VIRGINIA WATER RESOURCES RESEARCH CENTER

LONG-TERM WATER QUALITY TRENDS IN VIRGINIA'S WATERWAYS

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Long-Term Water Quality Trends in Virginia's Waterways

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Table of Contents

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Executive Summary

The quality of water in Virginia's rivers and streams affects the quality of life in the Commonwealth's communities, and the state's economic development potential. Each year, large amounts of money are spent by both the state and the private sector to protect and improve the quality of Virginia's waters. Yet, little information is available on the long-term success of these water-quality-protection expenditures.

The goal of this project was to investigate water-quality change in Virginia by conducting an analysis of long-term water-quality trends in selected rivers and streams. The data used for trend analysis were collected by the Virginia Department of Environmental Quality (DEQ) and the U.S. Geological Survey (USGS) over the past 30 years. These included data from 180 Virginia monitoring stations maintained by Virginia DEQ, 7 Virginia monitoring stations maintained by USGS, and 4 out-of-state monitoring stations maintained by USGS. Time periods covered by data from each monitoring station varied, but typically extended from the late 1960s or early-mid 1970s to early 1997. The monitoring stations included in the analysis were selected by DEQ based on the availability of long-term monitoring data and the goal of achieving statewide distribution. The data were downloaded from the STORET database. The DEQ and Virginia Tech personnel worked cooperatively to identify and remove erroneous values from the data sets.

Data were analyzed for nine water quality parameters: dissolved oxygen saturation (DO), biochemical oxygen demand (BOD), pH, total residue (TR), non-filterable residue (NFR - represents suspended solids), nitrate-nitrite nitrogen (NN), total Kjeldahl nitrogen (TKN), total phosphorus (TP), and fecal coliforms (FC).

Statistical analyses for trends were conducted using a seasonal Kendall Tau rank correlation test. Statistically significant trends were assumed to exist if Kendall's tau is significantly different from zero at the .01 level ($P < .01$). Where $.01<P<.10$, the existence of "apparent" (or "questionable") trends is recognized.

Study results provide evidence of water quality improvement with respect to DO, BOD, NFR, TP, and FC, and water quality deterioration for NN and TKN. Regional patterns were observed for most of the variables analyzed. Overall, significant and apparent declining trends outnumbered significant and apparent increasing trends for BOD, pH, NFR, TP, and FC, while the opposite *(i.e.,* increasing trends outnumbered declining trends) occurred for NN, TKN, and DO. Increasing and decreasing TR trends occurred in roughly equal numbers. Complete results for individual monitoring stations can be accessed on the internet site http://www.vwrrc.vt.edu/wq97/.

Study results should be interpreted cautiously. Simple numerical comparisons of increasing and declining trends cannot be interpreted as a direct representation of statewide water quality change because of uncertainties such as the location of monitoring stations (i.e., Does the monitoring network provide a general representation of statewide water quality?), variations among stations in periods of sampling and numbers of observations, and other factors. Other data

limitations included the unavailability of flow data, so trend analyses incorporating adjustments for flow could not be performed. Data were analyzed only for monotonic trends. Any changes of trend direction (for example, if a period of improving water quality were followed by a period during which water quality deteriorated) that may have occurred over the study period would not have been detected.

Keywords: trend analysis, water quality, Virginia's waterways

Introduction

The quality of water in Virginia's rivers and streams affects the health and welfare of Virginia's citizens, quality of life in the Commonwealth's communities, and the state's economic development potential. Each year, large sums are spent by both the state and the private sector to protect, improve, and monitor the quality of Virginia's waters. Yet, little information is available on the long-term success of these water-quality-protection expenditures.

The research described in this report was the first-phase of a two-phased, multi-year effort to enhance the Virginia Department of Environmental Quality's (DEQ) capability to detect and interpret long-term water-quality trends in Virginia's watersheds (Figure 1).

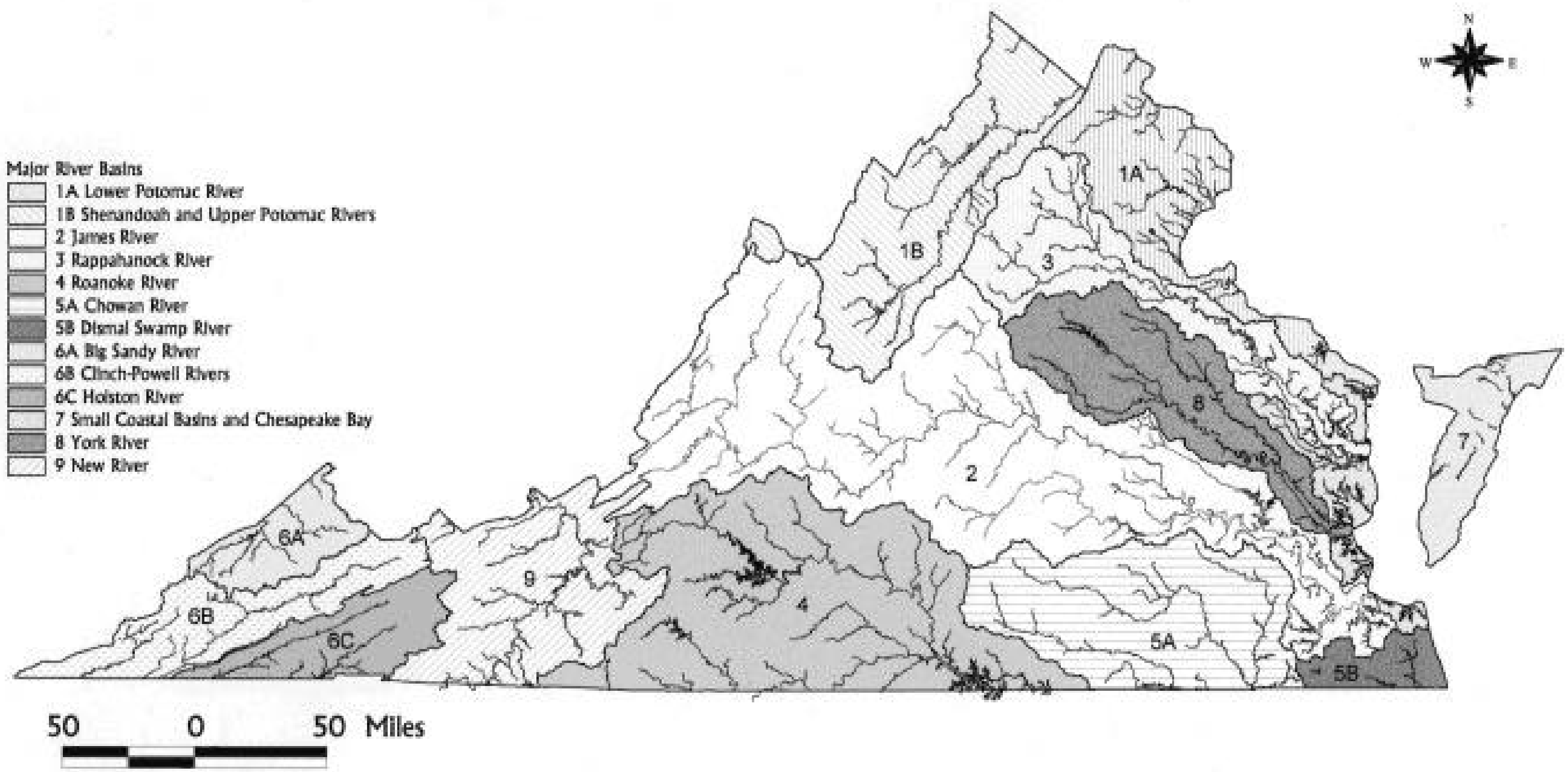
This report summarizes results of long-term trend analyses of Virginia's water-quality monitoring data collected over varying periods at individual monitoring stations. Data typically extend from the late 1960s or early-mid 1970s through early 1997. The second phase of this multi-year effort, scheduled to conclude in October 1999, will provide DEQ with the capability to conduct similar trend analyses in-house. The study will also determine relationships between observed water-quality trends and watershed characteristics (Zipper *et al.*, 1997).

Research Objective

The major goal of this study was to determine whether surface water quality in Virginia has improved or deteriorated using long-term data for key water quality indicators at 187 monitoring stations in Virginia. The specific research objective used the Seasonal Kendall's tau procedure to statistically evaluate long-term trends in Virginia's surface-water quality.

Precise flow data are not available for most monitoring stations. Therefore, statistical-analysis procedures did not include an adjustment for flow. Consideration of flow can aid the analysis of water-quality trends because, on a day-to-day basis, most water-quality characteristics vary in response to changes in flow.

Figure 1. Major River Basins in the State of Virginia



Research Methods

The research objective was addressed by using the seasonal Kendall technique to perform a statistical analysis of water quality data for 9 parameters (variables). The data were obtained from 180 monitoring stations maintained by the Department of Environmental Quality (DEQ), and 11 additional stations maintained by the U.S. Geological Survey (USGS). Four of the USGS stations are located out of the state (Figures 2).

The Data Set and Data Acquisition

The DEQ personnel identified the monitoring stations to be included in this study based on two primary criteria:

?? availability of water quality data at a frequency sufficient to support the Seasonal Kendall analytical technique, and

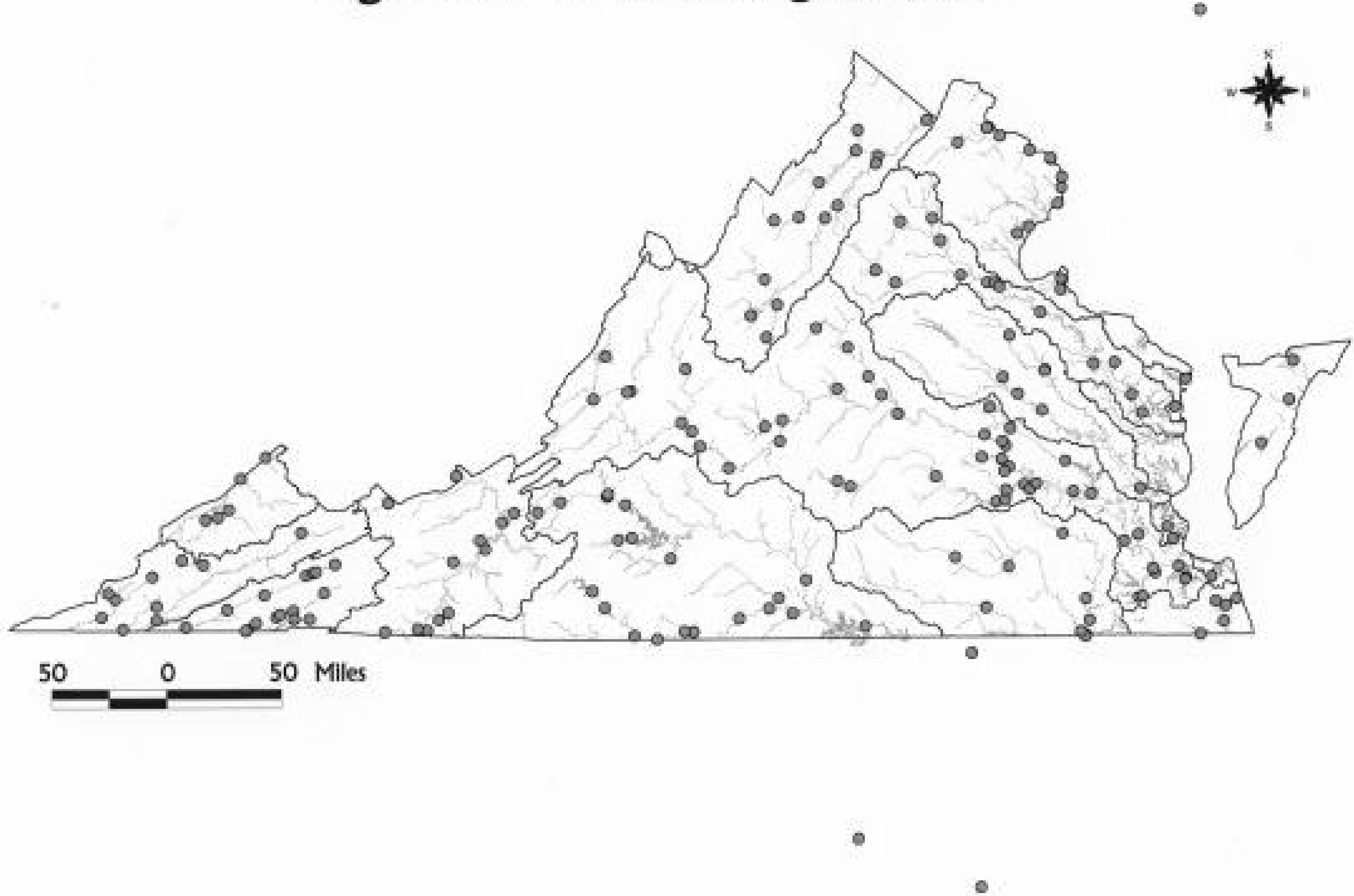
?? locations that provide statewide geographic representation.

Water quality data (9 parameters) for 191 water-quality monitoring stations were downloaded from the STORET database. The database extends from the late 1960s to early 1997. Availability of data for some the USGS monitoring stations (notably, pH) extend as far back as the 1940s. In order to assure that the analysis for the USGS monitoring-station would be comparable to those of the DEQ stations, data prior to 1966 were excluded from statistical analyses. Most stations were sampled monthly, although data sets for some stations show multiple-month and/or multiple-year gaps in the data record. A small number of stations lacked data for one or more variables.

The DEQ establishes a sample-collection schedule for each monitoring station at the beginning of each year, and maintains that schedule despite weather conditions. Thus, changes in flow appear as a source of random variation over the period of analysis. According to the DEQ, the only times when pre-determined schedules of sample collection were not followed occurred when weather or environmental conditions presented a physical danger to the party taking the sample. Such conditions tend to occur most frequently at stations where sampling requires the use of a boat (water samples are collected from stream centers, generally using a bridge or boat).

The laboratory analysis for the DEQ water samples are conducted by the Virginia Division of Consolidated Laboratory Services (DCLS) using the EPA's procedures, "Methods for Chemical Analysis of Water and Wastes" (EPA, 1983, and subsequent editions). In some cases, analytical methods were similar but not identical to the EPA procedures. Analytical methods used by the DCLS (including detection limits and precision) changed during the period of analysis, as new instrumentation and more advanced analytical methods became available.

Figure 2. Monitoring Stations



Water-Quality Variables

Water quality variables used in analyses are described below (STORET codes are given in parentheses). Land-use, point-source-effluents, and natural factors can influence each of these parameters. The text which follows describes some common water-quality influences. Reference values for some of these parameters are listed in Table 1.

***DO - Dissolved Oxygen Saturation (00301)*:** Barring toxic contamination, dissolved oxygen (DO) is generally considered as the most important determinant of a water body's suitability as habitat for aerobic organisms. DO is generally measured as mg dissolved O_2 per l of sampled water. For this analysis, DO concentrations have been converted to units of "percent saturation" using measured values of DO concentration and water temperature by the DEQ in accord with the EPA (1983) protocols. Table 2 includes DO concentrations at 100 percent saturation for a range of temperatures. In many cases, DO saturation values exceed 100 percent. According to the DEQ personnel, this occurs primarily as a result of algal activity during daylight, when the algae are actively producing DO as a byproduct of photosynthesis; the vast majority of the samples were collected during daylight. DO saturation can also exceed 100 percent as a result of water turbulence, but this is a rare occurrence at most of these monitoring stations.

High DO values represent a healthy water body. Low values can be caused by eutrophication (which itself is caused by high levels of nitrogen and phosphorous), nitrification of ammonium (NH_4^+) to nitrate (NO_3^-), and /or the presence of biodegradable organic materials (such as would be caused by high levels of BOD - *see below*).

BOD - Biochemical Oxygen Demand (00310): BOD is a measure of the potential of biodegradable organic materials that are present in the water body to deplete dissolved oxygen. When aerobic bacteria consume biodegradable organic matter, they use dissolved oxygen from the water column. BOD is measured by incubating a water sample in a closed, dark bottle at 20^{o}C for 5 days. BOD measurements are reported as mg of dissolved O_2 consumed during the incubation period per l of water. High BOD measures indicate the presence of biodegradable organic materials at relatively high concentrations. Sources of BOD can include sewage treatment plant effluents, septic systems, and runoff from livestock facilities. High levels of BOD can have a negative effect on water quality by depleting dissolved O_2.

Table 1. Reference values for water quality parameters

Parameter	Reference Value	Significance
Dissolved Oxygen	4 mg/l	< 4 mg/l more than 20 % of the time will limit game fish[1]
	5 mg/l	Daily average minimum concentration for non-trout waters[2]
	6.5 mg/l	< 6.5 mg/l more than 20 % of the time will limit cold-water game fish[1]
pH	6.0 - 9.0	Allowable range[2]
Dissolved Solids	100 mg/l	Average concentrations in eastern U.S.non-tidal surface waters are usually below this level. [1]
Suspended Solids	100 mg/l	Average concentrations in north Atlantic and south Atlantic regions of the U.S. rarely exceed this level [1]
Nitrate N	1 mg/l	Nationally, average concentrations at approximately 20% of 344 USGS monitoring stations were above this level (1980-89) [1]
	3 mg/l	Nationally, average concentrations at approximately 5% of 344 USGS monitoring stations were above this level (1980-89) [1]
	1 mg/l	US EPA recommends that waters with nitrate-N concentrations above this level not be used for feeding infants.
	10 mg/l	Maximum contaminant level for drinking-water supplies
Total Phosphorous	0.5 mg/l	Nationally, average concentrations at approximately 10% of 344 USGS monitoring stations were greater than this level (1982-89) [1]
Fecal Coliform	14 /100 ml	Allowable limit of sample median values in shellfish waters[2]
	200 /100 ml	Allowable limit in non-shellfish waters: Level not to be exceeded by two or more samples over 30 days [2]
	1000 / 100 ml	Allowable limit in non-shellfish waters: Level not to be exceeded at any time [2]

Sources:
1. Smith, R.A., R.B. Alexander, and K.J. Lanfear. 1993. Stream water quality in the conterminus United States Status and trends of selected indicators during the 1980's. National Water Summary 1990-91. USGS Water Supply Paper 2400. Washington, D.C.
2. Virginia Water Quality Standards (Virginia Regulations 680-21)

Table 2. Solubility of dissolved oxygen (DO) at various temperatures

Temperature		Dissolved Oxygen
^{o}C	^{o}F	Saturation (mg/l)
0	32.0	14.6
5	41.0	12.8
10	50.0	11.3
15	59.0	10.1
20	68.0	9.2
25	77.0	8.4
30	86.0	7.6

Note: Above values for 1 atmosphere pressure at sea level. DO solubility varies with atmospheric pressure , which is affected by elevation.

