont	Metals CCU	0.72	14	40.54	23.81	57.27
Northern Piedmont	Metals CCU	0.74	15	41.05	24.51	57.58
Northern Piedmont	Metals CCU	0.75	17	43.97	27.44	60.51
Northern Piedmont	Metals CCU	0.76	18	45.48	28.68	62.28
Northern Piedmont	Metals CCU	0.77	19	45.99	29.06	62.92
Northern Piedmont	Metals CCU	0.78	20	48.06	31.00	65.12
Northern Piedmont	Metals CCU	0.78	21	49.57	32.40	66.74
Northern Piedmont	Metals CCU	0.79	22	50.42	33.22	67.62
Northern Piedmont	Metals CCU	0.79	23	52.50	35.25	69.74
Northern Piedmont	Metals CCU	0.79	24	54.57	37.39	71.76
Northern Piedmont	Metals CCU	0.82	25	56.08	39.01	73.14
Northern Piedmont	Metals CCU	0.83	26	57.58	40.54	74.63
Northern Piedmont	Metals CCU	0.83	27	58.44	41.45	75.42
Northern Piedmont	Metals CCU	0.83	28	67.21	51.02	83.39
Northern Piedmont	Metals CCU	0.83	29	69.28	53.39	85.17
Northern Piedmont	Metals CCU	0.85	30	70.14	54.39	85.88
Northern Piedmont	Metals CCU	0.86	31	70.99	55.27	86.71
Northern Piedmont	Metals CCU	0.86	32	71.84	55.84	87.85
Northern Piedmont	Metals CCU	0.89	33	73.35	57.48	89.22
Northern Piedmont	Metals CCU	0.90	34	73.86	57.94	89.77
Northern Piedmont	Metals CCU	0.94	35	82.63	70.78	94.47
Northern Piedmont	Metals CCU	1.02	36	83.13	71.31	94.95
Northern Piedmont	Metals CCU	1.03	37	84.64	72.87	96.40
Northern Piedmont	Metals CCU	1.14	38	86.15	74.42	97.87
Northern Piedmont	Metals CCU	1.18	39	88.22	77.10	99.34
Northern Piedmont	Metals CCU	1.37	40	89.73	77.77	100.00

Northern Piedmont	Metals CCU	1.53	41	98.49	95.96	100.00
Northern Piedmont	Metals CCU	2.03	42	100.00	100.00	100.00
Central Appalachian Ridges and Valleys	Metals CCU	0.13	1	0.70	0.00	1.92
Central Appalachian Ridges and Valleys	Metals CCU	0.15	2	1.39	0.00	3.11
Central Appalachian Ridges and Valleys	Metals CCU	0.16	3	2.35	0.01	4.70
Central Appalachian Ridges and Valleys	Metals CCU	0.17	4	3.05	0.44	5.66
Central Appalachian Ridges and Valleys	Metals CCU	0.17	5	4.01	0.95	7.07
Central Appalachian Ridges and Valleys	Metals CCU	0.18	6	8.07	1.06	15.08
Central Appalachian Ridges and Valleys	Metals CCU	0.18	7	8.46	1.41	15.52
Central Appalachian Ridges and Valleys	Metals CCU	0.18	8	9.16	2.00	16.33
Central Appalachian Ridges and Valleys	Metals CCU	0.19	9	10.12	2.79	17.45
Central Appalachian Ridges and Valleys	Metals CCU	0.19	10	11.08	3.61	18.56
Central Appalachian Ridges and Valleys	Metals CCU	0.19	11	12.04	4.48	19.61
Central Appalachian Ridges and Valleys	Metals CCU	0.19	12	12.44	4.87	20.00
Central Appalachian Ridges and Valleys	Metals CCU	0.20	13	12.83	5.28	20.39
Central Appalachian Ridges and Valleys	Metals CCU	0.20	14	13.23	5.67	20.79
Central Appalachian Ridges and Valleys	Metals CCU	0.20	15	17.29	7.65	26.93
Central Appalachian Ridges and Valleys	Metals CCU	0.20	16	17.98	8.33	27.63
Central Appalachian Ridges and Valleys	Metals CCU	0.20	17	22.04	11.36	32.72
Central Appalachian Ridges and Valleys	Metals CCU	0.21	18	22.74	12.11	33.37
Central Appalachian Ridges and Valleys	Metals CCU	0.21	19	23.44	12.82	34.05
Central Appalachian Ridges and Valleys	Metals CCU	0.22	20	23.83	13.19	34.47
Central Appalachian Ridges and Valleys	Metals CCU	0.22	21	24.79	14.08	35.50
Central Appalachian Ridges and Valleys	Metals CCU	0.22	22	25.75	14.92	36.58
Central Appalachian Ridges and Valleys	Metals CCU	0.23	23	25.99	15.17	36.80
Central Appalachian Ridges and Valleys	Metals CCU	0.23	24	26.95	16.14	37.75
Central Appalachian Ridges and Valleys	Metals CCU	0.23	25	27.18	16.37	37.99
Central Appalachian Ridges and Valleys	Metals CCU	0.24	26	28.14	17.46	38.82
Central Appalachian Ridges and Valleys	Metals CCU	0.24	27	28.54	17.85	39.22
Central Appalachian Ridges and Valleys	Metals CCU	0.24	28	29.23	18.50	39.97
Central Appalachian Ridges and Valleys	Metals CCU	0.24	29	30.19	19.51	40.87
Central Appalachian Ridges and Valleys	Metals CCU	0.24	30	30.89	20.24	41.54
Central Appalachian Ridges and Valleys	Metals CCU	0.25	31	31.12	20.49	41.75
Central Appalachian Ridges and Valleys	Metals CCU	0.25	32	31.82	21.15	42.49
Central Appalachian Ridges and Valleys	Metals CCU	0.25	33	32.52	21.79	43.25
Central Appalachian Ridges and Valleys	Metals CCU	0.26	34	32.75	22.04	43.47
Central Appalachian Ridges and Valleys	Metals CCU	0.27	35	33.15	22.43	43.87
Central Appalachian Ridges and Valleys	Metals CCU	0.27	36	33.54	22.86	44.23
Central Appalachian Ridges and Valleys	Metals CCU	0.27	37	34.24	23.50	44.98
Central Appalachian Ridges and Valleys	Metals CCU	0.27	38	35.20	24.33	46.07
Central Appalachian Ridges and Valleys	Metals CCU	0.27	39	35.90	25.07	46.73
Central Appalachian Ridges and Valleys	Metals CCU	0.27	40	36.29	25.47	47.12
Central Appalachian Ridges and Valleys	Metals CCU	0.27	41	36.99	26.19	47.79
Central Appalachian Ridges and Valleys	Metals CCU	0.28	42	37.95	27.11	48.79
Central Appalachian Ridges and Valleys	Metals CCU	0.28	43	38.35	27.55	49.14
Central Appalachian Ridges and Valleys	Metals CCU	0.28	44	38.74	27.95	49.53
Central Appalachian Ridges and Valleys	Metals CCU	0.28	45	39.14	28.34	49.94
Central Appalachian Ridges and Valleys	Metals CCU	0.28	46	39.84	29.04	50.63
Central Appalachian Ridges and Valleys	Metals CCU	0.29	47	40.80	30.04	51.55
Central Appalachian Ridges and Valleys	Metals CCU	0.29	48	41.76	31.05	52.46
Central Appalachian Ridges and Valleys	Metals CCU	0.30	49	42.15	31.49	52.82
Central Appalachian Ridges and Valleys	Metals CCU	0.30	50	42.55	31.90	53.19
Central Appalachian Ridges and Valleys	Metals CCU	0.31	51	46.60	35.83	57.38

Central Appalachian Ridges and Valleys	Metals CCU	0.31	52	46.84	36.02	57.66
Central Appalachian Ridges and Valleys	Metals CCU	0.31	53	47.07	36.27	57.87
Central Appalachian Ridges and Valleys	Metals CCU	0.31	54	47.47	36.65	58.28
Central Appalachian Ridges and Valleys	Metals CCU	0.33	55	47.70	36.94	58.46
Central Appalachian Ridges and Valleys	Metals CCU	0.33	56	48.10	37.36	58.84
Central Appalachian Ridges and Valleys	Metals CCU	0.34	57	48.49	37.75	59.24
Central Appalachian Ridges and Valleys	Metals CCU	0.36	58	49.45	38.72	60.19
Central Appalachian Ridges and Valleys	Metals CCU	0.37	59	49.69	38.93	60.45
Central Appalachian Ridges and Valleys	Metals CCU	0.37	60	49.92	39.11	60.74
Central Appalachian Ridges and Valleys	Metals CCU	0.37	61	50.88	40.07	61.69
Central Appalachian Ridges and Valleys	Metals CCU	0.39	62	51.28	40.46	62.10
Central Appalachian Ridges and Valleys	Metals CCU	0.40	63	51.98	41.09	62.86
Central Appalachian Ridges and Valleys	Metals CCU	0.41	64	52.37	41.51	63.23
Central Appalachian Ridges and Valleys	Metals CCU	0.44	65	53.33	42.54	64.12
Central Appalachian Ridges and Valleys	Metals CCU	0.45	66	53.73	42.89	64.56
Central Appalachian Ridges and Valleys	Metals CCU	0.47	67	54.42	43.57	65.28
Central Appalachian Ridges and Valleys	Metals CCU	0.48	68	55.38	44.42	66.35
Central Appalachian Ridges and Valleys	Metals CCU	0.50	69	55.62	44.69	66.54
Central Appalachian Ridges and Valleys	Metals CCU	0.51	70	56.58	45.47	67.69
Central Appalachian Ridges and Valleys	Metals CCU	0.52	71	57.28	46.15	68.40
Central Appalachian Ridges and Valleys	Metals CCU	0.56	72	57.67	46.55	68.79
Central Appalachian Ridges and Valleys	Metals CCU	0.59	73	61.73	50.63	72.82
Central Appalachian Ridges and Valleys	Metals CCU	0.60	74	62.12	51.06	73.19
Central Appalachian Ridges and Valleys	Metals CCU	0.61	75	62.82	51.81	73.83
Central Appalachian Ridges and Valleys	Metals CCU	0.66	76	63.52	52.45	74.59
Central Appalachian Ridges and Valleys	Metals CCU	0.73	77	63.91	52.81	75.02
Central Appalachian Ridges and Valleys	Metals CCU	0.77	78	67.97	57.27	78.67
Central Appalachian Ridges and Valleys	Metals CCU	0.78	79	68.93	58.22	79.64
Central Appalachian Ridges and Valleys	Metals CCU	0.79	80	69.33	58.63	80.03
Central Appalachian Ridges and Valleys	Metals CCU	0.80	81	73.39	63.32	83.45
Central Appalachian Ridges and Valleys	Metals CCU	0.80	82	74.35	64.33	84.37
Central Appalachian Ridges and Valleys	Metals CCU	0.81	83	75.31	65.45	85.16
Central Appalachian Ridges and Valleys	Metals CCU	0.82	84	76.27	66.26	86.27
Central Appalachian Ridges and Valleys	Metals CCU	0.83	85	76.66	66.66	86.66
Central Appalachian Ridges and Valleys	Metals CCU	0.85	86	80.72	71.40	90.03
Central Appalachian Ridges and Valleys	Metals CCU	0.86	87	81.68	72.44	90.92
Central Appalachian Ridges and Valleys	Metals CCU	0.87	88	82.64	73.35	91.93
Central Appalachian Ridges and Valleys	Metals CCU	0.87	89	86.70	79.47	93.92
Central Appalachian Ridges and Valleys	Metals CCU	0.87	90	87.39	80.29	94.50
Central Appalachian Ridges and Valleys	Metals CCU	0.88	91	88.35	81.49	95.22
Central Appalachian Ridges and Valleys	Metals CCU	0.91	92	89.31	82.44	96.19
Central Appalachian Ridges and Valleys	Metals CCU	0.95	93	90.01	83.23	96.79
Central Appalachian Ridges and Valleys	Metals CCU	0.95	94	90.97	84.31	97.63
Central Appalachian Ridges and Valleys	Metals CCU	0.96	95	91.67	85.10	98.23
Central Appalachian Ridges and Valleys	Metals CCU	0.99	96	95.73	92.54	98.91
Central Appalachian Ridges and Valleys	Metals CCU	1.13	97	96.42	93.46	99.39
Central Appalachian Ridges and Valleys	Metals CCU	1.15	98	97.12	94.34	99.90
Central Appalachian Ridges and Valleys	Metals CCU	1.16	99	98.08	95.82	100.00
Central Appalachian Ridges and Valleys	Metals CCU	1.28	100	99.04	97.54	100.00
Central Appalachian Ridges and Valleys	Metals CCU	1.32	101	100.00	100.00	100.00
Southeastern Plains	Metals CCU	0.30	1	10.59	0.00	24.99
Southeastern Plains	Metals CCU	0.36	2	12.41	0.00	26.78
Southeastern Plains	Metals CCU	0.36	3	14.91	0.16	29.67