PH - pH (00400): pH is a measure of the hydrogen ion concentration present in water. More specifically: the numerical pH value represents the negative common-logarithm of the H^+ concentration expressed in mg/l. For example, if the H^+ concentration is 10^{-7} mg/l, the pH is defined as 7. A low pH (below 7) indicates acidic conditions, while a high pH (above 7) indicates alkaline conditions.

Virginia surface water quality standards are consistent with national standards in requiring pH to be in the range of 6.0 to 9.0. Values below this range typically reflect inputs of an acidic effluent, such as might be produced by acidic industrial discharges or acid mine drainage. Nitrification of ammonium (NH_4^+) to nitrate (NO_3^-) can also liberate H^+ and depress pH. pH values below 6 can occur in natural waters, but this is rare. When pH falls below 6, a variety of aquatic organisms found in natural waters can be negatively affected. Waters with pH below 4 are virtually void of vertebrate life forms. pH values above 9 are very rare in natural waters. If present, such values indicate the presence of an alkaline pollutant.

TR - Residue Total (00500): Residue total is a sum of filterable residue (proxy for total dissolved solids) and non-filterable residue (NFR - proxy for total suspended solids, see below). Laboratory determination of TR occurs via evaporation of a sample-aliquot at 103 to 105 degrees C. The residue remaining after evaporation is compared to the original aliquot to determine the total residue measure. Filterable residue data were not analyzed separately in this research.

NFR - Non-Filterable Residue (00530): NFR is a proxy value for total suspended solids. It can be measured by passing a water sample through a filter; particulate matter retained by the filter is dried at 103 to 105 degrees C and weighed. The resulting dry weight is compared to the original sample volume in order to calculate an NFR (suspended solids) concentration. Suspended solid concentrations in natural waters typically vary directly with flow. NFR values can vary widely with rainfall and streamflow, as rainfall events carry suspended soil particles into water bodies and increase water flow in those water bodies; at high rates of flow, rivers and streams are able to carry heavy sediment loads. High levels of suspended solids can be detrimental to a wide range of aquatic organisms, both bottom dwellers and those which live higher in the water column, due to physical alterations of habitat and turbidity. The presence of high levels of suspended solids can also impair recreational uses of water.

NN - Nitrate-Nitrite Nitrogen (00615 + 00620; 00630): This variable is a measure of the nitrogen present in nitrate (NO_3^-) and nitrite (NO_2^-) forms. Nitrite tends to be a transitory chemical form; nitrate is generally the predominant component of NN. Nitrate-N is an essential plant nutrient. Sources of nitrate can include runoff and leachate from agricultural fields, leachates from septic drainfields, wastewater treatment plant discharges, and atmospheric deposition. Microbial transformations of high-N organic wastes and NH_4^+ (nitrification) can also serve as sources of nitrate- and nitrite-N. High levels of nitrogen in any form can contribute to algal blooms and rapid growth of aquatic vegetation. The presence of high nitrate concentrations can render water unsuitable for use in public supplies.

TKN - Total Kjeldahl Nitrogen (00625): Total Kjeldahl nitrogen is a measure of the nitrogen present in the organic and ammonium (NH_4^+) forms. High levels of TKN can be an indicator of contamination by human or animal wastes. Runoff from agricultural fields and livestock operations, and sewage treatment facilities lacking the best available technologies, can act as TKN sources. In aerobic water bodies, organic and ammonium nitrogen tend to be transformed to nitrate-nitrogen by microorganisms; this transformation consumes dissolved O_2 and produces acidity. In addition, both ammonium and nitrate-N are susceptible to uptake by plants and, more importantly, by the algae and other forms of phytoplankton that cause eutrophication. In sum, both the direct and indirect effects of high TKN levels can contribute to O_2 depletion.

TP - Total Phosphorous (00665): Phosphorous tends to be scarce in natural systems that are relatively unaffected by human influence. Human activities, however, tend to concentrate P in the food chain as P is an essential plant nutrient that is depleted fairly rapidly in agricultural soils if not replaced with fertilizer additions. Phosphorous levels in surface water can be affected by runoff from agricultural fields and livestock operations, and by effluents sewage treatment facilities that lack tertiary treatment for P. High levels of P can contribute to algal blooms and excessive aquatic-plant growth

FC - Fecal Coliform (31616)**:** Fecal coliform are bacteria that occur in the fecal matter of warm-blooded animals, including humans, livestock, and wildlife. The presence of fecal coliform is measured by passing a water sample of known volume through a membrane filter with pores sufficiently small to prevent passage of the fecal-coliform bacteria. The filter is then incubated in a culture medium that allows retained bacteria to grow into visible colonies. Results are typically reported as visible colonies per 100 ml of sample. The presence of fecal coliform is an indicator that disease-causing organisms (pathogens) may be present. Fecal coliform contamination of streams can occur as a result of livestock operations, water activities of wildlife, sewage treatment plants that are not operating properly, or defective residential on-site sewage treatment such as a failing septic system or a direct discharge.

Water Quality Monitoring Station Locations and Codes

Location of monitoring stations studied are listed in Table A-1 (Appendix 1).

DEQ Station Numbers: Each monitoring station is designated by a unique station-identifier code that contains information about the station's location.

For example, in the station number 6BGUE006.50.

?? "6B" represents the watershed basin (Clinch-Powell section of Tennessee - Big Sandy basin - Table 3).

?? "GUE" represents the water body that is sampled. In this case, that water body is the Guest River.

?? 006.50 represents the specific location of the monitoring station, relative to the water body's downstream terminus. In this case, the sampling location is 6.50 river-miles above the Guest River's junction with the Clinch River.

USGS Stations: The USGS monitoring stations have 8-digit numeric station codes (example: 01646580). Four of these stations are located out of state, on waterways of interest to Virginia.

Table 3. River Basin (and Sub-basin) Codes

Basin/Sub-Basin		Area	Popu-lation	Pop. Density	Land Use (%)		
		(mile^2)	(1000)	(/mile^2)	Forest	Agric	Urban
1	Potomac and Shenandoah Rivers	5,747	1,974	343	43	36	13
1A	Shenandoah and Upper Potomac						
1B	Lower Potomac						
2	James River	10,206	1,905	187	65	19	12
3	Rappahanock River	2,715	186	68	51	36	6
4	Roanoke River	6,382	670	105	62	25	10
5	Chowan and Dismal Swamp	4,061	586	144	64	28	6
5A	Chowan						
5B	Dismal Swamp						
6	Tennessee and Big Sandy Rivers	4,140	310	75	*	*	*
6A	Big Sandy						
6B	Clinch-Powell						
6C	Holston						
7	Small Coastal Basins and Chesapeake Bay	1,588	386	243	30	22	24
8	York River	2,662	250	94	65	20	10
9	New River	3,070	212	69	59	35	3

* Big Sandy watershed is 86% forest and 5 % agricultural. Tennessee River watershed (Holston and Clinch-Powell basins) is 48 % forested and 40 % agricultural.

Data pertain to Virginia portions of watersheds only. Source: Virginia DEQ. 1996. Virginia Water Quality Assessment for 1996 and Non-Point Source Pollution Watershed Assessment Report. (305(b) Report).

Data Screening

The statistical analysis (seasonal Kendall analysis) and data-screening procedures were automated by means of an original algorithm using the SAS/IML (SAS/IML is a registered trademark of SAS Institute, Inc., Cary, NC) programming code. The programming code used in our earlier work (Rheem and Holtzman, 1990; Zipper *et al.*, 1992) has been replaced by a more efficient program written by P. Darken and G. Holtzman called WQ1.

***Outliers*:** Values lying outside the analytical limits of the laboratory procedures, or beyond the boundaries of what would be reasonably expected to occur in natural waters even under extreme conditions, were discarded prior to statistical analysis. Limits used to identify values eliminated as outliers are written in the output for each station and summarized in Table 4. These limits were identified by the DEQ personnel.

Table 4. Data Boundaries Used to Identify Outliers, and Common Lower Detection Limits

	Outlier - Identifier Boundaries		Common Lower Detection Limits
Parameter	Lower	Upper	
DO (% sat)	0.1	300	
BOD (mg/l)	0	1000	1
pH	2*	13.9	
TR (mg/l)	1	100,000	
NFR (mg/l)	1	100,000	1, 3, 5
NN (mg/l)	0.01**	500	0.1, 0.4, 0.5**
TKN (mg/l)	0.1	500	0.1
TP (mg/l)	0.01	100	0.01, 0.1
FC (per 100 ml)	0	100,000	= 100

* Determined empirically (all pH observations less than 2.0 were identified by DEQ as erroneous).

** Applied variously to nitrate, nitrite, and nitrate+nitrite.

Erroneous Values: A major difficulty in conducting the research occurred due to the presence of values that were well outside of the range of what were considered to be reasonable for a given parameter at a given monitoring station. Values that appeared to be unreasonable for a given parameter at a given monitoring station were assumed to be in error, identified in the program output as "erroneous values," and eliminated from the analysis. We presume that erroneous values occurred due to improper sampling, analytical technique, or data recording. Because of the wide range of conditions present, we were unable to automate the process of identifying erroneous values. Many apparently erroneous values were identified by visual inspection of the data on a station-specific basis. Virginia Tech personnel identified apparent outliers as suspect values through the review of graphical and tabular output subsequent to a preliminary statistical analysis. The DEQ personnel reviewed the raw data for each suspect variable. Those values identified by the DEQ personnel as erroneous in the process of this review were given a remark code of "1" during the data-input portion of the statistical analysis program, eliminated from the data set prior to statistical analysis, and identified as erroneous values in the program output.

Other criteria for identifying data values as erroneous, and eliminating these data from the analysis, are identified below:

?? an incorrect date (example: month is listed as "13");

?? an incorrect remark code (for example, an incorrect value coded as lower detection limit);

?? a remark code indicating an analytical error or an imprecise value (Table 5);

?? NFR, when NFR was greater than TR;

?? for sampling dates in June, July, and August 1979: when NFR or TR was found to be 20% (or more) higher than the maximum for that monitoring station outside of the June-August 1979 period, the NFR/TR value was considered to be erroneous. This procedure was developed due to apparent problems in NFR and TR analytical procedures during this time period. Numerous suspect NFR and TR values were observed during this time period, leading to the hypothesis that erroneous values may have resulted from improper technique by a summer employee.

These criteria were developed in consultation with the DEQ. Caution was exercised in identifying erroneous values. The DEQ personnel identified values as erroneous only when they were relatively certain that the value was, in fact, erroneous. As indicated below, the Seasonal Kendall's Tau procedure is robust in that its results are resistant to influence by one or a few extreme or erroneous values.

Table 5. STORET Remark Codes

Code	Meaning
(blank)	Data not remarked. Numbers should be interpreted exactly as reported.
A	Value reported is the mean of two or more determinations.
B	Results based upon colony counts outside the acceptable range.
C	Calculated. Value stored was not measured directly, but was calculated from other data available.
D	Field measurement. Some parameter codes (e.g. 401, "Field pH") imply this condition without this remark.
E	Extra sample taken in compositing process.
F	In the case of species, F indicates Female sex.
G	Value reported is the maximum of two or more determinations.
H	Value based on field kit determination; results may not be accurate.
J	Estimated. Value shown is not a result of analytical measurement.
K	Off-scale low. Actual value not known, but known to be less than value shown. Usually, used to indicate a failure to detect the substance.
L	Off-scale high. Actual value not known, but known to be greater than value shown.
M	Presence of material verified, but not quantified. Indicates a positive detection, at a level too low to permit accurate quantification. In the case of temperature or oxygen reduction potential, M indicates a negative value. In the case of species, M indicates Male sex.
N	Presumptive evidence of presence of material.
O	Sampled for, but analysis lost. Accompanying value is not meaningful for analysis.
P	Too numerous to count.
Q	Sample held beyond normal holding time.
R	Significant rain in the past 48 hours.
S	Laboratory test.
T	Value reported is less than the criteria of detection.
U	Material was analyzed for, but not detected. Value stored is the limit of detection for the process in use. In the case of species, Undetermined sex.
W	Value observed is less than the lowest value reportable under remark "T".
X	Value is quasi vertically-***integrated*** sample.
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume.
$	Calculated value. Numerical value was neither measured nor reported to the database, but was calculated from other data available during generation of the retrieval report.

Other Data Management Issues

pH Values: The pH data for the early years were listed with a precision of one-tenth pH unit (e.g., 7.1), whereas modern pH values were listed at a precision of one-one hundredth of a pH unit (e.g., pH 7.12). According to the DEQ personnel, the precision of the second decimal place is questionable. We rounded all pH values off to one-tenth of a pH unit prior to conducting seasonal-Kendall analyses.

NN Values*:* Nitrate-nitrite nitrogen values were determined using two separate methods. For some sampling dates at most sampling locations, the DEQ data included a single value representing nitrogen concentration in the nitrate and nitrite form (STORET Code 00630). In other cases, two separate analyses were performed by the DEQ, both nitrate (00615) and nitrite (00620); in these cases, the two values were summed to calculate NN. This process created some statistical complications when either one of these values was listed as a lower-detection limit. In these cases, the epsilon method was used (see "Detection Limits" below).

Statistical Methods

Much of what appears in this section is derived from our earlier work on Seasonal Kendall Analysis (Rheem 1992; E.P. Smith *et al.*, 1993). The data consist of measurements of 9 water-quality variables made at 191 monitoring stations. The measurements were made over varying time periods between the late 1960s and early 1997 at intervals of varying lengths, but, generally, at three- to four-week intervals.

From a general statistical perspective, the water-quality variables at each site can be regarded as a multivariate time series (E.P. Smith *et al.*, 1993). For this study, however, the multivariate aspect was ignored. Thus, each water-quality variable at each site is analyzed as a univariate time series. With a few embellishments discussed below, we have followed the methods of Hirsch, *et al.* (1982) and Gilbert (1987, Chapters 16 and 17) to detect and describe *monotonic* trends. Interpretation of the Seasonal Kendall Test is also discussed by Helsel (1993), and by R.A. Smith *et al.*, (1993). Hirsch *et al.* (1991) contains a general review of statistical techniques for detection of water-quality trends.

Monotonic trends occur when a population of observations shifts over time. The detection of a monotonic trend does not imply that the trend is linear, occurs in one or more discrete steps, or in any other pattern (Hirsch et al., 1991). The only requirement is that the change occurs with time over the period of analysis. A monotonic change appears as unidirectional when analyzed over a given time period, although it is possible that a monotonic trend could be interpreted as bidirectional if the data were disaggregated and analyzed separately over two time periods.

Seasonal Kendall Analysis: Trend analysis consists of (i) statistical significance testing of the hypothesis that there is no time trend versus the alternative hypothesis of an overall increase or decrease with time, and (ii) estimating the rate of change of the water-quality variable with respect to time. As explained by Gilbert (1987, pp. 225-228), the seasonal Kendall test and slope estimator are used because of their robust statistical properties. They are valid for data that are non-normal and cyclic. They are well suited, moreover, to data with missing values and to data that are "truncated" at upper and lower detection limits

Seasonal Kendall Tau: Seasonal Kendall tau, a nonparametric correlation coefficient, is a measure of the strength or consistency of a monotonic relationship between a water-quality characteristic and time. Ranging from -1 to +1, its interpretation is analogous to that of the more familiar Pearson coefficient of correlation. A value of exactly -1 (+1) would be obtained only if there were, for each month of the year, a decrease (increase) from year to year for each year represented by available data. The analysis is *robust* because it takes into account only whether the yearly change is positive or negative, and completely ignores the magnitude of the change. The analysis is *seasonal* because month-to-month changes are ignored. Indeed, Seasonal Kendall tau is a weighted average of twelve rank-correlation coefficients (Kendall, 1970), one for each month of the year. Kendall's (1970) rank-correlation coefficient (Kendall's tau) is a coefficient of correlation between the rank of the water-quality variable and time.

On a more technical level, this statistic is called "*modified* Kendall's tau" in the statistics literature because, if monthly observations for successive years are equivalent (that is, no information is present that allows one observation to be considered as greater or less than the other; the observations are "tied"), the correlation coefficient can still range from -1 to +1. More precisely, the version of tau used is similar to Kendall's tau – Breslow's type which is typically used in survival analysis. The lower detection-limited values are treated as being tied with each other and tied with any values less than the reported detection limit (Brown *et al.*, 1974).

For each variable and station, seasonal Kendall tau and the twelve monthly tau values are tabulated. The null hypothesis can be stated as: there is no monotonic trend. The P-value accompanying each tau value is the result of a test of significance of the hypothesis "tau = 0" versus the alternative "tau not equal to 0." The seasonal test is much more sensitive (*i.e.*, powerful) than the monthly tests for the simple reason that the seasonal test is based on a much larger sample (approximately 12 times larger). Thus, it is possible to have a seasonal Kendall tau that is significantly different from zero while none of the monthly taus upon which it is based is significantly different from zero.