Southeastern Plains	Metals CCU	0.39	4	17.42	4.46	30.38
Southeastern Plains	Metals CCU	0.43	5	19.92	6.44	33.41
Southeastern Plains	Metals CCU	0.62	6	21.74	8.09	35.40
Southeastern Plains	Metals CCU	0.75	7	24.25	10.26	38.24
Southeastern Plains	Metals CCU	0.76	8	26.75	12.16	41.35
Southeastern Plains	Metals CCU	0.82	9	27.37	12.72	42.01
Southeastern Plains	Metals CCU	0.83	10	29.87	15.25	44.50
Southeastern Plains	Metals CCU	0.84	11	32.38	16.73	48.02
Southeastern Plains	Metals CCU	0.89	12	33.41	17.50	49.32
Southeastern Plains	Metals CCU	0.91	13	35.91	19.76	52.07
Southeastern Plains	Metals CCU	0.97	14	38.42	20.82	56.01
Southeastern Plains	Metals CCU	0.98	15	38.71	21.09	56.33
Southeastern Plains	Metals CCU	0.99	16	40.53	22.29	58.77
Southeastern Plains	Metals CCU	0.99	17	51.12	31.66	70.59
Southeastern Plains	Metals CCU	1.01	18	51.41	31.94	70.89
Southeastern Plains	Metals CCU	1.07	19	52.03	32.53	71.52
Southeastern Plains	Metals CCU	1.11	20	53.06	33.23	72.88
Southeastern Plains	Metals CCU	1.17	21	53.67	33.83	73.51
Southeastern Plains	Metals CCU	1.29	22	54.28	34.21	74.36
Southeastern Plains	Metals CCU	1.34	23	54.89	34.87	74.92
Southeastern Plains	Metals CCU	1.34	24	55.51	35.49	75.53
Southeastern Plains	Metals CCU	1.38	25	58.01	37.75	78.27
Southeastern Plains	Metals CCU	1.39	26	59.83	38.97	80.69
Southeastern Plains	Metals CCU	1.43	27	60.86	39.91	81.81
Southeastern Plains	Metals CCU	1.45	28	71.45	49.37	93.53
Southeastern Plains	Metals CCU	1.50	29	72.48	50.39	94.58
Southeastern Plains	Metals CCU	1.57	30	72.78	50.59	94.97
Southeastern Plains	Metals CCU	1.75	31	83.37	65.75	100.00
Southeastern Plains	Metals CCU	1.90	32	85.87	68.81	100.00
Southeastern Plains	Metals CCU	1.94	33	86.91	69.81	100.00
Southeastern Plains	Metals CCU	2.85	34	89.41	72.75	100.00
Southeastern Plains	Metals CCU	2.89	35	100.00	100.00	100.00
Blue Ridge Mountains	Metals CCU	0.25	1	1.70	0.00	4.76
Blue Ridge Mountains	Metals CCU	0.26	2	2.40	0.00	5.77
Blue Ridge Mountains	Metals CCU	0.29	3	9.57	0.00	21.57
Blue Ridge Mountains	Metals CCU	0.32	4	11.27	0.00	23.65
Blue Ridge Mountains	Metals CCU	0.48	5	12.50	0.00	25.08
Blue Ridge Mountains	Metals CCU	0.75	7	26.85	9.12	44.58
Blue Ridge Mountains	Metals CCU	0.76	8	34.02	14.38	53.66
Blue Ridge Mountains	Metals CCU	0.76	9	35.72	16.59	54.84
Blue Ridge Mountains	Metals CCU	0.78	10	42.89	22.37	63.42
Blue Ridge Mountains	Metals CCU	0.80	11	50.07	29.40	70.73
Blue Ridge Mountains	Metals CCU	0.80	12	57.24	38.81	75.67
Blue Ridge Mountains	Metals CCU	0.81	13	57.94	39.71	76.17
Blue Ridge Mountains	Metals CCU	0.82	14	59.64	41.58	77.70
Blue Ridge Mountains	Metals CCU	0.82	15	61.33	43.23	79.44
Blue Ridge Mountains	Metals CCU	0.85	16	63.03	45.07	80.99
Blue Ridge Mountains	Metals CCU	0.86	17	70.20	55.54	84.87
Blue Ridge Mountains	Metals CCU	0.86	18	77.38	64.30	90.45
Blue Ridge Mountains	Metals CCU	0.86	19	78.61	65.21	92.01
Blue Ridge Mountains	Metals CCU	0.87	20	79.03	65.51	92.54
Blue Ridge Mountains	Metals CCU	0.90	21	86.20	75.63	96.76
Blue Ridge Mountains	Metals CCU	0.91	22	87.43	77.11	97.75



Blue Ridge Mountains	Metals CCU	0.92	23	94.61	89.46	99.75
Blue Ridge Mountains	Metals CCU	0.92	24	95.84	91.33	100.00
Blue Ridge Mountains	Metals CCU	0.96	25	97.07	93.31	100.00
Blue Ridge Mountains	Metals CCU	1.01	26	98.77	96.64	100.00
Blue Ridge Mountains	Metals CCU	1.33	27	100.00	100.00	100.00
Central Appalachians	Metals CCU	0.21	1	2.74	0.00	7.28
Central Appalachians	Metals CCU	0.28	2	6.50	0.00	14.83
Central Appalachians	Metals CCU	0.29	3	8.05	0.00	16.69
Central Appalachians	Metals CCU	0.29	4	10.79	0.32	21.26
Central Appalachians	Metals CCU	0.30	5	14.55	1.82	27.29
Central Appalachians	Metals CCU	0.30	6	17.29	2.90	31.68
Central Appalachians	Metals CCU	0.31	7	18.84	3.69	34.00
Central Appalachians	Metals CCU	0.36	8	20.39	5.05	35.74
Central Appalachians	Metals CCU	0.36	9	23.13	6.27	39.98
Central Appalachians	Metals CCU	0.37	10	26.90	8.26	45.53
Central Appalachians	Metals CCU	0.40	11	28.45	9.17	47.72
Central Appalachians	Metals CCU	0.40	12	31.18	10.80	51.56
Central Appalachians	Metals CCU	0.40	13	33.92	12.26	55.57
Central Appalachians	Metals CCU	0.44	14	36.65	14.00	59.31
Central Appalachians	Metals CCU	0.52	15	39.39	15.47	63.30
Central Appalachians	Metals CCU	0.53	16	55.31	27.45	83.17
Central Appalachians	Metals CCU	0.56	17	56.86	28.72	85.00
Central Appalachians	Metals CCU	0.59	18	60.63	32.16	89.10
Central Appalachians	Metals CCU	0.76	19	64.39	35.21	93.58
Central Appalachians	Metals CCU	0.81	20	68.16	38.67	97.65
Central Appalachians	Metals CCU	0.83	21	84.08	60.33	100.00
Central Appalachians	Metals CCU	0.92	22	100.00	100.00	100.00

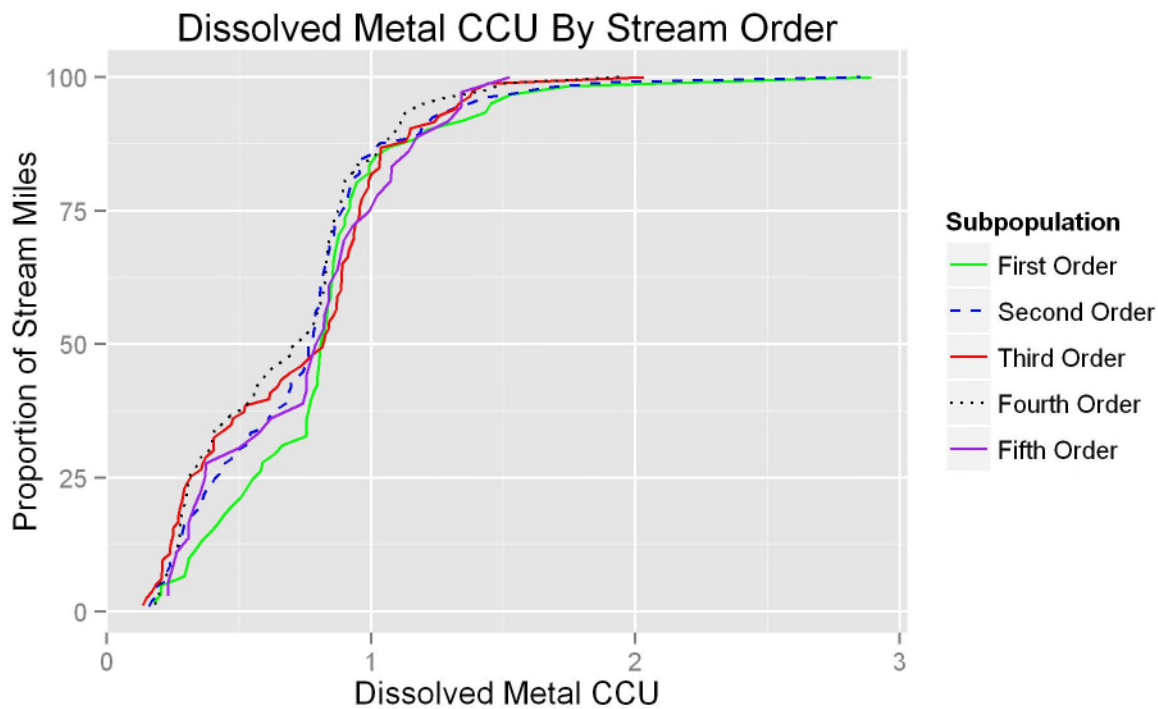


Figure 116. Metal CCU by Stream Order (Level III) CDF graph.

Figure 116 and Table 69 display Metals CCU CDF curves by stream order. The stream order CDFs are relatively tight together at the 50<sup>th</sup> percentile. The 98.4<sup>th</sup> percentile of first order streams is 1.75. Ninety-nine percent of second order stream miles are less than 1.9 Metals CCU. One hundred percent of third order streams are less than 2.03 and 100% of fourth order streams are less than 1.94. One hundred percent of fifth order streams have Metals CCU scores less than 1.52.

Table 69. Metal CCU Population Estimates by Stream Order.

Subpopulation	Indicator	Value	NResp	Estimate.P	LCB95Pct.P	UCB95Pct.P
First Order	Metals CCU	0.18	1	1.64	0.00	4.35
First Order	Metals CCU	0.20	2	3.28	0.00	7.12
First Order	Metals CCU	0.20	3	4.92	0.20	9.64
First Order	Metals CCU	0.29	4	6.56	1.30	11.82
First Order	Metals CCU	0.30	5	8.20	2.21	14.18
First Order	Metals CCU	0.31	6	9.84	3.17	16.50
First Order	Metals CCU	0.33	7	11.48	4.20	18.75
First Order	Metals CCU	0.36	8	13.11	5.34	20.89
First Order	Metals CCU	0.39	9	14.75	6.62	22.89
First Order	Metals CCU	0.42	10	16.39	7.86	24.92
First Order	Metals CCU	0.44	11	18.03	9.05	27.02
First Order	Metals CCU	0.47	12	19.67	10.44	28.90
First Order	Metals CCU	0.51	13	21.31	11.92	30.70

First Order	Metals CCU	0.53	14	22.95	13.20	32.70
First Order	Metals CCU	0.55	15	24.59	14.82	34.36
First Order	Metals CCU	0.58	16	26.23	16.25	36.21
First Order	Metals CCU	0.59	17	27.87	17.67	38.07
First Order	Metals CCU	0.64	18	29.51	19.13	39.88
First Order	Metals CCU	0.66	19	31.15	20.49	41.80
First Order	Metals CCU	0.75	20	32.79	22.28	43.30
First Order	Metals CCU	0.75	22	36.07	25.43	46.70
First Order	Metals CCU	0.76	23	37.70	27.12	48.29
First Order	Metals CCU	0.77	24	39.34	28.83	49.86
First Order	Metals CCU	0.78	25	40.98	30.32	51.65
First Order	Metals CCU	0.80	26	42.62	31.96	53.28
First Order	Metals CCU	0.80	27	44.26	33.40	55.13
First Order	Metals CCU	0.80	28	45.90	35.23	56.58
First Order	Metals CCU	0.80	29	47.54	36.84	58.24
First Order	Metals CCU	0.81	30	49.18	38.71	59.65
First Order	Metals CCU	0.81	31	50.82	40.02	61.62
First Order	Metals CCU	0.82	32	52.46	41.60	63.32
First Order	Metals CCU	0.83	33	54.10	43.37	64.83
First Order	Metals CCU	0.83	34	55.74	45.00	66.48
First Order	Metals CCU	0.84	35	57.38	46.47	68.29
First Order	Metals CCU	0.85	36	59.02	47.88	70.15
First Order	Metals CCU	0.85	37	60.66	49.67	71.64
First Order	Metals CCU	0.85	38	62.30	51.60	72.99
First Order	Metals CCU	0.86	39	63.93	53.60	74.27
First Order	Metals CCU	0.86	40	65.57	55.25	75.89
First Order	Metals CCU	0.86	41	67.21	57.03	77.39
First Order	Metals CCU	0.87	42	68.85	59.05	78.66
First Order	Metals CCU	0.88	43	70.49	61.12	79.86
First Order	Metals CCU	0.90	44	72.13	62.79	81.48
First Order	Metals CCU	0.90	45	73.77	64.69	82.85
First Order	Metals CCU	0.92	46	75.41	66.74	84.08
First Order	Metals CCU	0.92	47	77.05	68.80	85.30
First Order	Metals CCU	0.93	48	78.69	70.65	86.73
First Order	Metals CCU	0.94	49	80.33	72.67	87.99
First Order	Metals CCU	0.99	50	81.97	74.44	89.50
First Order	Metals CCU	0.99	51	83.61	76.57	90.64
First Order	Metals CCU	1.02	52	85.25	78.45	92.04
First Order	Metals CCU	1.07	53	86.89	80.11	93.66
First Order	Metals CCU	1.17	54	88.52	82.07	94.98
First Order	Metals CCU	1.21	55	90.16	84.01	96.32
First Order	Metals CCU	1.34	56	91.80	86.24	97.37
First Order	Metals CCU	1.43	57	93.44	88.57	98.31
First Order	Metals CCU	1.45	58	95.08	90.37	99.79
First Order	Metals CCU	1.53	59	96.72	92.95	100.00
First Order	Metals CCU	1.75	60	98.36	95.68	100.00
First Order	Metals CCU	2.89	61	100.00	100.00	100.00
Second Order	Metals CCU	0.16	1	0.95	0.00	2.51
Second Order	Metals CCU	0.17	2	1.90	0.00	4.18
Second Order	Metals CCU	0.19	3	2.86	0.10	5.62
Second Order	Metals CCU	0.19	4	3.81	0.64	6.98
Second Order	Metals CCU	0.19	5	4.76	1.24	8.28
Second Order	Metals CCU	0.22	6	5.71	1.90	9.53