The technical explanation gets to the heart of this conceptually simple statistical method. The Kendall analysis of the time series is, in fact, an analysis of the differences between all pairs of observations for each month. All observations below the lower detection limit are considered tied, and the differences of all tied pairs are zero. The seasonal Kendall test of significance compares the number of positive differences with the number of negative differences. Seasonal Kendall tau is the ratio of the number of positive differences minus the number of negative differences to the number of pairs (discounted for ties). (See Kendall, 1970, [pp. 34 ff.] for the exact formulation.) Thus, tau is zero only if the number of positive differences and the number of negative differences are exactly the same. If they are not exactly the same, then tau is nonzero, and, if the disparity is great enough, then tau is statistically significant, *i.e*., significantly different from zero, regardless of the number of ties. The seasonal Kendall slope estimator (or median-change per year), on the other hand, is the median of all the differences including the zero differences, divided by the number of years involved.

Estimates of Slope: The rate of change of each water-quality variable is quantified by the seasonal Kendall slope estimator (see Hirsch, et al., 1982, and Gilbert, 1987, pp. 227-228; see also Theil, 1950, and Sen, 1968). It is the median, over all pairs of years for each month, of the change-per-year of the water quality variable.

The seasonal Kendall slope estimator has the same robust statistical properties as seasonal Kendall tau. Moreover, the test of significance of seasonal Kendall tau can also be interpreted as a test of significance of the hypothesis that the median change per year (slope) is different from zero, but there is one caveat as explained below. The seasonal Kendall slope estimator, along with 90% and 95% confidence limits of the change per year, is tabulated (i) in the original units of measurement (slope), and (ii) as a percentage of the median, in the program output (Zipper et al, 1998) for each variable at each monitoring station.

***Caveat: The apparent paradox of a statistically significant estimated slope of zero*:** As explained in the preceding paragraph, it is generally reasonable to interpret the test of significance of tau as, equivalently, a test of significance of the slope. Under certain circumstances, however, an apparent paradox arises.

If a large number of the water-quality-variable observations are below the lower detection limit, then it is possible for seasonal Kendall tau to be significantly different from zero, and for the seasonal Kendall slope estimate to be zero.

When this happens, the detailed output should be inspected. In most cases, it will be found that many observations are below the detection limit, but higher levels are detected from time to time. A statistically significant tau indicates a statistically significant difference in the frequency with which these high levels have been observed in the two halves of the time series. In other words, it indicates that the instances of higher levels are not uniformly (not "randomly") distributed in time. If the high levels have occurred more often toward the beginning of the period of observation and less frequently toward the end, then tau will be negative. If the high levels have occurred more frequently toward the end of the period of observation, then tau will be positive. Yet, in either case, because many observations have been below the detection limit and higher levels are relatively rare, the "best" estimate of the slope is zero.

The apparent paradox arises from use of the misleading term “slope” for this statistic (Kendall’s seasonal slope estimator). The term “slope” connotes a straight line and implies misleadingly that we are testing for a strictly linear relationship, as in simple linear regression. In fact, we are testing for a monotonic relationship, any monotonically increasing or decreasing function. Such relationships can include straight lines, but they can also include convex functions, concave functions, and “S” curves (etc.) so long as they are monotonic.

P-Values: The sign of the Kendall’s tau statistic tells us whether the measure of a given water-quality parameter has increased or decreased over time. If tau is equal to a non-zero value, there is some statistical evidence that a trend exists. The next question is "how significant is that statistical evidence?" The P-value (Pearson, 1900) is a statistic designed to answer that question. It is the probability of observing a tau value of equal or greater magnitude than that observed if there were no real trend present. Thus, if the P-value is equal to .01 (*i.e.*, 1%), one of two possibilities are present: either there really is a non-zero trend, or something very unusual (with probability of 1 percent or less) has occurred (Fisher, 1956) and a non-zero trend is not present. Thus, when the P-value is less than or equal to .01, we say "there is a statistically significant trend", meaning that we are confident that there actually is a long-term trend, and that the results are not just a random-sampling fluke.

Comparisons of Slope (Median Change per Year) Among Stations: To compare the rate of change of a particular variable at one station to the rate of change of the same variable at another station, we tentatively suggest comparing the slopes’ 90% confidence intervals in the original units of measure. If the 90% confidence intervals for the median change per year for a given variable at two different stations do not overlap, then it is reasonable to infer that the rates of change for that variable at these two monitoring stations are significantly different from one another.

Other Statistical Issues

***Multiple Observations Per Month*:** It was necessary to detect and modify the data for months during which there were multiple observations, because the seasonal Kendall procedure allows only one observation per month. Some months had multiple observations. In each of those months, the median of the observations was chosen as a representative value for that month so that the data set would consist only of monthly observations. This method is valid when multiple observations in a month occur randomly with respect to time (Helsel and Hirsch, 1992).

Lack of Flow Data: Because accurate flow data were not available for many monitoring stations, data were not adjusted for flow in conducting seasonal Kendall analysis.

Remark Codes: STORET remark codes are single-character variables that accompany water-quality values entered in the STORET database (Table 5). If the remark-code field is blank, the data value may be interpreted as entered. Non-blank remark codes typically indicate a condition that should be placed on interpretation of the associated data value. Data with non-blank remark codes to indicate conditions other than detection-limits or calculated values ($ -

DO only) were eliminated from the trend analysis. Below each graphic display (Zipper et al, 1998), those observations eliminated from the analysis due to remark codes are listed. Detection-limited values--as indicated by remark codes K, L, M, T, U, or P (for FC) --were analyzed as described under "Detection Limits" below. Remark codes other than those indicating detection limits occurred only rarely.

Detection Limits: For each variable at each monitoring station, all observations remark-coded as being at a lower detection limit were treated as tied. Similarly, all observations remarked as being at an upper detection limit were treated as tied. The procedure is valid even if the detection limits change multiple times during the period of observation. Values less than or equal to a lower detection limit (and similarly, greater than or equal to an upper detection limit) were treated as tied with values designated as being at the detection limit. Values remarked as being analyzed for but not detected were treated the same as values at a lower detection limit. Common detection limits are listed in Table 4.

This procedure was complicated for the nitrate-nitrite nitrogen (NN) variable, because in some cases two values were added to create the NN value used in this analysis. Where both nitrate and nitrite were remark-coded as lower detection limits, the combined value was remark-coded as a lower detection limit; where neither was remark-coded as a lower detection limit, the two values were simply summed to create NN. Where only one of the two values (either nitrate or nitrite) was remark-coded as a lower detection limit, the combined variable was defined as being greater than the non-detection-limited component, but less than the sum of the two components. This analysis required development of statistical procedure designated as the “epsilon method". Usage of the epsilon method is documented in the remark-code sections of the output for the NN variable at each monitoring station (Zipper et al, 1998).

Results

Output and Interpretation

Detailed results for each parameter at each water-quality monitoring station can be found in the Appendix to this report and an internet site (Zipper, Holtzman, and Darken, 1998). Table A-2 (Appendix A) contains an estimate of Kendall's tau, and an indicator of its statistical significance, for each analysis performed. Table A-3 contains estimates of slope (median change per year). The sign of non-zero values of Kendall's tau indicates whether the best-estimate of that slope (median change per year) is positive or negative (*i.e.*, increases or decreases with time). P-values indicate the statistical significance of the slope estimate as well as Kendall's tau.

Table A-4 lists the median value of each parameter at each monitoring station, and Table A-5 lists the slopes as a percentage of the median values listed in Table A-4. The slopes-as-percentage-of-medians can be used to compare estimated rates of change among different variables at individual stations. However, these figures can be misleading in situations where the majority of a data set is characterized by relatively low values (such as measurements at detection limits) but a small number of high values are concentrated either early or late in the time period analyzed. In cases such as these, medians can be quite low causing slopes to appear as quite high when expressed as a percentage of the median. Median values, rather than means, were used for this analysis because the presence of detection-limited values distorts a calculated mean. Table A-6 lists the period of analysis for each variable at each monitoring station (years only) and Table A-7 lists the number of monthly values upon which the analysis is based. In some cases, no data are available for multiple-month or multiple-year periods between the starting and ending dates. In some cases, a finding of "no trend" may have occurred where trends were actually present but could not be detected due to insufficient data availability.

More detailed output, including graphic displays, is available on the internet (Zipper et al., 1998). Each graphic display represents a plot of monthly data values. In most cases, each point represents analysis of a single water sample, as water-quality monitoring samples are typically taken on a monthly basis. Where two or more samples were taken at a given station during a single calendar month, the graphic display-point represents the median of those observations as used for this analysis.

In some cases, the values displayed by the graphic output represent the detection limit of the analytical procedure. For example, total phosphorous (TP) analytical procedures used during some time periods utilized a detection limit of 0.1 mg/l. If the actual concentration of total phosphorous for a sample analyzed using this procedure is less than 0.1 mg/l, the result is recorded as "equal to or less than the detection limit" and graphed as 0.1 mg/l. Most graphic displays have a dotted line, with slope equal to the estimated median-change-per-year (seasonal-Kendall slope estimator) drawn through the estimated median water-quality level at the mid-point of the time series. The top of the graphic display for each variable includes values for Kendall's tau, best estimate of slope, and the statistical P-value. Summary statistics are printed out below the graphic display for each water-quality variable at each monitoring station. Below the summary statistics, data values excluded from the analysis as outliers or erroneous values are listed. Detection-limited values are listed under "Remark Codes."

Trends and Medians

Trends and medians for each of the nine water quality variables are discussed in the following section. The discussion is based on Figures 3 through 29 and Tables 6 through 16.

Distributions of trends within the median quintile-segments (Table 6) are presented in bar graphs (Figures 5, 8, 11, etc.). Trends in the bar graphs are depicted along the horizontal axis as arrows, with "up" arrows representing increasing trends. ($P < 0.01$ is represented by 2 arrows; $0.01 < P < 0.1$ is represented by 1 arrow), "down" arrows depicting declining trends ($P < 0.01$ is represented by 2 arrows; $0.01 < P < 0.1$ is represented by 1 arrow). A bi-directional arrow signifies that no significant or apparent trend was found to be present ($P > 0.1$). Bar graphs represent distributions of trends within each median quintile-segment where lower = lower quintile-segment, 2nd = second-lowest quintile-segment, 3rd = third-lowest quintile-segment, 4th = fourth-lowest quintile-segment, and high = highest quintile-segment. In some cases, the median values used to determine quintile-segments represent detection limits rather than actual concentrations or water-quality measurements (see Tables 4 and 6). Use of these bar graphs can allow a person to determine whether declining trends, for example, for a particular variable within a given basin (or statewide) tended to occur at stations where median values for that variable tended to be either high or low, relative to other stations in that basin (or statewide).

In the interpretations that follow, description of a "significant" trend indicates a P-value of less than .01 ($P < .01$), while description of an apparent (or "questionable") trend indicates a P-value of less than .10 but greater than .01 ($.01 < P < .10$). A statement such as "trends are present" may refer to the combined presence of both significant and apparent trends. If several apparent trends occur in a given watershed or location, it would appear reasonable to believe that the majority are actually present. Similarly, the term "stations with high medians" is used to refer to stations whose medians occur within the upper median quintile-segment (Table 6), while the term "relatively high medians" refers to the fourth median-quintile segment as well as the upper segment. "Low medians" and "relatively low medians" are terms used in a corresponding manner.

All interpretive statements which follow apply only to stream segments represented by the monitoring stations studied. Lack of an observed trend may mean that a trend was not present, or that the quantity of data available for a given water-quality variable at a given monitoring station was insufficient to allow a trend to be detected. Table A-7 lists the number of monthly observations available for each parameter at each monitoring station. Trend analyses were not performed where no month had more than one observation.

Table 6. Median quintile-segments for water quality parameters

Quintile Parameters	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
	% sat	mg/l		mg/l	mg/l	mg/l	mg/l	mg/l	/100 ml
				Upper					
Upper bound	105.10	8.00	8.6	32250	40.00	4.20	10.00	1.30	6000
Lower bound	96.50	2.13	8.1	332	18.00	0.89	0.64	0.11	350
# observations	39	25	37	35	35	37	36	33	35
				Fourth					
Upper bound	96.40	2.00	8.0	323	17.00	0.88	0.60	--	300
Lower bound	93.40	2.00	7.7	195	9.00	0.49	0.50	--	110
# observations	39	38	40	35	35	37	29	--	37
				Third					
Upper bound	93.30	1.90	7.6	194	8.00	0.47	0.45	0.10	100
Lower bound	90.90	1.10	7.25	126	6.50	0.29	0.35	0.10	100
# observations	38	30	37	35	30	38	30	142	99
				Second					
Upper bound	90.85	--	7.2	124	6.00	0.28	0.30	--	--
Lower bound	84.30	--	7.1	84	5.50	0.14	0.23	--	--
# observations	38	--	33	25	25	41	44	--	--
				Lower					
Upper bound	84.10	1.00	7.0	82	5.00	0.13	0.20	0.08	93
Lower bound	55.00	1.00	6.4	36	3.00	0.05	0.10	0.02	3
# observations	38	93	44	36	59	36	53	16	9

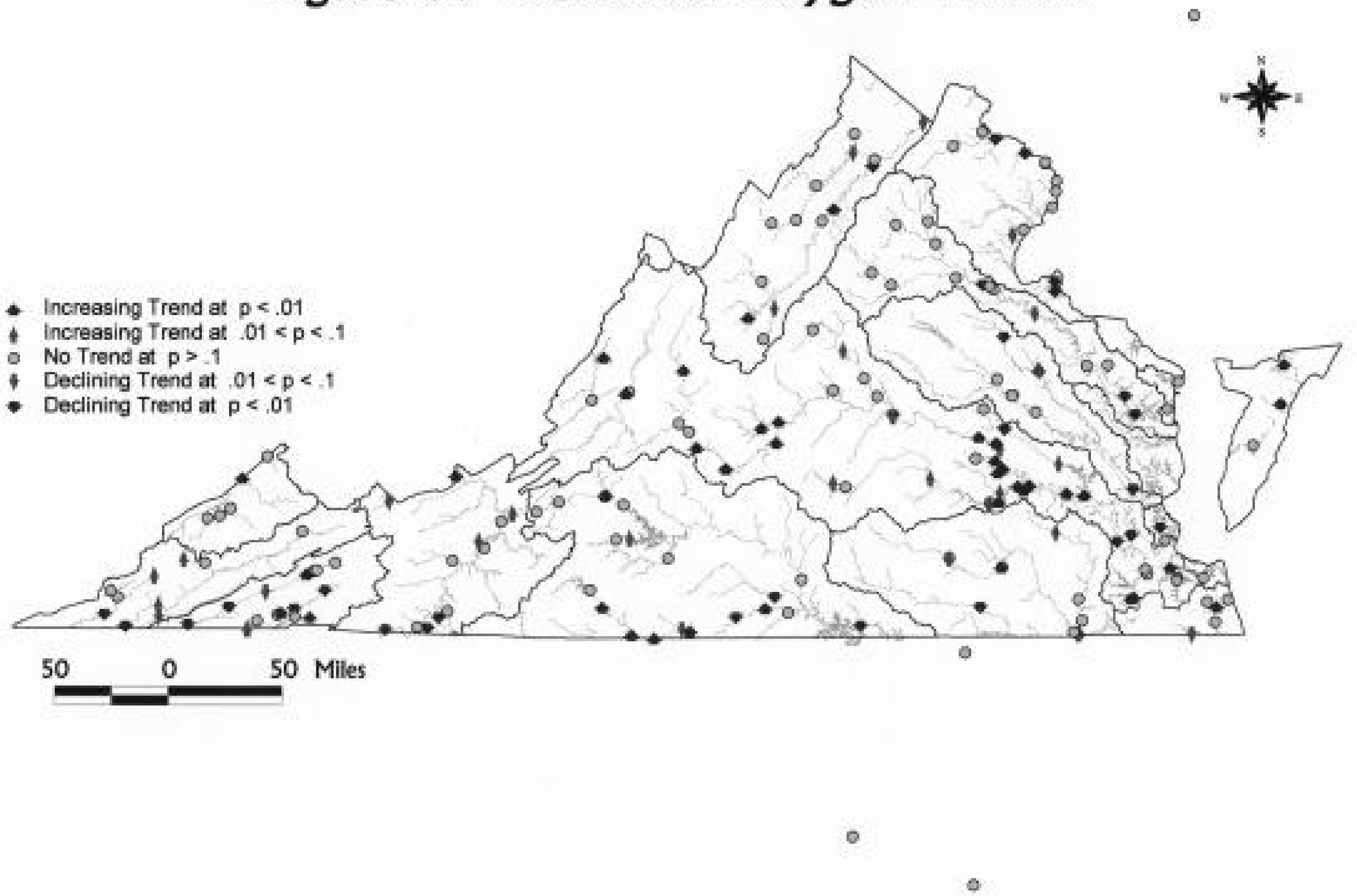
Dissolved Oxygen Saturation (DO): More than 50 % of the Virginia monitoring stations exhibited significant or apparent DO trends (Table 7, Figure 3). Increasing trends (significant and apparent) outnumbered declining trends by roughly a 4-to-3 margin. Significant and apparent increasing trends were observed at more than 30 % of all stations and are prevalent in the upper *James* basin. The *Roanoke* basin and the upper portion of the Eastern Shore, in the *Coastal Basins / Chesapeake Bay* region, also exhibited relatively high incidences of increasing trends. No significant or apparent increasing trends were observed in the *Potomac*, *Rappahannock* River, or *York* basins. Declining trends occurred in the middle and lower *Rappahannock* basin, the *Potomac* basin, the lower *New* River basin, and the upper and lower *York* basin. No declining trends were observed in the *Big Sandy* basin. Only two stations in the lower *James* basin, adjacent to one another, showed declining trends.

Table 7. Summary of dissolved oxygen (DO) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	14	0	0	7	2	5
1B - Shenandoah	14	2	1	8	2	1
2 - James	50	22	8	16	0	4
3 - Rappahannock	14	0	0	10	1	3
4 - Roanoke	20	6	1	10	1	2
5A - Chowan	11	1	1	5	2	2
5B - Dismal Swamp	5	1	0	3	1	0
6A - Big Sandy	5	1	0	4	0	0
6B - Clinch-Powell	10	0	3	4	1	2
6C - Holston	16	3	2	6	1	4
7 - Coastal Basins	8	2	0	5	0	1
8 - York	8	0	0	3	1	4
9 - New	12	1	2	5	1	3
Virginia Totals	187	39	18	86	13	31
Out-of-State	*4*	0	0	4	0	0

†Sig. = significant trend (P < 0.01)
App. = apparent trend (0.01 < P < 0.10)
No Sig. or App. Trend = no significant or apparent trend (P > 0.10)

Figure 3. Dissolved Oxygen Trends



Relatively high DO medians tended to occur west of the Fall Line (Figures 4, 5), whereas relatively low medians tended to occur east of the Fall Line. High medians were prevalent in the *Big Sandy* basin and along the North Fork of the Shenandoah River in the *Shenandoah* basin. Relatively high medians were also common in the upper reaches of the *James*, *Potomac* and *Rappahannock* basins. Low medians were prevalent in the middle *Potomac* basin, the lower *Rappahannock* basin, the lower *James* basin, the lower *Chowan* basin, and the *Chesapeake* Bay basin. In the *York* and *Holston* basins, declining DO trends tended to occur at monitoring stations with relatively low DO medians.

Figure 4. Dissolved Oxygen Medians

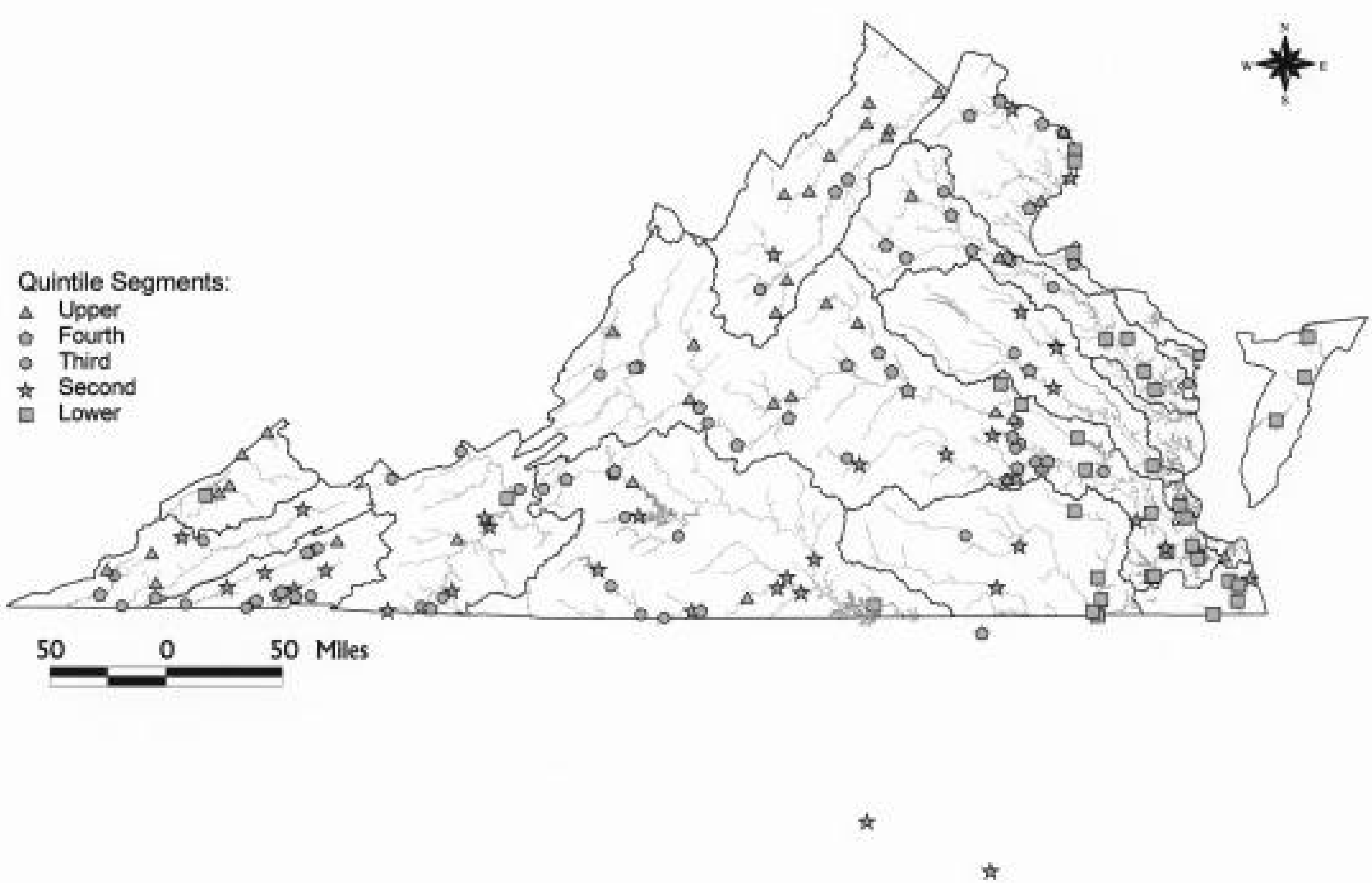
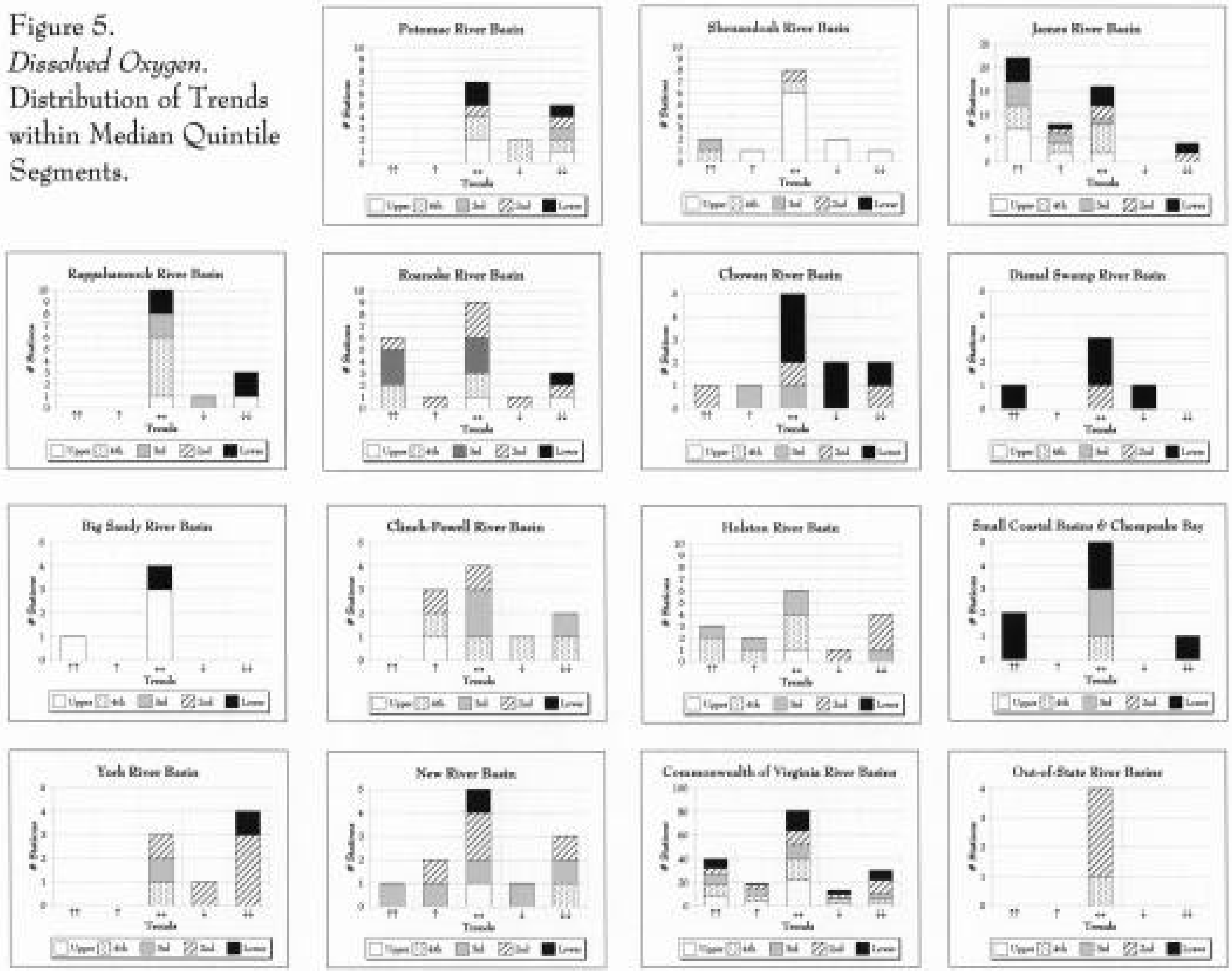


Figure 5.
Dissolved Oxygen.
Distribution of Trends
within Median Quintile
Segments.



Biochemical Oxygen Demand (BOD): Of the nine variables studied, biochemical oxygen demand (BOD) exhibited the most dramatic pattern of water quality change. Over 60% of the Virginia monitoring stations studied exhibited significant or apparent declining trends; the majority of the declining trends were significant (Table 8, Figure 6). Only one station, in the *Dismal Swamp* basin, showed either a significant or an apparent increasing BOD trend. Declining trends were prevalent in southwestern *Big Sandy*, *Clinch-Powell*, *Holston*, and *New* River basins. Declining trends were also prevalent in the *Shenandoah*, upper *Rappahannock*, upper and middle *James*, and the mid-*Potomac* basins. Clusters of stations that failed to exhibit apparent or significant trends were observed in the *York* River, lower *Rappahannock* River, and lower *Roanoke* basins.

Table 8. Summary of biochemical oxygen demand (BOD) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	13	0	0	8	0	5
1B - Shenandoah	14	0	0	3	2	9
2 - James	50	0	0	20	14	16
3 - Rappahannock	14	0	0	8	4	2
4 - Roanoke	19	0	0	11	3	5
5A - Chowan	11	0	0	4	3	4
5B - Dismal Swamp	5	0	1	2	0	2
6A - Big Sandy	5	0	0	0	0	5
6B - Clinch-Powell	10	0	0	0	0	10
6C - Holston	16	0	0	1	0	15
7 - Coastal Basins	8	0	0	3	0	5
8 - York	8	0	0	7	1	0
9 - New	12	0	0	4	1	7
Virginia Totals	185	0	1	71	28	85
Out-of-State	1	0	0	1	0	0

†Sig. = significant trend ($P < 0.01$); App. = apparent trend ($0.01 < P < 0.10$); no Sig. or App. Trend = no significant or apparent trend ($P > 0.10$)

Most of the median values for BOD were at the lower detection limit and were thus considered to be within the lower quintile-segment (Figures 7, 8). Upper quintile-segment medians were prevalent in the *Dismal Swamp* basin and in the *Small Coastal basins and Chesapeake Bay*. Upper quintile-segment medians also occurred in the *Potomac* basin, while relatively high (fourth segment) medians tended to occur in the *Rappahannock* basin and the *James* basin east of the Fall Line. Declining trends at stations with relatively high medians were prevalent in the *Potomac* and *Small Coastal / Chesapeake* basins.

Figure 6. Biochemical Oxygen Demand Trends

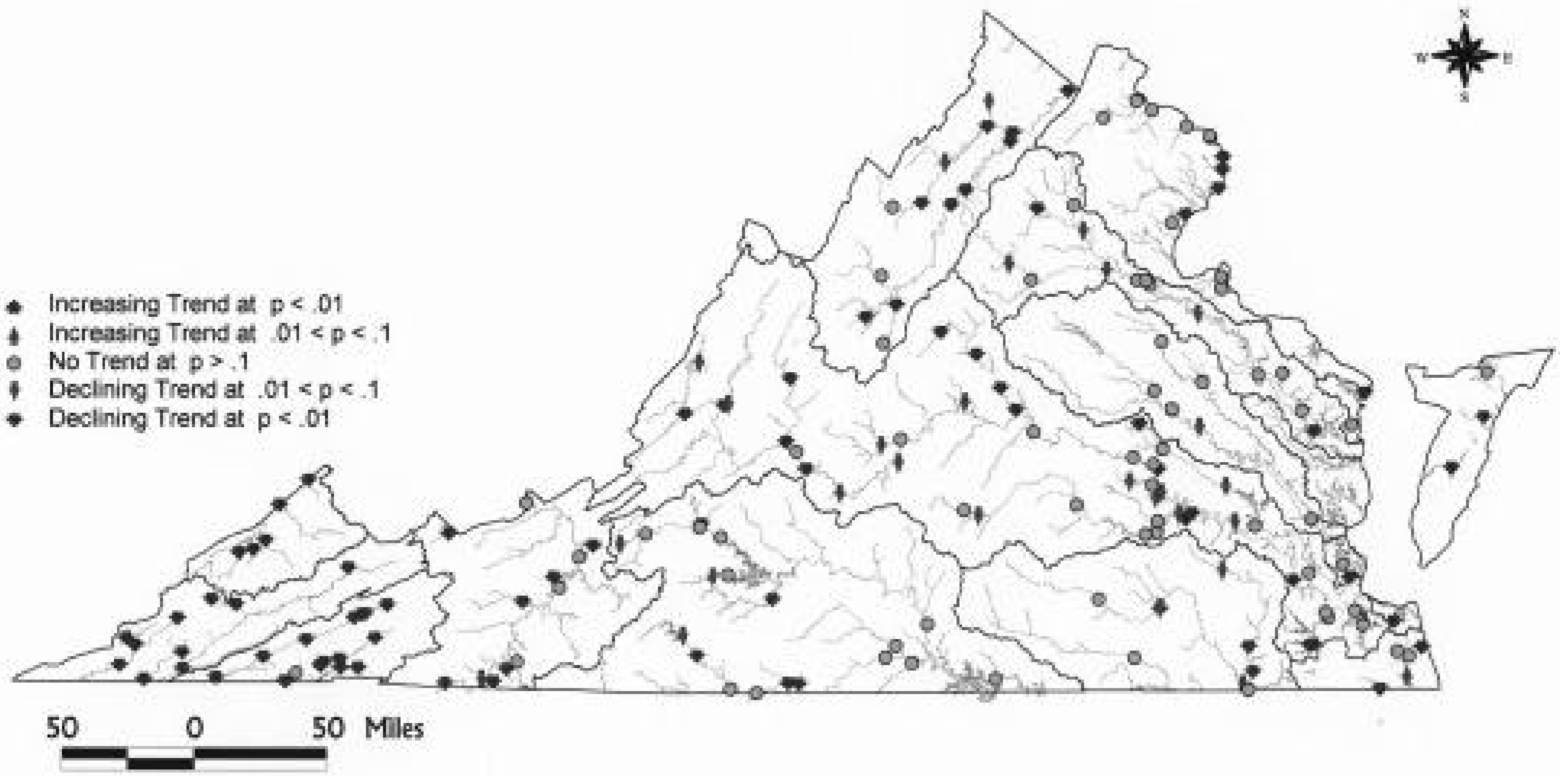
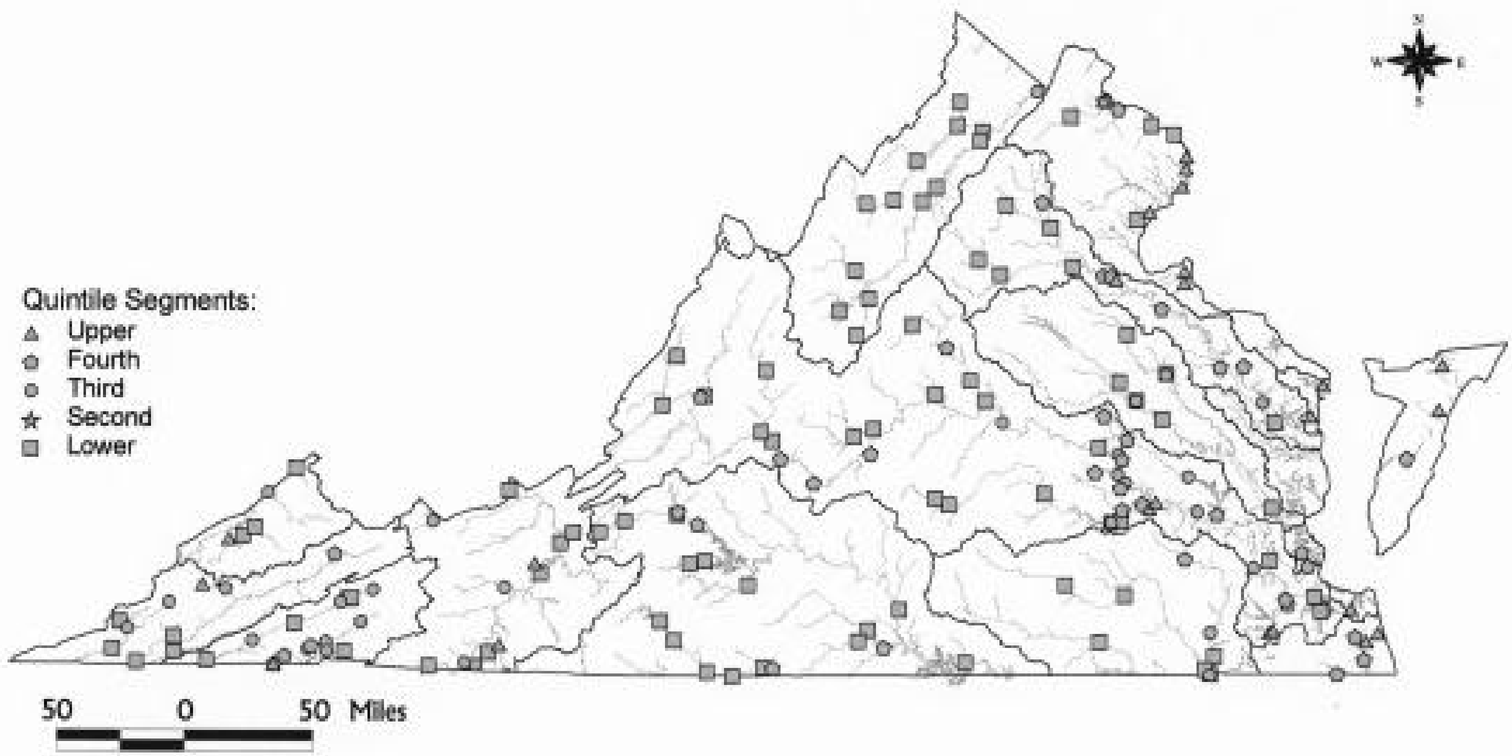