Second Order	Metals CCU	0.22	7	6.67	2.63	10.70
Second Order	Metals CCU	0.23	8	7.62	3.42	11.82
Second Order	Metals CCU	0.24	9	8.57	4.25	12.89
Second Order	Metals CCU	0.24	10	9.52	5.21	13.84
Second Order	Metals CCU	0.25	11	10.48	5.90	15.05
Second Order	Metals CCU	0.27	12	11.43	6.59	16.27
Second Order	Metals CCU	0.28	13	12.38	7.62	17.14
Second Order	Metals CCU	0.28	14	13.33	8.38	18.28
Second Order	Metals CCU	0.28	15	14.29	9.13	19.45
Second Order	Metals CCU	0.29	16	15.24	10.04	20.43
Second Order	Metals CCU	0.29	17	16.19	11.07	21.31
Second Order	Metals CCU	0.30	18	17.14	11.97	22.32
Second Order	Metals CCU	0.32	19	18.10	12.81	23.38
Second Order	Metals CCU	0.34	20	19.05	13.52	24.58
Second Order	Metals CCU	0.36	21	20.00	14.22	25.78
Second Order	Metals CCU	0.36	22	20.95	15.02	26.89
Second Order	Metals CCU	0.37	23	21.90	16.11	27.70
Second Order	Metals CCU	0.37	24	22.86	17.13	28.58
Second Order	Metals CCU	0.39	25	23.81	18.00	29.62
Second Order	Metals CCU	0.41	26	24.76	18.74	30.78
Second Order	Metals CCU	0.42	27	25.71	19.46	31.96
Second Order	Metals CCU	0.43	28	26.67	20.21	33.12
Second Order	Metals CCU	0.44	29	27.62	20.98	34.26
Second Order	Metals CCU	0.47	30	28.57	21.75	35.39
Second Order	Metals CCU	0.48	31	29.52	22.68	36.36
Second Order	Metals CCU	0.51	32	30.48	23.62	37.33
Second Order	Metals CCU	0.54	33	31.43	24.44	38.42
Second Order	Metals CCU	0.54	34	32.38	25.28	39.48
Second Order	Metals CCU	0.54	35	33.33	26.10	40.56
Second Order	Metals CCU	0.59	36	34.29	27.14	41.44
Second Order	Metals CCU	0.61	37	35.24	28.01	42.46
Second Order	Metals CCU	0.61	38	36.19	28.94	43.44
Second Order	Metals CCU	0.62	39	37.14	29.80	44.49
Second Order	Metals CCU	0.65	40	38.10	30.65	45.54
Second Order	Metals CCU	0.68	41	39.05	31.57	46.53
Second Order	Metals CCU	0.68	42	40.00	32.44	47.56
Second Order	Metals CCU	0.69	43	40.95	33.25	48.65
Second Order	Metals CCU	0.70	44	41.90	34.16	49.65
Second Order	Metals CCU	0.70	45	42.86	34.99	50.73
Second Order	Metals CCU	0.72	46	43.81	36.02	51.60
Second Order	Metals CCU	0.74	47	44.76	37.00	52.52
Second Order	Metals CCU	0.75	48	45.71	37.86	53.57
Second Order	Metals CCU	0.75	49	46.67	38.78	54.55
Second Order	Metals CCU	0.76	50	47.62	39.76	55.47
Second Order	Metals CCU	0.76	51	48.57	40.67	56.47
Second Order	Metals CCU	0.76	52	49.52	41.71	57.34
Second Order	Metals CCU	0.76	53	50.48	42.63	58.32
Second Order	Metals CCU	0.78	54	51.43	43.55	59.31
Second Order	Metals CCU	0.78	55	52.38	44.42	60.34
Second Order	Metals CCU	0.79	56	53.33	45.36	61.31
Second Order	Metals CCU	0.79	58	55.24	47.28	63.20
Second Order	Metals CCU	0.79	59	56.19	48.39	63.99
Second Order	Metals CCU	0.80	60	57.14	49.38	64.90