Figure 7. Biochemical Oxygen Demand Medians



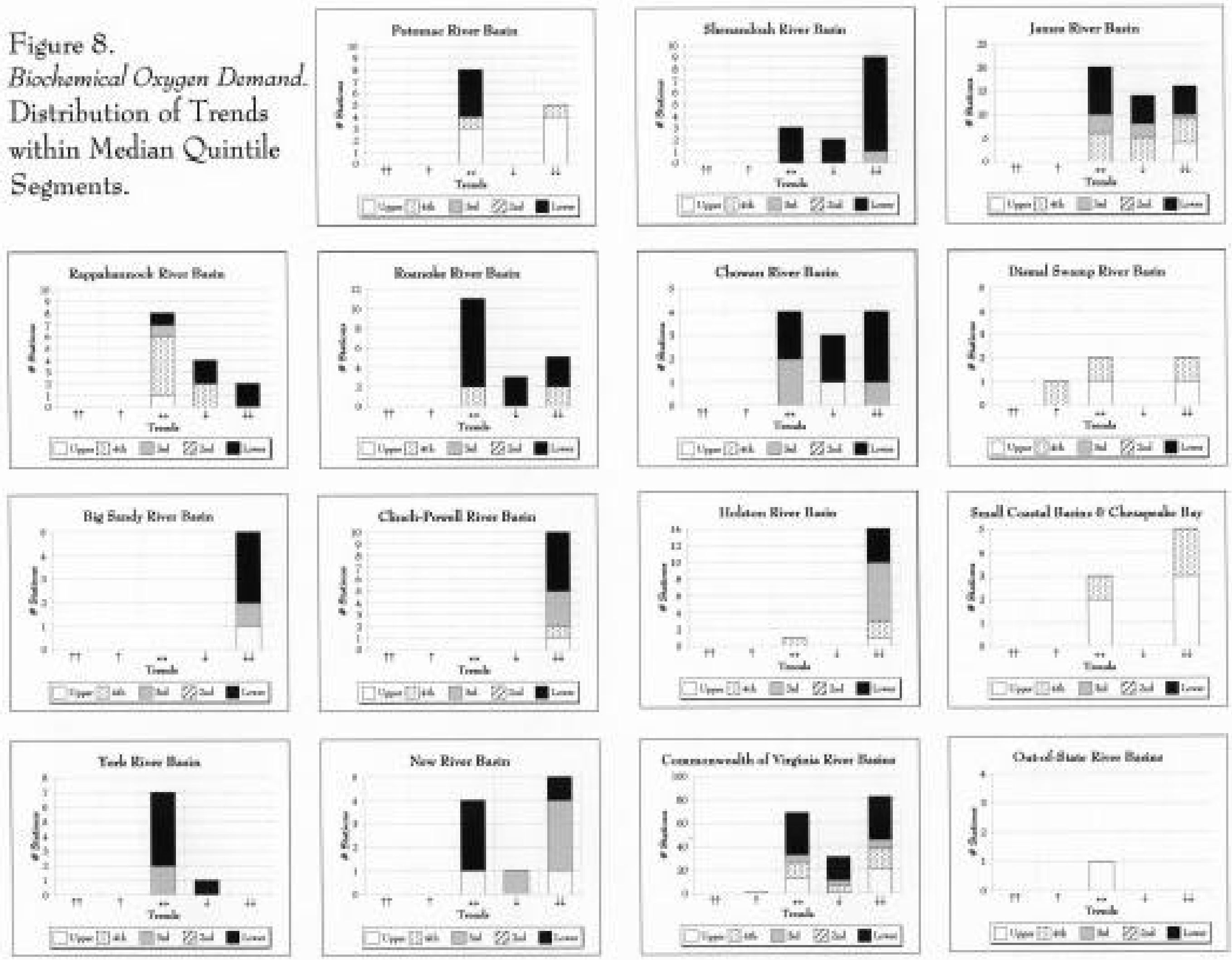


Figure 8.
Biochemical Oxygen Demand.
Distribution of Trends within Median Quintile Segments.

pH: pH trends were mixed throughout the Commonwealth, as 12 of the 13 basins exhibited both increasing (significant or apparent) and decreasing (significant and apparent) pH trends. The exception was the *Big Sandy* basin where no significant declining or apparent declining trends were found to be present (Table 9, Figure 9). Increasing trends are prevalent in the middle and upper *James*, the upper *New* River, and coalfield areas (the *Big Sandy* basin, the upper *Powell*, and the *Clinch River basin's* Guest River), while declining trends were prevalent in the *Holston* basin. Declining trends were also observed in the upper *Rappahannock* basin and the lower *James* River and *Roanoke* basins.

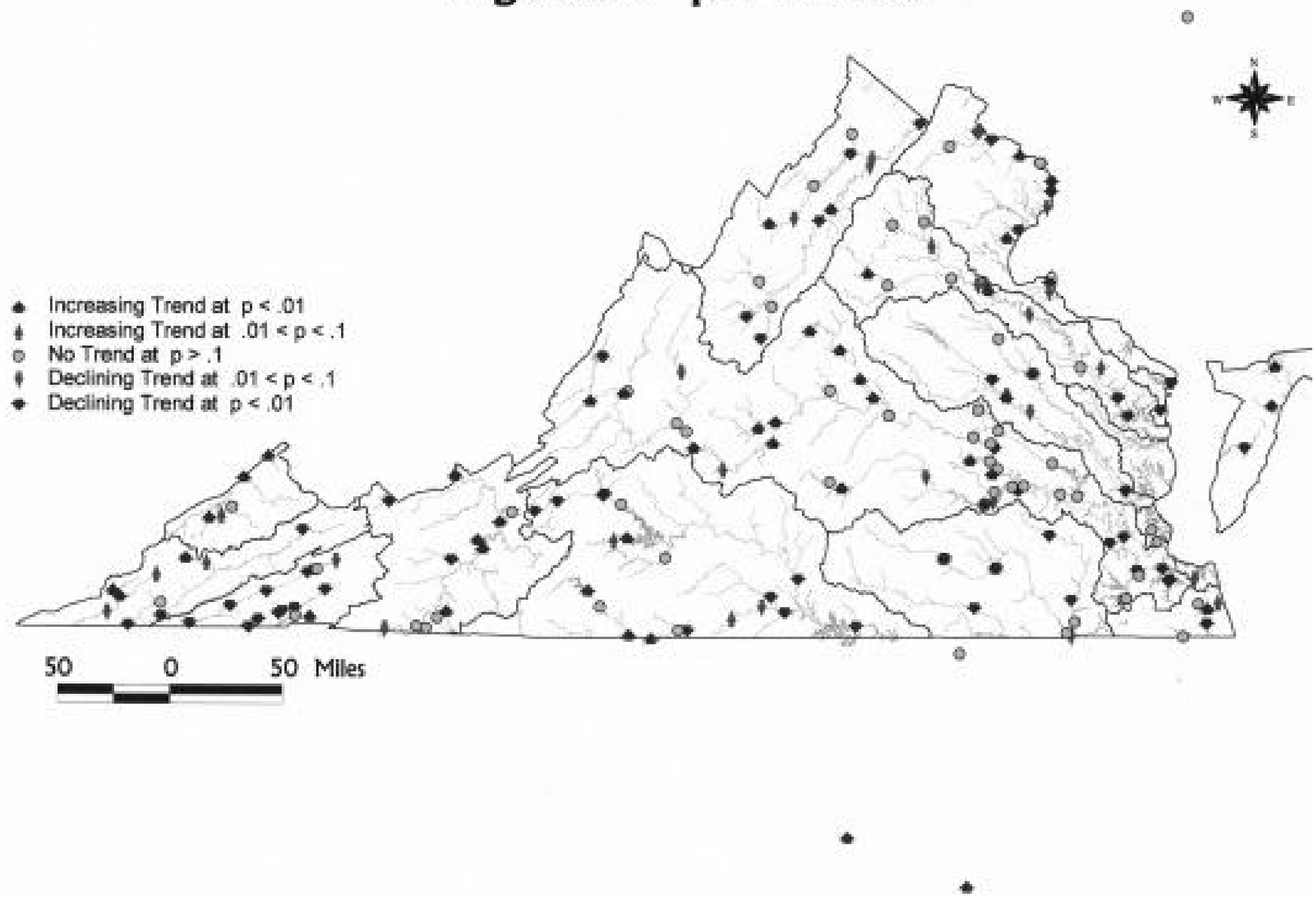
Table 9. Summary of pH (pH) trends

Basin	**Total Stations**	**Increasing Trends**		**No Sig or App. Trend**	**Declining Trends**	
		Sig.†	**App.**		**App.**	**Sig.**
1A - Potomac	14	2	0	2	4	6
1B - Shenandoah	14	2	0	4	3	5
2 - James	50	14	3	22	2	9
3 - Rappahannock	14	3	2	5	2	2
4 - Roanoke	20	4	1	5	1	9
5A - Chowan	11	2	0	2	2	5
5B - Dismal Swamp	5	1	1	2	0	1
6A - Big Sandy	5	3	1	1	0	0
6B - Clinch-Powell	10	3	2	1	1	3
6C - Holston	16	1	0	2	1	12
7 - Coastal Basins	8	2	0	2	1	3
8 - York	8	1	0	2	2	3
9 - New	12	5	0	4	1	2
Virginia Totals	187	43	10	54	20	60
Out-of-State	4	2	0	2	0	0

†Sig. = significant trend ($P < 0.01$); App. = apparent trend ($0.01 < P < 0.10$)
No Sig. or App. Trend = no significant or apparent trend ($P > 0.10$)

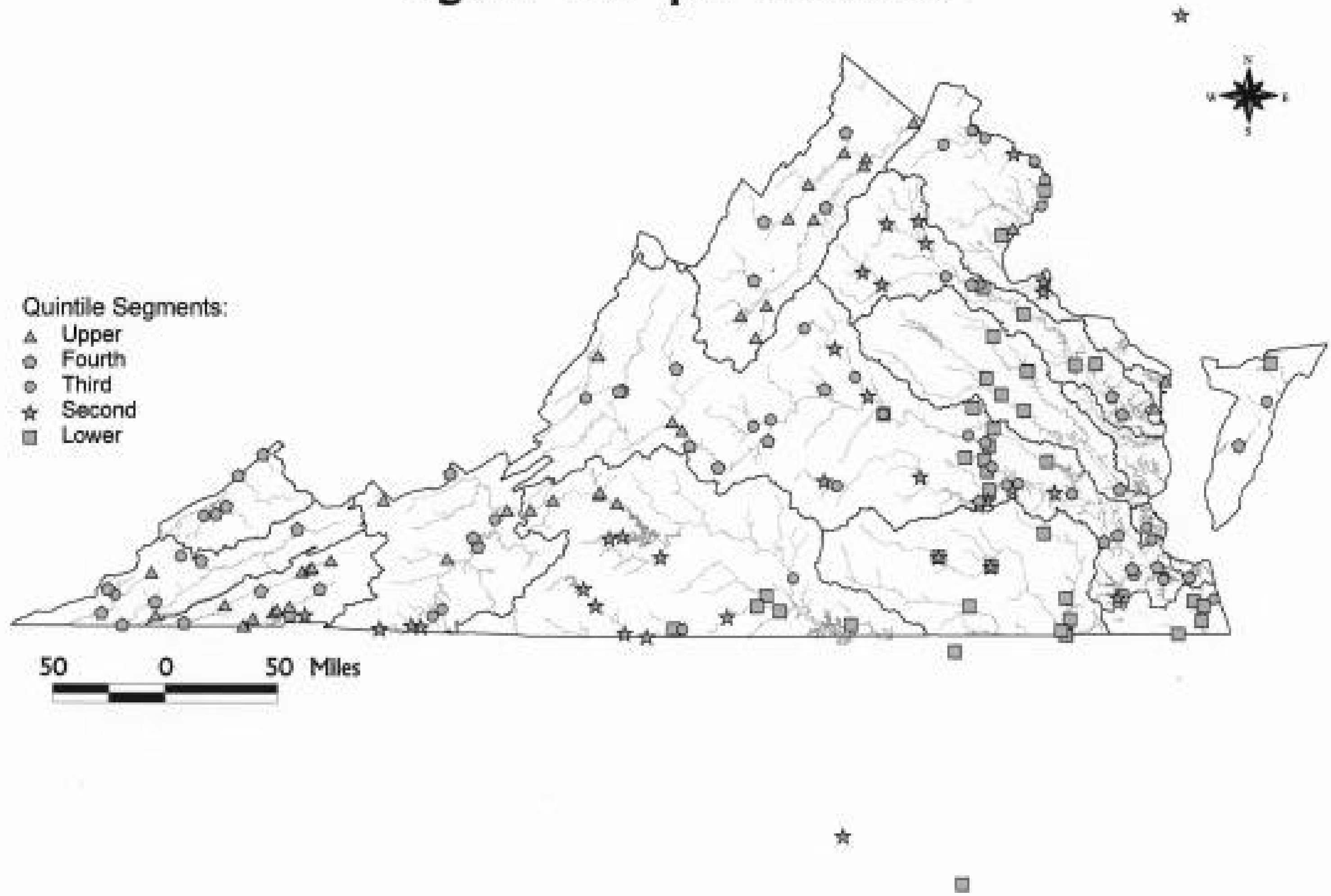
On a statewide basis, declining pH trends outnumbered increasing trends by roughly a 3-to-2 margin. However, 9 of the significant and apparent increasing pH trends were located at monitoring stations that we suspect were influenced by coal mining activity. The coal industry's use of alkaline reagents to neutralize acid mine drainage has increased dramatically since the late 1960s and early 1970s. Excluding these stations due to these unique circumstances, declining pH trends throughout remaining areas of the state outnumbered increasing trends by nearly a 2-to-1 margin.

Figure 9. pH Trends



A pattern in the distribution of pH medians was observed (Figures 10, 11). High medians tend to cluster in the *Shenandoah* basin, the upper *James* basin, the upper *Roanoke* basin, and in the *Holston* basin; these are all western Virginia areas characterized by limestone valleys. Two stations in the upper portion of the *Small Coastal basins and Chesapeake Bay* watershed also had upper quintile-segment medians. Other basins exhibiting relatively high medians (including fourth quintile-segment) included the *Big Sandy*, *Clinch-Powell*, upper and lower *James*, and lower *Rappahannock* basins. No lower quintile-segment medians were observed west of the Blue Ridge although a few second-segment medians occurred in the lower *New* basin near the North Carolina border. Most lower-segment medians were concentrated in basins along the Fall Line including the *Potomac*, *Rappahannock*, *York*, and *Chowan* basins. Low medians also occurred in the *Roanoke* River and *Dismal Swamp* basins.

Figure 10. pH Medians



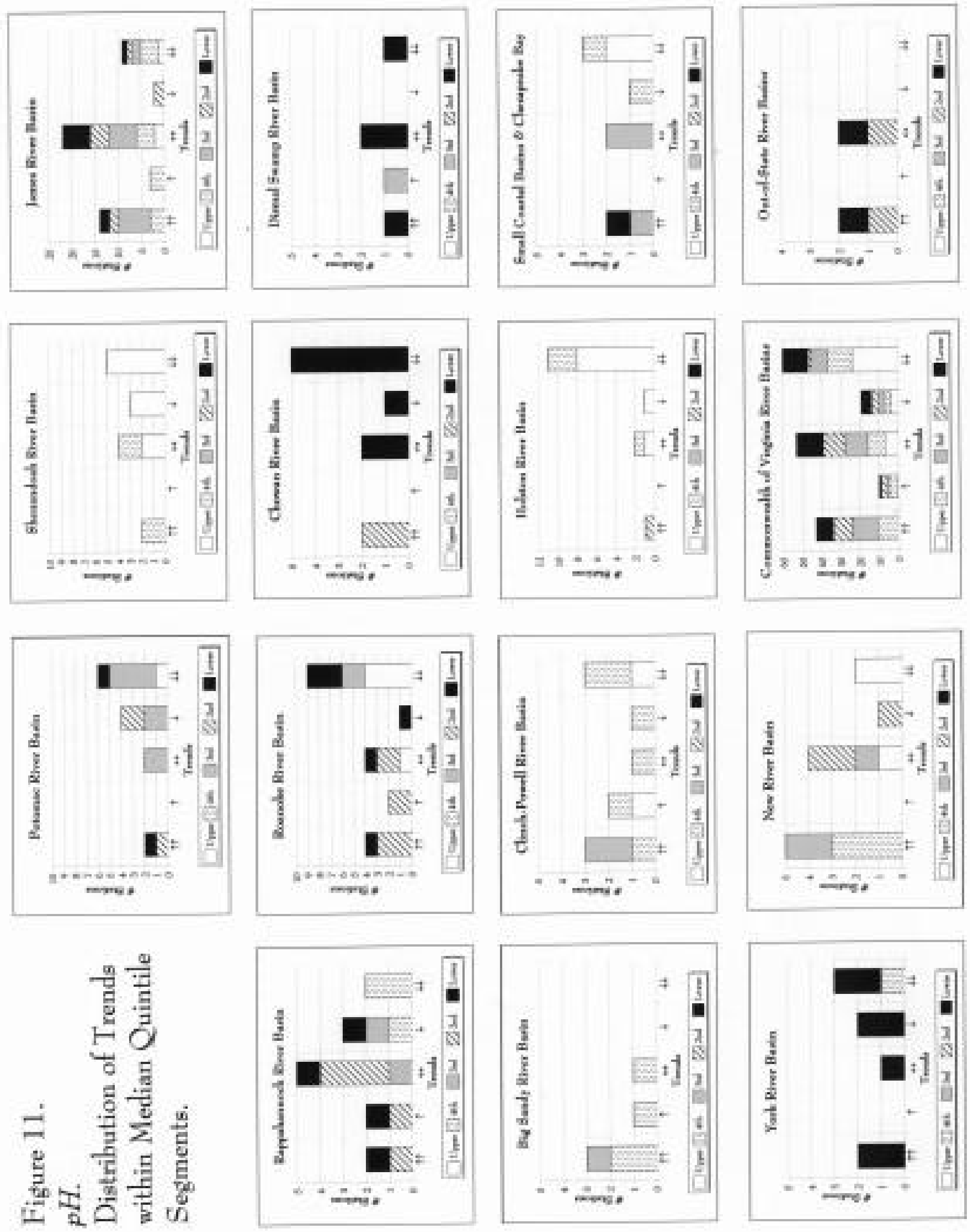


Figure 11.
pH.
Distribution of Trends within Median Quintile Segments.

Total Residue (TR): On a statewide level, numbers of increasing trends (significant and apparent) and decreasing trends (significant and apparent) were roughly in balance (34 declining, 31 increasing). The majority of the stations studied (63%) failed to exhibit significant or apparent trends (Table 10, Figure 12). Declining trends occurred along the Fall Line in the *James* basin, and in the *Holston* and *Shenandoah* basins. Increasing trends were observed in the coalfield region, within the *Big Sandy* basin the upper-*Powell*. A few increasing trends were detected in the lower *Holston*, the upper *Potomac*, and the *Dismal Swamp* basins.

High-segment medians for TR were concentrated in the *Small Coastal basins and Chesapeake Bay*, in the *Dismal Swamp* basin, and in the lower reaches of the *Potomac* River, *Rappahannock* River, *York* River, and the *James* basins (Figures 13, 14). These are primarily stations where TR concentrations are influenced by tidal activity (saline waters will have high TR). Relatively high median values also tended to occur in the coalfields, in the *Big Sandy*, upper *Powell* basins, and in the Guest River (tributary of the *Clinch*). Lower quintile-segment medians occurred only along and west of the Fall Line, including the upper *Rappahannock* River, middle *James*, lower *New* River, and *Roanoke* basins.

Non-Filterable Residue (NFR): Almost half of the stations studied exhibited declining (significant or apparent) NFR trends (Table 11, Figure 15). Declining trends were quite prevalent in far southwestern Virginia's *Big Sandy*, *Clinch-Powell*, and *Holston* basins. Declining trends were also observed the upper *Potomac* and *Shenandoah* basins, and throughout the *James* basin. The lower portion of the *Chowan* basin also exhibited declining trends. Only a few stations (14 stations, 8%) exhibited increasing NFR trends; 5 of these 14 stations were located in the lower *James* basin between the Richmond and Hampton Roads. Declining trends (significant and apparent) outnumbered increasing trends by more than a 6-to-1 margin.

In a general sense, the geographic distribution of NFR medians resembles the pattern established TR medians (Figures 16, 17). Relatively high medians (upper and fourth quintile-segments) tend to occur in the eastern portion of the state in the *Potomac* River, lower *Rappahannock* River, lower *York* River, lower *James* River, *Dismal Swamp* River, and the *Coastal and Chesapeake Bay* basins. High medians were also observed in southwestern Virginia in the *Big Sandy* and *Holston* basins and in the *Roanoke* basin in south-central Virginia. Low medians generally were not observed east of the Fall Line, but were concentrated north and west of the Fall Line in the upper *Potomac*, upper *Rappahannock*, *Shenandoah*, upper *James*, upper *Roanoke*, *Chowan*, upper *New* River, and *Holston* basins. Areas where stations with relatively high medians exhibited declining NFR trends include the *Big Sandy*, *Clinch-Powell*, and *Small Coastal / Chesapeake* basins.

Table 10. Summary of total residue (TR) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	14	2	2	7	2	1
1B - Shenandoah	14	0	1	9	2	2
2 - James	46	2	1	31	8	4
3 - Rappahannock	12	0	0	10	1	1
4 - Roanoke	19	1	1	15	0	2
5A - Chowan	9	0	1	7	1	0
5B - Dismal Swamp	5	4	0	1	0	0
6A - Big Sandy	5	3	0	2	0	0
6B - Clinch-Powell	10	5	1	3	1	0
6C - Holston	16	1	3	7	2	3
7 - Coastal Basins	8	1	1	5	1	0
8 - York	5	0	0	5	0	0
9 - New	12	1	0	8	3	0
Virginia Totals	175	20	11	110	21	13
Out-of-State	1	0	0	1	0	0

†Sig. = significant trend ($P < 0.01$)
App. = apparent trend ($0.01 < P < 0.10$)
No Sig. or App. Trend = no significant or apparent trend ($P > 0.10$)

Table 11. **Summary of non-filterable residue (NFR) trends**

Basin	Total Stations	Increasing Trends Sig.†	Increasing Trends App.	No Sig or App. Trend	Declining Trends App.	Declining Trends Sig.
1A - Potomac	14	1	0	5	4	4
1B - Shenandoah	14	0	0	7	4	3
2 - James	50	4	2	20	11	13
3 - Rappahannock	14	1	0	9	2	2
4 - Roanoke	19	0	1	12	2	4
5A - Chowan	9	0	1	2	2	4
5B - Dismal Swamp	5	0	1	2	0	2
6A - Big Sandy	5	0	0	0	1	4
6B - Clinch-Powell	10	0	0	1	1	8
6C - Holston	16	0	2	6	5	3
7 - Coastal Basins	8	1	0	1	2	4
8 - York	8	0	0	7	1	0
9 - New	12	0	0	8	2	2
Virginia Totals	184	7	7	80	37	53
Out-of-State	0	0	0	0	0	0

†Sig. = significant trend ($P < 0.01$)
App. = apparent trend ($0.01 < P < 0.10$)
No Sig. or App. Trend = no significant or apparent trend ($P > 0.10$)

Figure 12. Total Residue Trends

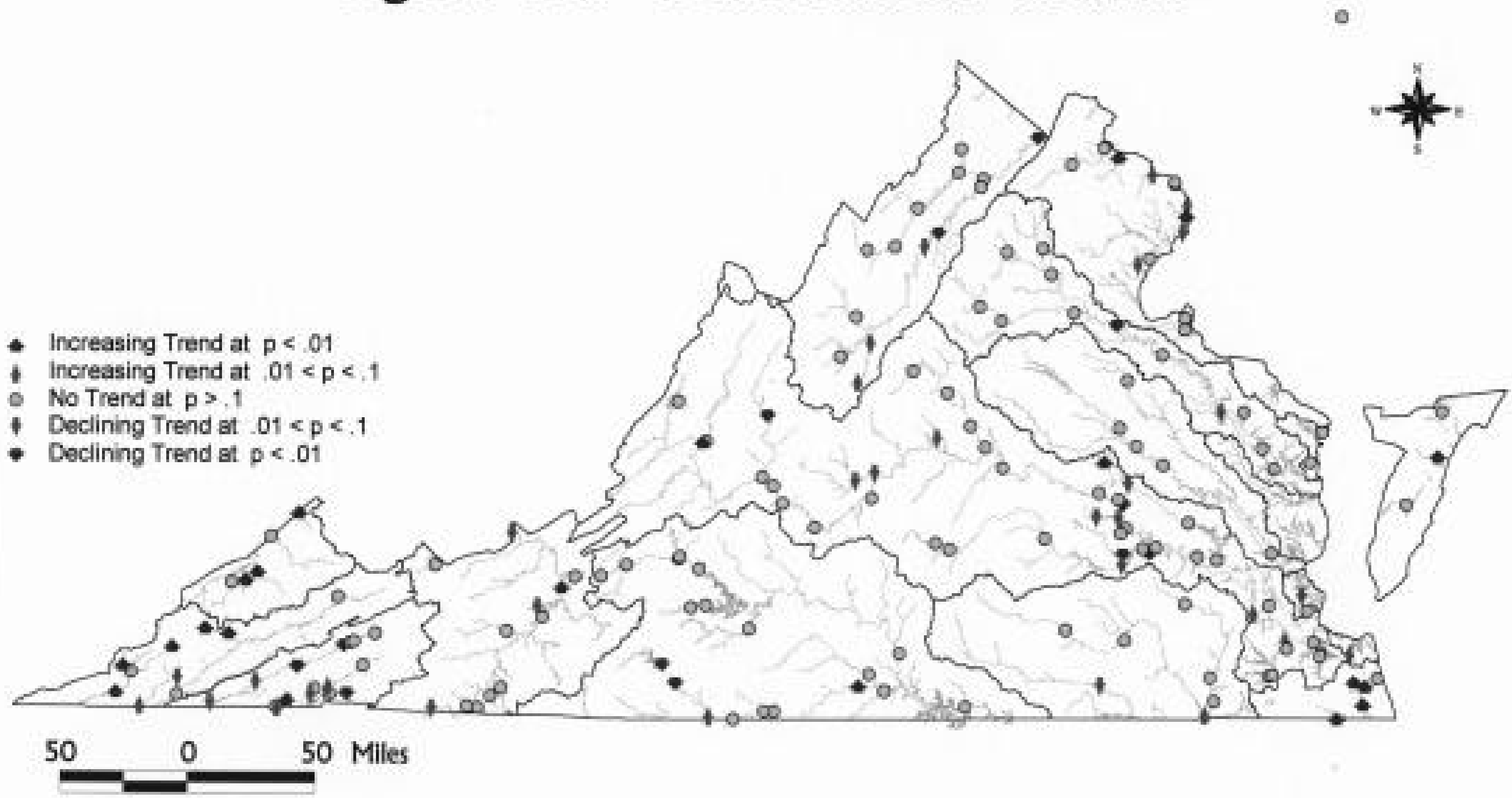
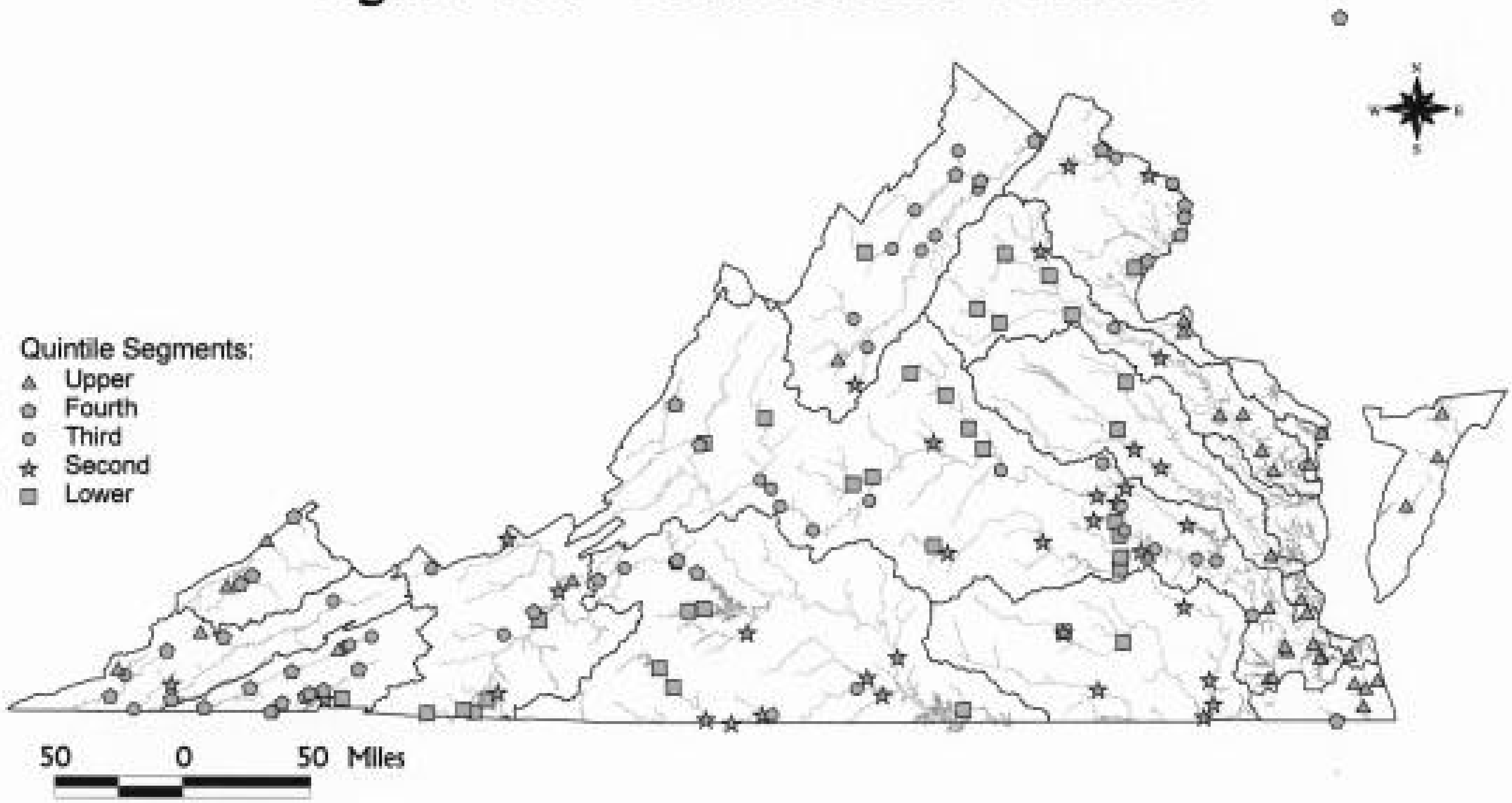


Figure 13. Total Residue Medians



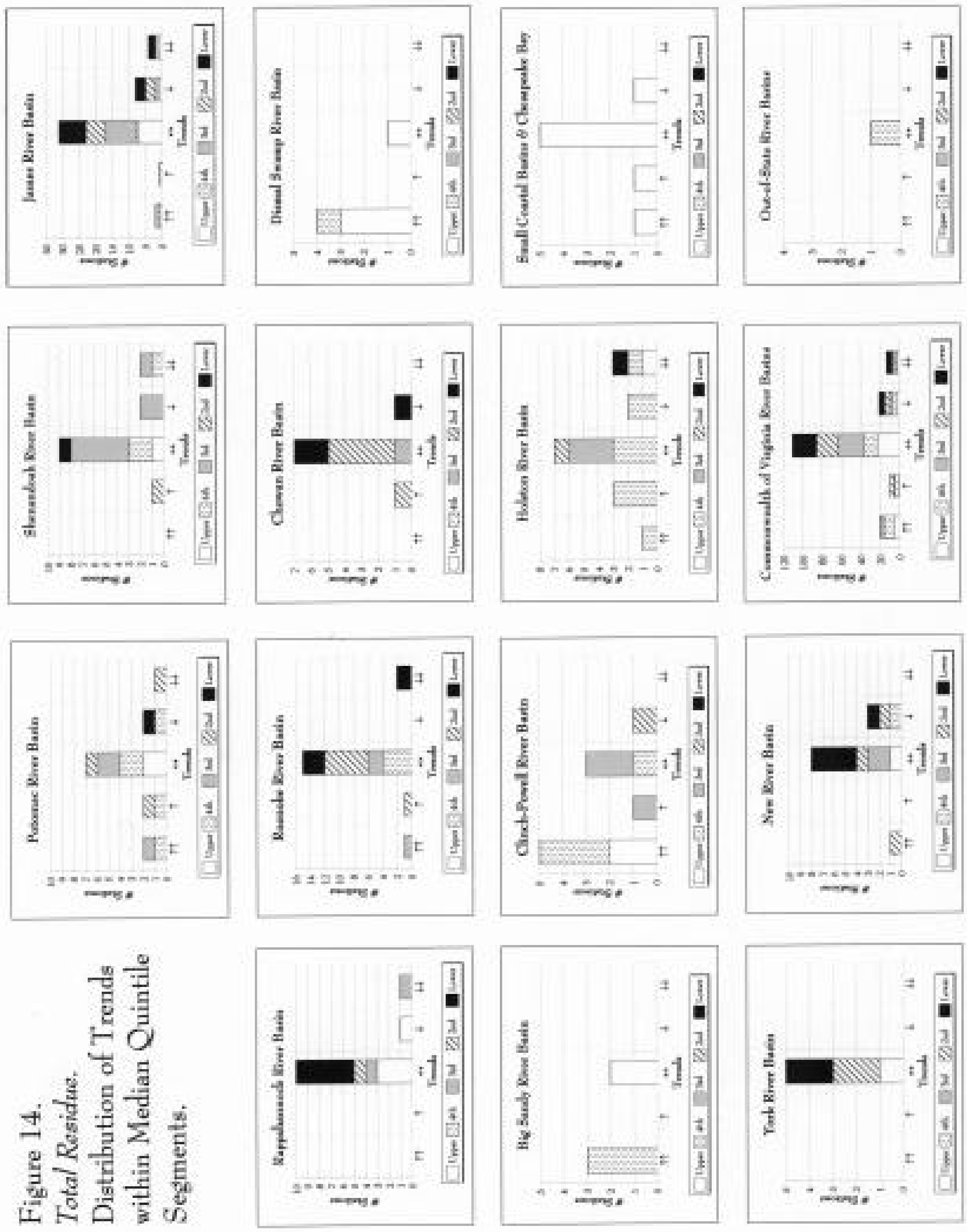


Figure 14.
Total Residue.
Distribution of Trends within Median Quintile Segments.