Second Order	Metals CCU	0.81	61	58.10	50.42	65.77
Second Order	Metals CCU	0.81	62	59.05	51.36	66.74
Second Order	Metals CCU	0.81	63	60.00	52.46	67.54
Second Order	Metals CCU	0.81	64	60.95	53.60	68.30
Second Order	Metals CCU	0.82	65	61.90	54.60	69.21
Second Order	Metals CCU	0.82	66	62.86	55.57	70.15
Second Order	Metals CCU	0.82	67	63.81	56.58	71.04
Second Order	Metals CCU	0.82	68	64.76	57.55	71.98
Second Order	Metals CCU	0.83	69	65.71	58.53	72.90
Second Order	Metals CCU	0.83	70	66.67	59.62	73.72
Second Order	Metals CCU	0.84	71	67.62	60.52	74.71
Second Order	Metals CCU	0.84	72	68.57	61.47	75.67
Second Order	Metals CCU	0.85	73	69.52	62.59	76.46
Second Order	Metals CCU	0.86	74	70.48	63.54	77.42
Second Order	Metals CCU	0.86	75	71.43	64.50	78.36
Second Order	Metals CCU	0.86	76	72.38	65.58	79.18
Second Order	Metals CCU	0.87	77	73.33	66.66	80.01
Second Order	Metals CCU	0.88	78	74.29	67.81	80.76
Second Order	Metals CCU	0.89	79	75.24	68.92	81.55
Second Order	Metals CCU	0.91	80	76.19	70.01	82.37
Second Order	Metals CCU	0.91	81	77.14	71.02	83.27
Second Order	Metals CCU	0.91	82	78.10	71.94	84.26
Second Order	Metals CCU	0.92	83	79.05	73.12	84.97
Second Order	Metals CCU	0.93	84	80.00	74.28	85.72
Second Order	Metals CCU	0.93	85	80.95	75.44	86.47
Second Order	Metals CCU	0.95	86	81.90	76.51	87.30
Second Order	Metals CCU	0.96	87	82.86	77.66	88.06
Second Order	Metals CCU	0.96	88	83.81	78.84	88.78
Second Order	Metals CCU	0.97	89	84.76	79.61	89.91
Second Order	Metals CCU	1.00	90	85.71	80.45	90.98
Second Order	Metals CCU	1.01	91	86.67	81.63	91.70
Second Order	Metals CCU	1.04	92	87.62	82.43	92.81
Second Order	Metals CCU	1.16	93	88.57	83.61	93.53
Second Order	Metals CCU	1.18	94	89.52	84.80	94.25
Second Order	Metals CCU	1.19	95	90.48	85.88	95.07
Second Order	Metals CCU	1.21	96	91.43	87.11	95.74
Second Order	Metals CCU	1.23	97	92.38	88.22	96.54
Second Order	Metals CCU	1.28	98	93.33	89.49	97.18
Second Order	Metals CCU	1.32	99	94.29	90.76	97.81
Second Order	Metals CCU	1.38	100	95.24	91.80	98.68
Second Order	Metals CCU	1.43	101	96.19	93.05	99.33
Second Order	Metals CCU	1.56	102	97.14	94.34	99.95
Second Order	Metals CCU	1.67	103	98.10	95.80	100.00
Second Order	Metals CCU	1.90	104	99.05	97.38	100.00
Second Order	Metals CCU	2.85	105	100.00	100.00	100.00
Third Order	Metals CCU	0.13	1	1.20	0.00	3.16
Third Order	Metals CCU	0.15	2	2.41	0.00	5.11
Third Order	Metals CCU	0.17	3	3.61	0.29	6.94
Third Order	Metals CCU	0.18	4	4.82	0.92	8.72
Third Order	Metals CCU	0.20	5	6.02	1.70	10.35
Third Order	Metals CCU	0.21	6	7.23	2.46	11.99
Third Order	Metals CCU	0.21	7	8.43	3.58	13.29
Third Order	Metals CCU	0.21	8	9.64	4.42	14.86

Third Order	Metals CCU	0.24	9	10.84	5.29	16.40
Third Order	Metals CCU	0.24	10	12.05	6.12	17.98
Third Order	Metals CCU	0.24	11	13.25	7.28	19.23
Third Order	Metals CCU	0.25	12	14.46	8.16	20.75
Third Order	Metals CCU	0.25	13	15.66	9.34	21.98
Third Order	Metals CCU	0.27	14	16.87	10.45	23.29
Third Order	Metals CCU	0.27	15	18.07	11.61	24.54
Third Order	Metals CCU	0.27	16	19.28	12.87	25.68
Third Order	Metals CCU	0.28	17	20.48	13.92	27.04
Third Order	Metals CCU	0.29	18	21.69	14.93	28.45
Third Order	Metals CCU	0.29	19	22.89	16.01	29.77
Third Order	Metals CCU	0.30	20	24.10	17.29	30.90
Third Order	Metals CCU	0.32	21	25.30	18.22	32.38
Third Order	Metals CCU	0.36	22	26.51	19.13	33.88
Third Order	Metals CCU	0.36	23	27.71	20.42	35.00
Third Order	Metals CCU	0.37	24	28.92	21.35	36.48
Third Order	Metals CCU	0.40	25	30.12	22.81	37.43
Third Order	Metals CCU	0.40	26	31.33	24.00	38.65
Third Order	Metals CCU	0.40	27	32.53	25.34	39.72
Third Order	Metals CCU	0.44	28	33.73	26.84	40.63
Third Order	Metals CCU	0.47	29	34.94	28.25	41.63
Third Order	Metals CCU	0.48	30	36.14	29.42	42.87
Third Order	Metals CCU	0.52	31	37.35	30.91	43.79
Third Order	Metals CCU	0.52	32	38.55	32.09	45.02
Third Order	Metals CCU	0.61	33	39.76	33.42	46.10
Third Order	Metals CCU	0.62	34	40.96	34.49	47.43
Third Order	Metals CCU	0.65	35	42.17	35.60	48.74
Third Order	Metals CCU	0.66	36	43.37	36.58	50.17
Third Order	Metals CCU	0.69	37	44.58	37.63	51.53
Third Order	Metals CCU	0.73	38	45.78	38.87	52.70
Third Order	Metals CCU	0.76	39	46.99	40.05	53.92
Third Order	Metals CCU	0.78	40	48.19	41.14	55.25
Third Order	Metals CCU	0.81	41	49.40	42.06	56.74
Third Order	Metals CCU	0.82	42	50.60	43.29	57.92
Third Order	Metals CCU	0.83	43	51.81	44.32	59.29
Third Order	Metals CCU	0.84	44	53.01	45.47	60.55
Third Order	Metals CCU	0.84	45	54.22	46.59	61.84
Third Order	Metals CCU	0.86	46	55.42	47.55	63.30
Third Order	Metals CCU	0.87	47	56.63	48.90	64.35
Third Order	Metals CCU	0.87	48	57.83	50.31	65.35
Third Order	Metals CCU	0.87	49	59.04	51.81	66.26
Third Order	Metals CCU	0.89	50	60.24	52.77	67.71
Third Order	Metals CCU	0.89	51	61.45	54.17	68.72
Third Order	Metals CCU	0.89	52	62.65	55.12	70.19
Third Order	Metals CCU	0.89	53	63.86	56.24	71.47
Third Order	Metals CCU	0.89	54	65.06	57.39	72.73
Third Order	Metals CCU	0.91	55	66.27	58.45	74.08
Third Order	Metals CCU	0.91	56	67.47	59.53	75.41
Third Order	Metals CCU	0.92	57	68.67	60.79	76.56
Third Order	Metals CCU	0.93	58	69.88	62.14	77.62
Third Order	Metals CCU	0.94	59	71.08	63.60	78.57
Third Order	Metals CCU	0.94	60	72.29	64.81	79.77
Third Order	Metals CCU	0.95	61	73.49	66.17	80.82