Figure 15. Non-Filterable Residue Trends

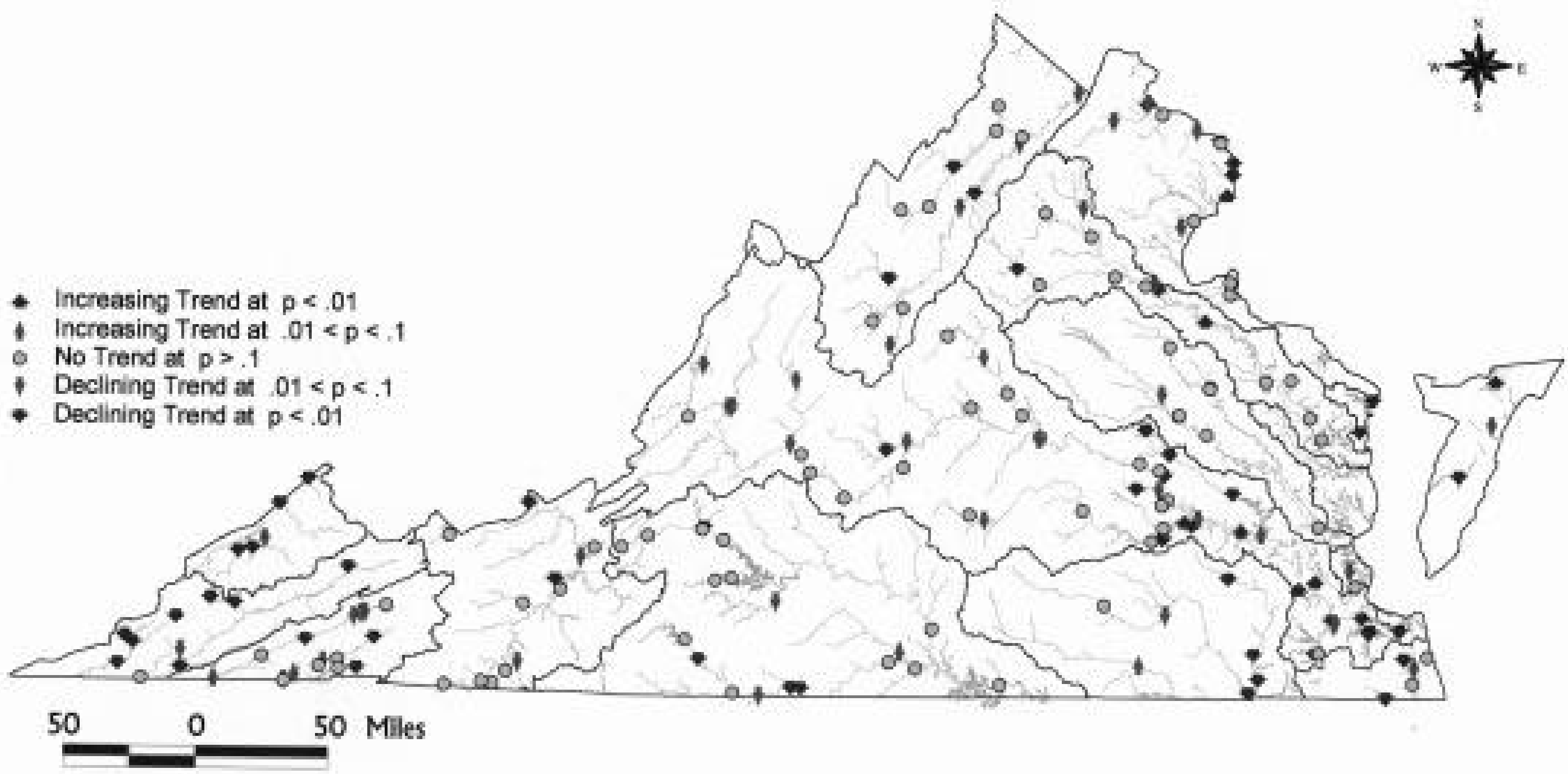
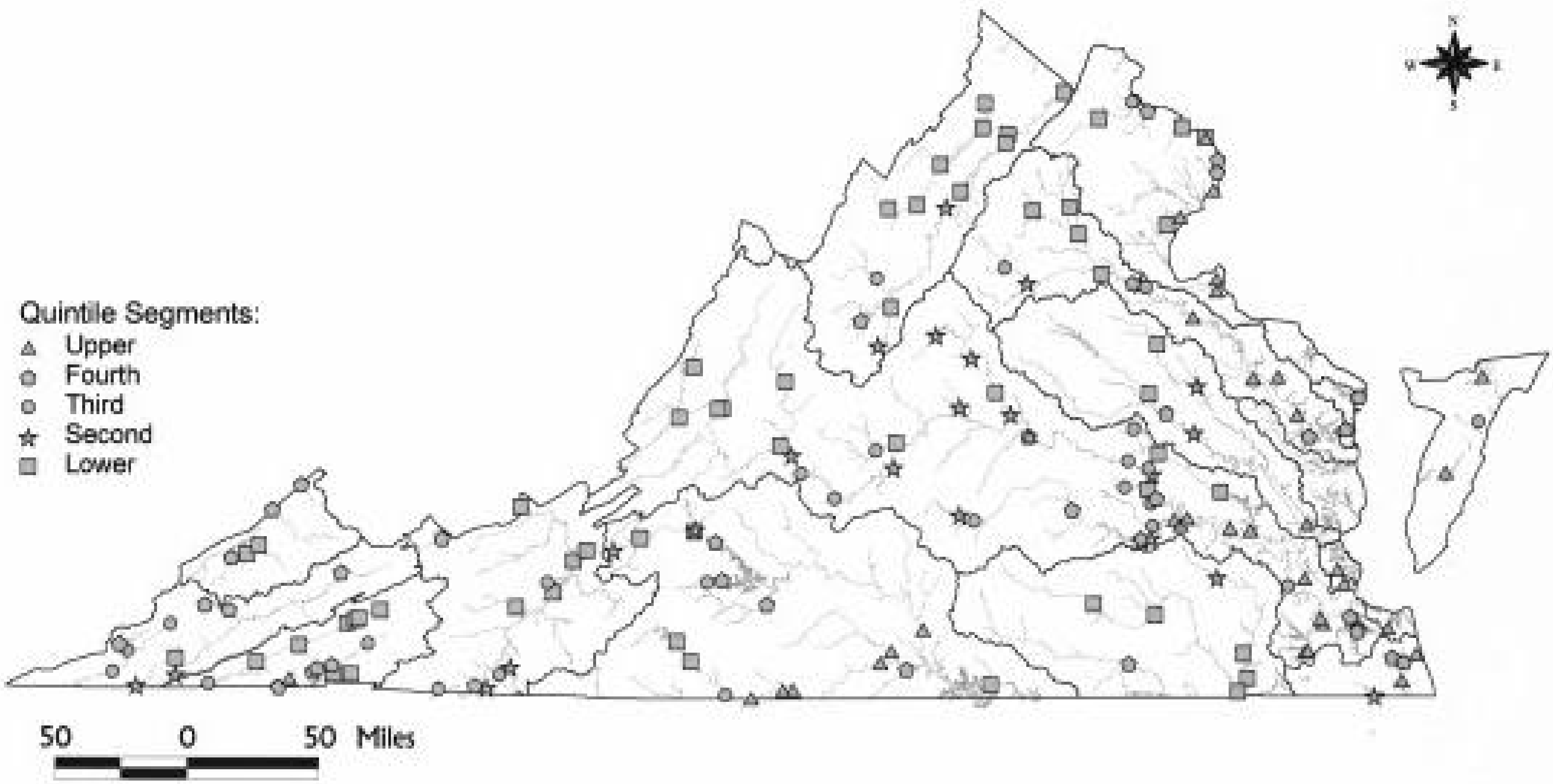


Figure 16. Non-Filterable Residue Medians



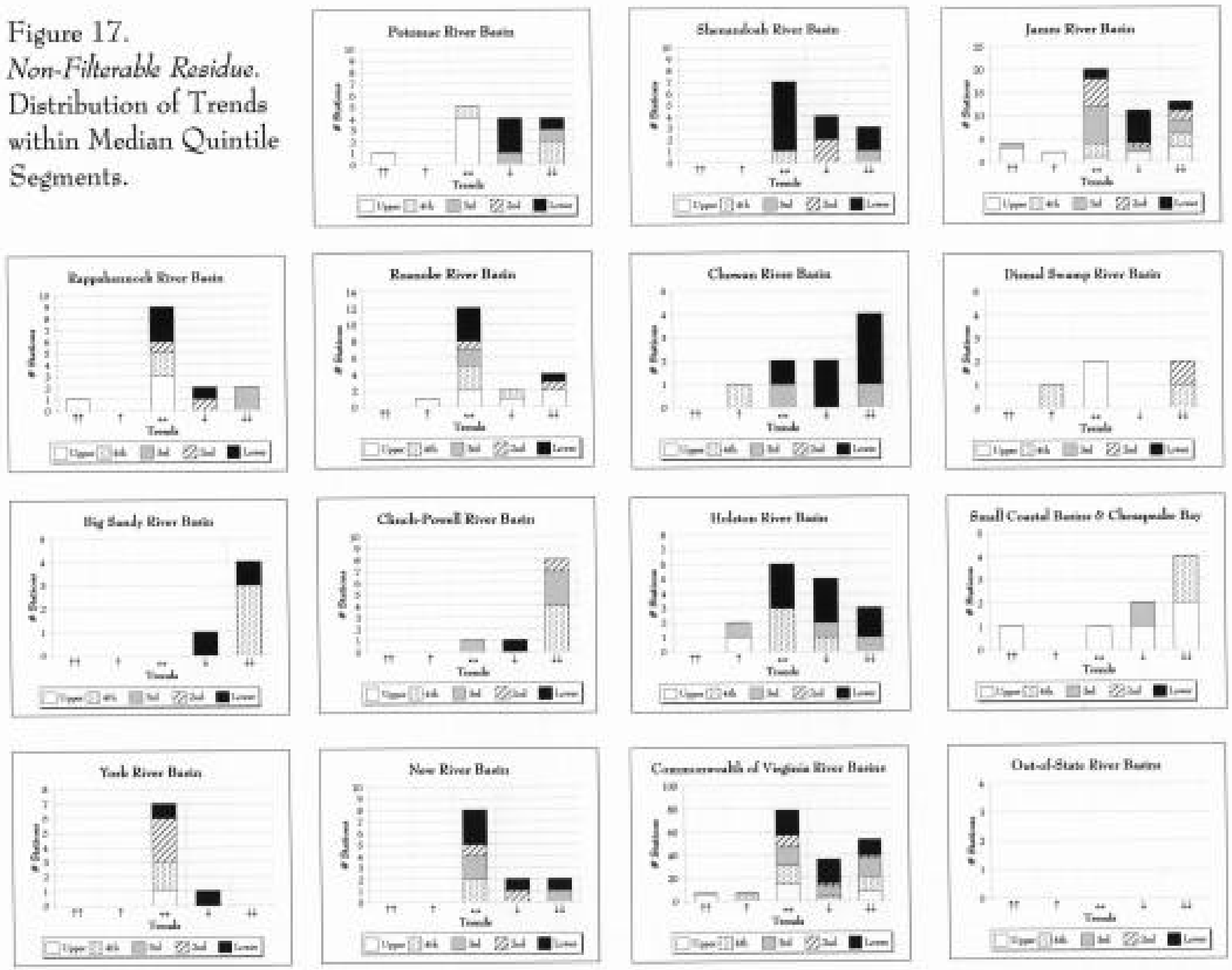


Figure 17.
Non-Filterable Residue.
Distribution of Trends within Median Quintile Segments.

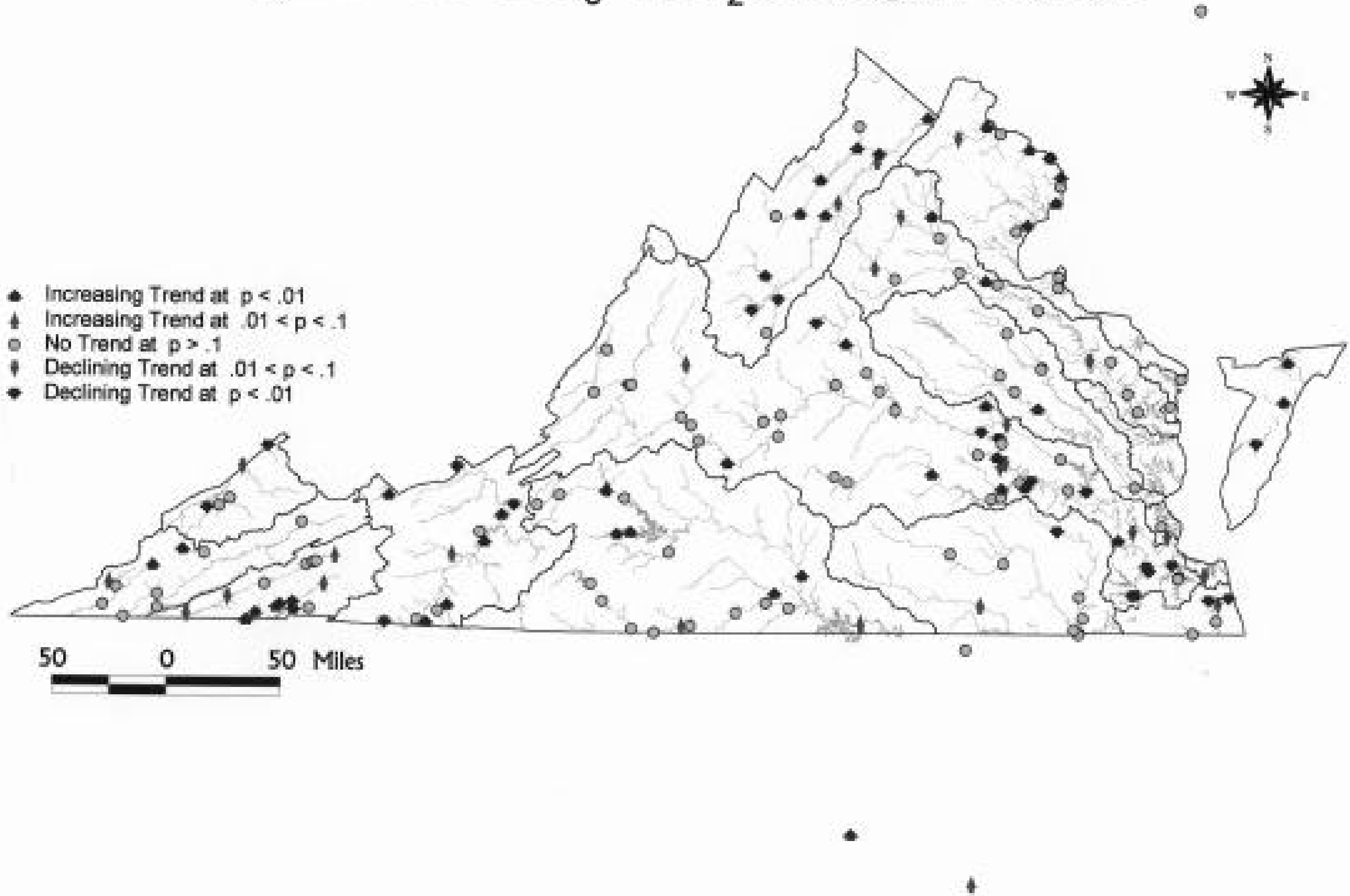
Nitrate-Nitrite Nitrogen (NN): About half (50.2 %) of the stations exhibited significant or apparent NN trends (Table 12, Figure 18). Increasing NN trends (significant and apparent) outnumbered decreasing trends by roughly a 3-to-2 margin. Declining trends comprised about 20% of the stations and tended to concentrate in the lower *James* basin east of the Fall Line (50 % of the state's significant declining trends were located in the lower James). Significant increasing and apparent increasing trends were found present at 31 % of all stations and were prevalent in the lower portions of the *Shenandoah* basin and along the upper *Potomac* basin. Increasing trends were also prevalent along the South and Middle Forks of the *Holston* and in the *New River* basin. Eight stations in the *Roanoke* basin exhibited significant increasing or apparent increasing trends, while no declining trends were present.

Table 12. Summary of nitrate-nitrite nitrogen (NN) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	14	7	0	6	1	0
1B - Shenandoah	14	7	2	3	0	2
2 - James	49	8	1	25	4	11
3 - Rappahannock	13	1	1	9	2	0
4 - Roanoke	20	5	3	12	0	0
5A - Chowan	11	0	1	9	0	1
5B - Dismal Swamp	5	0	0	2	1	2
6A - Big Sandy	5	0	0	2	1	2
6B - Clinch-Powell	10	2	1	7	0	0
6C - Holston	16	7	2	5	2	0
7 - Coastal Basins	8	2	0	3	2	1
8 - York	8	1	0	6	1	0
9 - New	12	5	1	3	0	3
Virginia Totals	185	45	12	92	14	22
Out-of-State	4	1	1	2	0	0

†Sig. = significant trend (P < 0.01)
App. = apparent trend (0.01 < P < 0.10)
No Sig. or App. Trend = no significant or apparent trend (P > 0.10)

Figure 18. NO_3- NO_2 Nitrogen Trends



Lower-quintile NN medians are concentrated in eastern Virginia, in the lower *Potomac, York*, *Rappahannock* basins, and *James* basins, and in the *Small Coastal basins and Chesapeake Bay a*nd *Dismal Swamp* basins (Figures 19, 20). Relatively high medians (including upper- and second quintiles) tended to occur in the northern and western parts of Virginia, including the upper *Potomac, Shenandoah,* upper *Rappahannock*, *New* River, *Holston,* and *Clinch-Powell* basins. Areas where stations with relatively high medians exhibited increasing trends include the *Potomac, Shenandoah, Holston,* and *Rappahannock* basins. On a statewide basis, there is a tendency for increasing NN trends to occur at stations with relatively high medians.