Third Order	Metals CCU	0.96	62	74.70	67.49	81.91
Third Order	Metals CCU	0.96	63	75.90	68.96	82.85
Third Order	Metals CCU	0.96	64	77.11	70.40	83.81
Third Order	Metals CCU	0.98	65	78.31	71.66	84.96
Third Order	Metals CCU	0.99	66	79.52	73.12	85.92
Third Order	Metals CCU	0.99	67	80.72	74.64	86.81
Third Order	Metals CCU	1.00	68	81.93	76.02	87.83
Third Order	Metals CCU	1.03	69	83.13	77.26	89.01
Third Order	Metals CCU	1.03	70	84.34	78.24	90.44
Third Order	Metals CCU	1.03	71	85.54	79.33	91.75
Third Order	Metals CCU	1.04	72	86.75	80.86	92.64
Third Order	Metals CCU	1.13	73	87.95	82.40	93.50
Third Order	Metals CCU	1.14	74	89.16	83.75	94.57
Third Order	Metals CCU	1.15	75	90.36	85.17	95.55
Third Order	Metals CCU	1.24	76	91.57	86.37	96.77
Third Order	Metals CCU	1.26	77	92.77	87.88	97.66
Third Order	Metals CCU	1.32	78	93.98	89.53	98.42
Third Order	Metals CCU	1.33	79	95.18	91.27	99.09
Third Order	Metals CCU	1.37	80	96.39	92.97	99.80
Third Order	Metals CCU	1.39	81	97.59	94.78	100.00
Third Order	Metals CCU	1.44	82	98.80	96.66	100.00
Third Order	Metals CCU	2.03	83	100.00	100.00	100.00
Fourth Order	Metals CCU	0.18	1	1.27	0.00	3.48
Fourth Order	Metals CCU	0.19	2	2.53	0.00	5.70
Fourth Order	Metals CCU	0.20	3	3.80	0.21	7.39
Fourth Order	Metals CCU	0.20	4	5.06	1.59	8.54
Fourth Order	Metals CCU	0.22	5	6.33	2.32	10.34
Fourth Order	Metals CCU	0.24	6	7.59	3.00	12.19
Fourth Order	Metals CCU	0.25	7	8.86	3.87	13.85
Fourth Order	Metals CCU	0.26	8	10.13	4.67	15.58
Fourth Order	Metals CCU	0.27	9	11.39	5.76	17.03
Fourth Order	Metals CCU	0.27	10	12.66	6.67	18.65
Fourth Order	Metals CCU	0.27	11	13.92	7.67	20.18
Fourth Order	Metals CCU	0.28	12	15.19	8.78	21.59
Fourth Order	Metals CCU	0.28	13	16.46	9.99	22.92
Fourth Order	Metals CCU	0.28	14	17.72	11.11	24.33
Fourth Order	Metals CCU	0.29	15	18.99	12.22	25.76
Fourth Order	Metals CCU	0.30	16	20.25	13.60	26.91
Fourth Order	Metals CCU	0.30	17	21.52	15.01	28.02
Fourth Order	Metals CCU	0.31	18	22.78	15.92	29.65
Fourth Order	Metals CCU	0.31	19	24.05	17.00	31.10
Fourth Order	Metals CCU	0.31	20	25.32	17.96	32.67
Fourth Order	Metals CCU	0.33	21	26.58	19.24	33.93
Fourth Order	Metals CCU	0.34	22	27.85	20.42	35.28
Fourth Order	Metals CCU	0.36	23	29.11	21.83	36.40
Fourth Order	Metals CCU	0.39	24	30.38	23.34	37.42
Fourth Order	Metals CCU	0.40	25	31.65	24.69	38.61
Fourth Order	Metals CCU	0.40	26	32.91	25.72	40.10
Fourth Order	Metals CCU	0.41	27	34.18	27.13	41.23
Fourth Order	Metals CCU	0.45	28	35.44	28.40	42.48
Fourth Order	Metals CCU	0.47	29	36.71	29.31	44.10
Fourth Order	Metals CCU	0.52	30	37.97	30.56	45.39
Fourth Order	Metals CCU	0.54	31	39.24	31.92	46.56

Fourth Order	Metals CCU	0.56	32	40.51	33.32	47.69
Fourth Order	Metals CCU	0.56	33	41.77	34.52	49.03
Fourth Order	Metals CCU	0.58	34	43.04	36.03	50.04
Fourth Order	Metals CCU	0.60	35	44.30	37.61	50.99
Fourth Order	Metals CCU	0.63	36	45.57	38.59	52.55
Fourth Order	Metals CCU	0.66	37	46.84	39.79	53.88
Fourth Order	Metals CCU	0.70	38	48.10	40.79	55.41
Fourth Order	Metals CCU	0.70	39	49.37	41.80	56.93
Fourth Order	Metals CCU	0.73	40	50.63	43.23	58.03
Fourth Order	Metals CCU	0.75	41	51.90	44.24	59.56
Fourth Order	Metals CCU	0.77	42	53.16	45.56	60.77
Fourth Order	Metals CCU	0.79	43	54.43	46.77	62.09
Fourth Order	Metals CCU	0.79	44	55.70	48.36	63.03
Fourth Order	Metals CCU	0.80	45	56.96	49.71	64.22
Fourth Order	Metals CCU	0.81	46	58.23	51.27	65.19
Fourth Order	Metals CCU	0.82	47	59.49	52.60	66.38
Fourth Order	Metals CCU	0.82	49	62.03	54.97	69.08
Fourth Order	Metals CCU	0.83	50	63.29	56.00	70.58
Fourth Order	Metals CCU	0.83	51	64.56	57.56	71.55
Fourth Order	Metals CCU	0.83	52	65.82	58.76	72.88
Fourth Order	Metals CCU	0.83	53	67.09	60.05	74.13
Fourth Order	Metals CCU	0.84	54	68.35	61.59	75.12
Fourth Order	Metals CCU	0.84	55	69.62	63.00	76.24
Fourth Order	Metals CCU	0.85	56	70.89	64.56	77.21
Fourth Order	Metals CCU	0.86	57	72.15	65.88	78.42
Fourth Order	Metals CCU	0.86	58	73.42	67.55	79.29
Fourth Order	Metals CCU	0.87	59	74.68	68.78	80.59
Fourth Order	Metals CCU	0.88	60	75.95	70.37	81.53
Fourth Order	Metals CCU	0.89	61	77.22	71.54	82.90
Fourth Order	Metals CCU	0.89	62	78.48	72.41	84.55
Fourth Order	Metals CCU	0.89	63	79.75	73.87	85.63
Fourth Order	Metals CCU	0.90	64	81.01	75.19	86.84
Fourth Order	Metals CCU	0.93	65	82.28	76.85	87.70
Fourth Order	Metals CCU	0.94	66	83.54	78.53	88.56
Fourth Order	Metals CCU	1.01	67	84.81	80.31	89.31
Fourth Order	Metals CCU	1.02	68	86.08	81.33	90.82
Fourth Order	Metals CCU	1.03	69	87.34	82.42	92.26
Fourth Order	Metals CCU	1.07	70	88.61	83.80	93.42
Fourth Order	Metals CCU	1.09	71	89.87	85.11	94.64
Fourth Order	Metals CCU	1.11	72	91.14	86.25	96.03
Fourth Order	Metals CCU	1.11	73	92.41	87.74	97.07
Fourth Order	Metals CCU	1.14	74	93.67	89.31	98.04
Fourth Order	Metals CCU	1.19	75	94.94	91.01	98.87
Fourth Order	Metals CCU	1.28	76	96.20	92.99	99.41
Fourth Order	Metals CCU	1.43	77	97.47	94.63	100.00
Fourth Order	Metals CCU	1.50	78	98.73	96.69	100.00
Fourth Order	Metals CCU	1.94	79	100.00	100.00	100.00
Fifth Order	Metals CCU	0.23	1	2.78	0.00	7.65
Fifth Order	Metals CCU	0.23	2	5.56	0.00	12.15
Fifth Order	Metals CCU	0.25	3	8.33	0.80	15.87
Fifth Order	Metals CCU	0.26	4	11.11	3.39	18.83
Fifth Order	Metals CCU	0.31	5	13.89	5.44	22.34
Fifth Order	Metals CCU	0.31	6	16.67	8.34	24.99



Fifth Order	Metals CCU	0.33	7	19.44	10.32	28.57
Fifth Order	Metals CCU	0.35	8	22.22	12.03	32.41
Fifth Order	Metals CCU	0.37	9	25.00	14.80	35.20
Fifth Order	Metals CCU	0.37	10	27.78	18.41	37.14
Fifth Order	Metals CCU	0.50	11	30.56	21.81	39.30
Fifth Order	Metals CCU	0.57	12	33.33	24.37	42.30
Fifth Order	Metals CCU	0.62	13	36.11	25.90	46.32
Fifth Order	Metals CCU	0.74	14	38.89	28.76	49.02
Fifth Order	Metals CCU	0.76	15	41.67	31.19	52.15
Fifth Order	Metals CCU	0.76	16	44.44	33.33	55.56
Fifth Order	Metals CCU	0.77	17	47.22	35.89	58.55
Fifth Order	Metals CCU	0.79	18	50.00	39.18	60.82
Fifth Order	Metals CCU	0.82	19	52.78	41.53	64.02
Fifth Order	Metals CCU	0.82	20	55.56	43.34	67.77
Fifth Order	Metals CCU	0.84	21	58.33	46.56	70.11
Fifth Order	Metals CCU	0.84	22	61.11	49.11	73.11
Fifth Order	Metals CCU	0.87	23	63.89	52.67	75.11
Fifth Order	Metals CCU	0.88	24	66.67	55.73	77.60
Fifth Order	Metals CCU	0.90	25	69.44	58.74	80.15
Fifth Order	Metals CCU	0.93	26	72.22	62.03	82.42
Fifth Order	Metals CCU	0.99	27	75.00	65.01	84.99
Fifth Order	Metals CCU	1.02	28	77.78	68.99	86.56
Fifth Order	Metals CCU	1.07	29	80.56	71.08	90.04
Fifth Order	Metals CCU	1.08	30	83.33	75.09	91.58
Fifth Order	Metals CCU	1.14	31	86.11	79.22	93.00
Fifth Order	Metals CCU	1.17	32	88.89	81.98	95.80
Fifth Order	Metals CCU	1.29	33	91.67	85.44	97.90
Fifth Order	Metals CCU	1.34	34	94.44	88.39	100.00
Fifth Order	Metals CCU	1.34	35	97.22	92.78	100.00
Fifth Order	Metals CCU	1.52	36	100.00	100.00	100.00

# Appendix N: CADDIS Notes

In Virginia, the Stressor Analysis process for benthic TMDLs follows the steps outlined EPA's Stressor Identification Guidance manual. VDEQ has not officially implemented the use of the automated CADDIS version; however, regions are encouraged to utilize available tools to enhance the stressor analysis process. As part of the Benthic TMDLs workgroup, two impaired stream segments were piloted through the CADDIS process in order to evaluate it for use in the Commonwealth. The following section describes the case studies for Mill Creek in Rockingham County, Virginia.

## ***Mill Creek (Rockingham County, VA; Station Code: 1BMIC)***

Mill Creek was an ideal candidate since it had a large dataset and a completed TMDL. The CADDIS results and the TMDL Plan were in agreement. For Mill Creek, the available data was compiled, as well as general observations and knowledge of the watershed. Metals, organics, ammonia, nutrient enrichment, and sedimentation were assessed as potential stressors (one for each worksheet). In this example, there are two stressors that are likely impacting the stream biota. One is nutrients, which are "diagnosed" by the results of a 24 hr. diurnal D.O. study. The other is sediment, which has a high probability of causing impacts (as indicated by the worksheet). Sedimentation is largely supported by the results of the Log Relative Bed Stability data (which was performed during a probabilistic monitoring sampling event) and by VDEQ's standard biomonitoring habitat assessments.

In order to enter scores into the data sheet, the user must leave the cursor over the evidence type in the first column. A comment will appear that describes the conditions resulting in a given score for that cell. Keep in mind that frequently data for a given type of evidence will not be available; in that instance just leave the cell in Column B blank. Column B cells have a pull down list that will appear when the cell is clicked on. Select one of the available scores and it will be entered (notice that the scores aren't necessarily consecutive; they follow the scoring "rules" given on EPA's CADDIS website). Once all the scores for the data you have available are entered, it will give you an average score at the bottom of the score column (Column B). The average score will indicate how strongly supported or weakened the candidate stressor is, w/ +3 being strongly supported, and -3 being strongly refuted. And as mentioned above, if at any point in the spreadsheet you enter either an "R" (refuted) or "D" (diagnosed) into a cell, you are DONE. The trick here is to be certain of your data, and its interpretation.