Figure 19. NO_3^-- NO_2 Nitrogen Medians

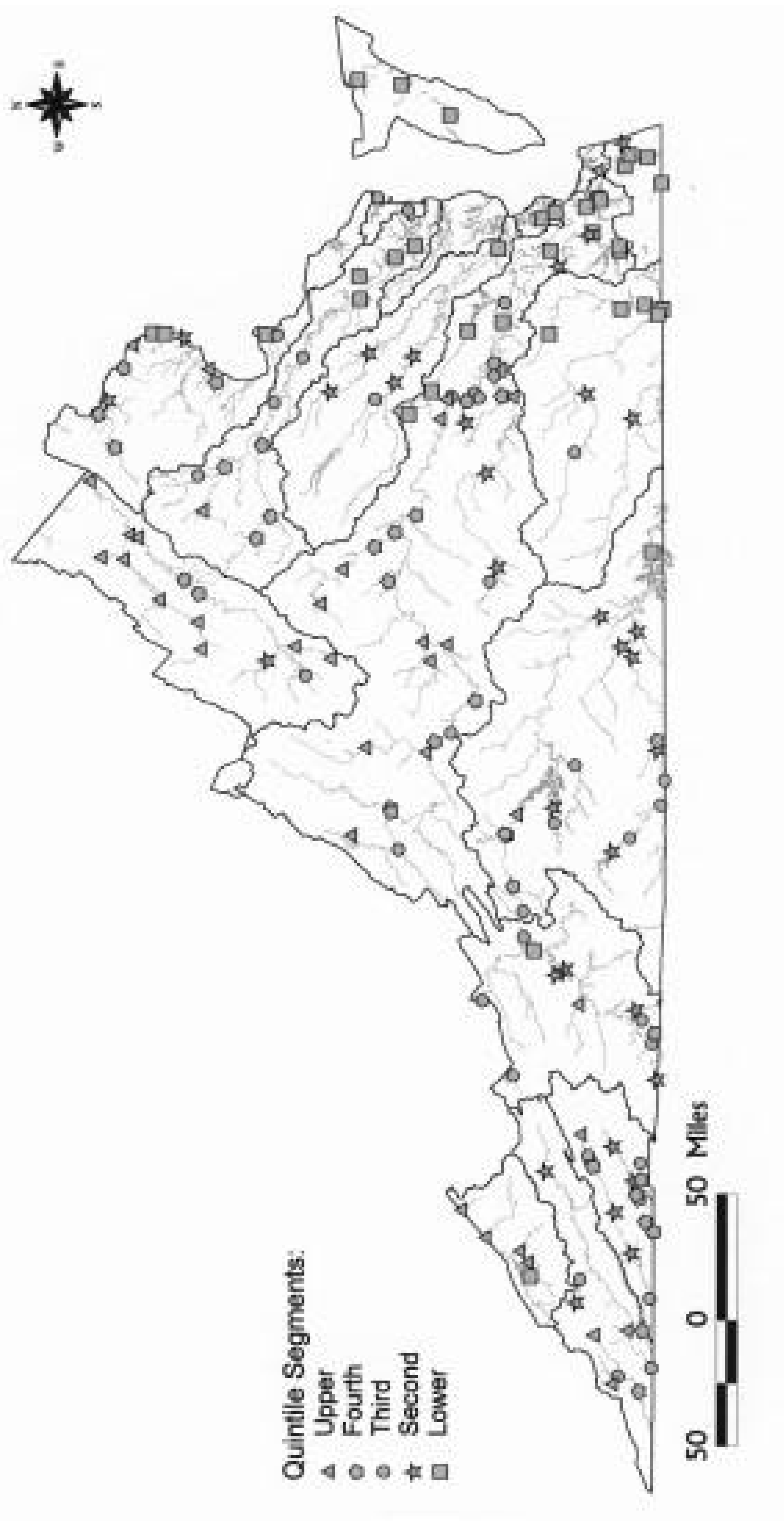
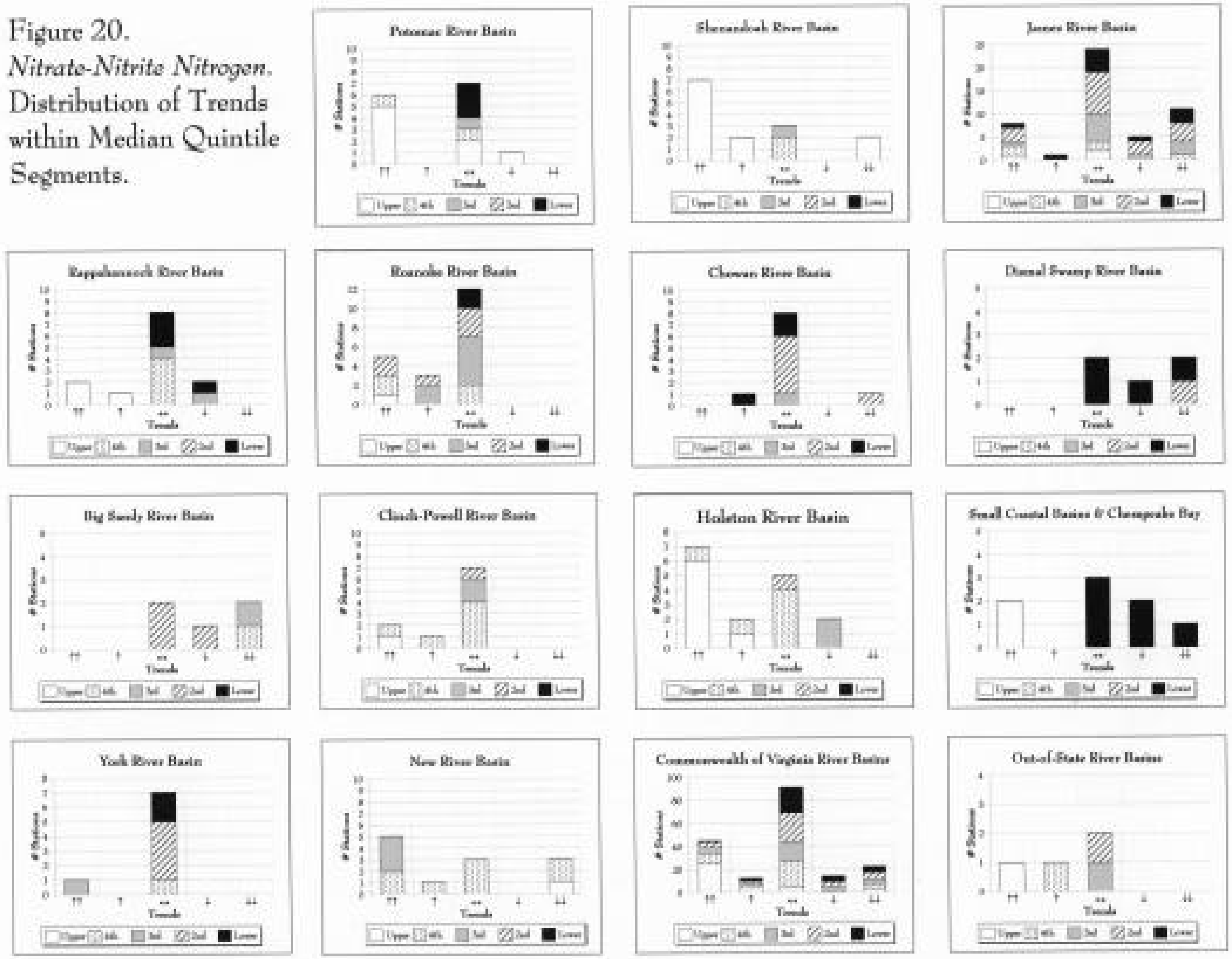


Figure 20.
Nitrate-Nitrite Nitrogen.
Distribution of Trends within Median Quintile Segments.



Total Kjeldahl Nitrogen (TKN): Apparent and/or increasing TKN trends occurred in all basins except the *Big Sandy* (Table 13, Figure 21), while the Shenandoah basin exhibited only 1 apparent and no significant increasing TKN trends. Increasing TKN trends (significant and apparent) outnumbered decreasing TKN trends by roughly an 8-to-3 margin. Statewide, almost half (47 %) of the monitoring stations exhibited significant or apparent increasing trends. Increasing trends were especially prevalent in southwestern Virginia's *Holston* basin, eastern Virginia's *Rappahannock* basin, and central Virginia's *Roanoke* basin. Increasing trends outnumbered decreasing trends by a substantial margin in the *Potomac* and lower *James* basins and in the *Small Coastal basins* adjacent to the *Chesapeake Bay*. Only 17 percent of the stations showed significant declining or apparent declining trends; these stations occurred throughout most of the state. Stations in the eastern part of the state along the North Carolina border exhibited no declining trends. A cluster of declining trends was observed in the South Fork of the Shenandoah River in the *Shenandoah* basin.

Table 13. Summary of total Kjeldahl nitrogen (TKN) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	14	5	2	4	1	2
1B - Shenandoah	14	0	1	7	0	6
2 - James	50	11	8	24	2	6
3 - Rappahannock	14	7	3	3	1	0
4 - Roanoke	20	7	2	8	1	2
5A - Chowan	11	4	3	3	1	0
5B - Dismal Swamp	5	3	1	1	0	0
6A - Big Sandy	5	0	0	4	0	1
6B - Clinch-Powell	10	1	2	6	1	0
6C - Holston	16	10	2	1	1	2
7 - Coastal Basins	8	3	2	1	1	1
8 - York	8	2	2	4	0	0
9 - New	12	5	3	2	0	2
Virginia Totals	187	58	31	68	8	22
Out-of-State	4	0	0	2	0	2

†Sig. = significant trend (P < 0.01)
App. = apparent trend (0.01 < P < 0.10)
No Sig. or App. Trend = no significant or apparent trend (P > 0.10)

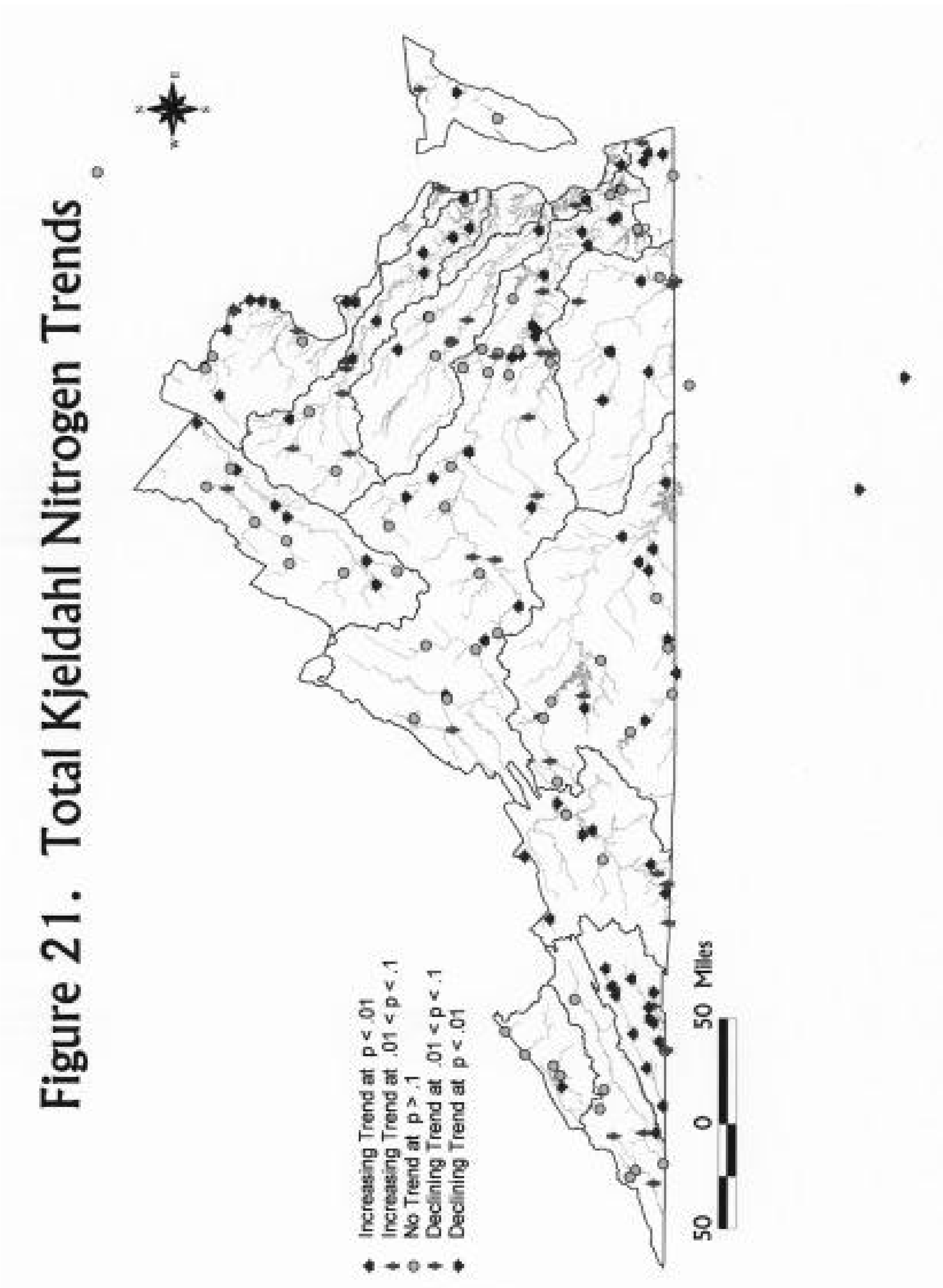


Figure 21. Total Kjeldahl Nitrogen Trends
Increasing Trend at p < .01
Increasing Trend at .01 < p < .1
No Trend at p > .1
Declining Trend at .01 < p < .1
Declining Trend at p < .01
50
0
50 Miles

In the lower *James* basin, increasing TKN trends and declining NN trends were prevalent, whereas the opposite pattern occurred in the *Shenandoah* basin.

The geographic pattern of TKN medians throughout the state was the reverse geographic pattern for NN (Figures 22, 23). Areas with a prevalence of low TKN medians tended to be areas with a prevalence of high NN medians, and vice versa. Upper-quintile segment TKN medians were prevalent in eastern Virginia, while lower quintile medians tended to occur in western portions of the state.

Figure 22. Total Kjeldahl Nitrogen Medians

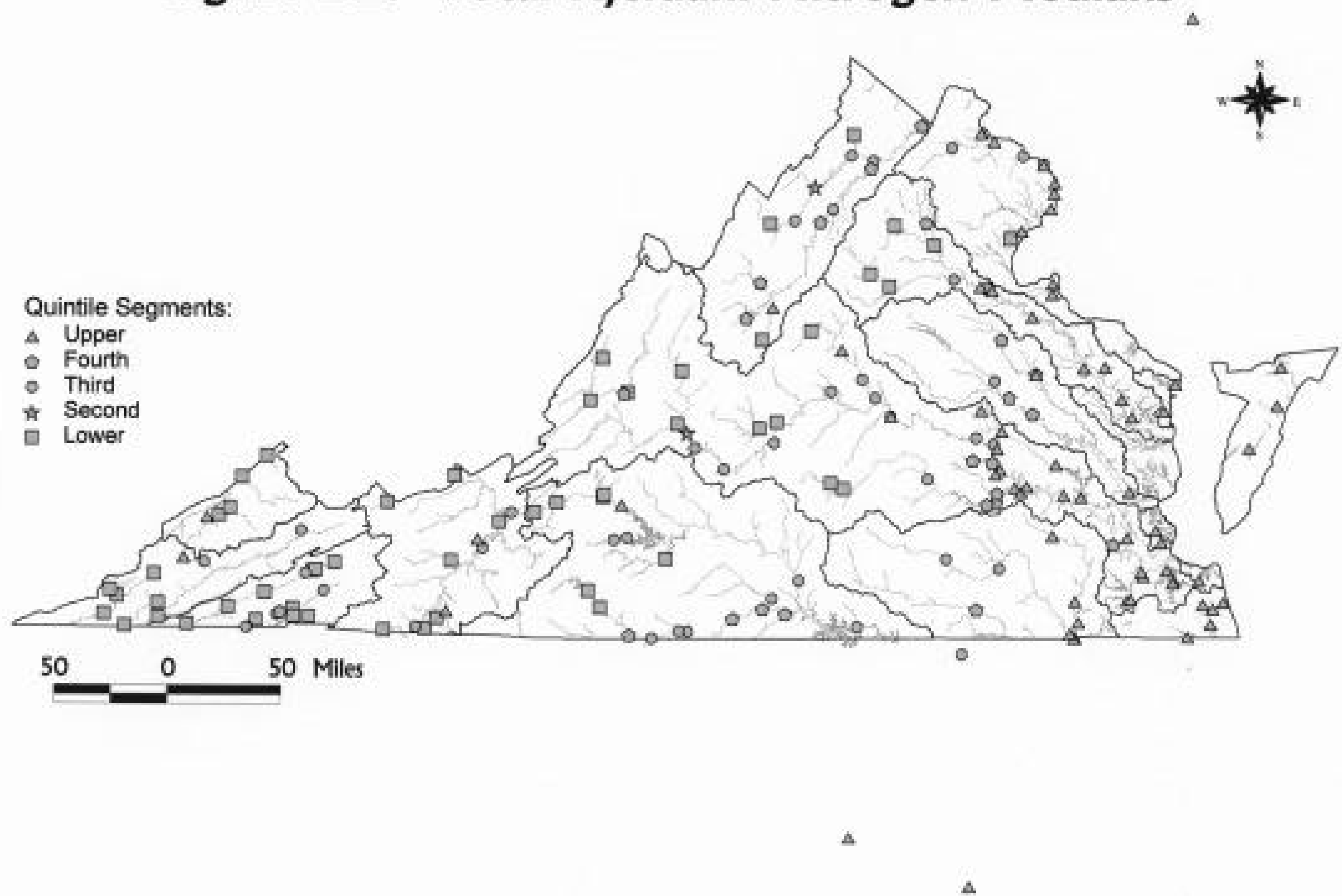
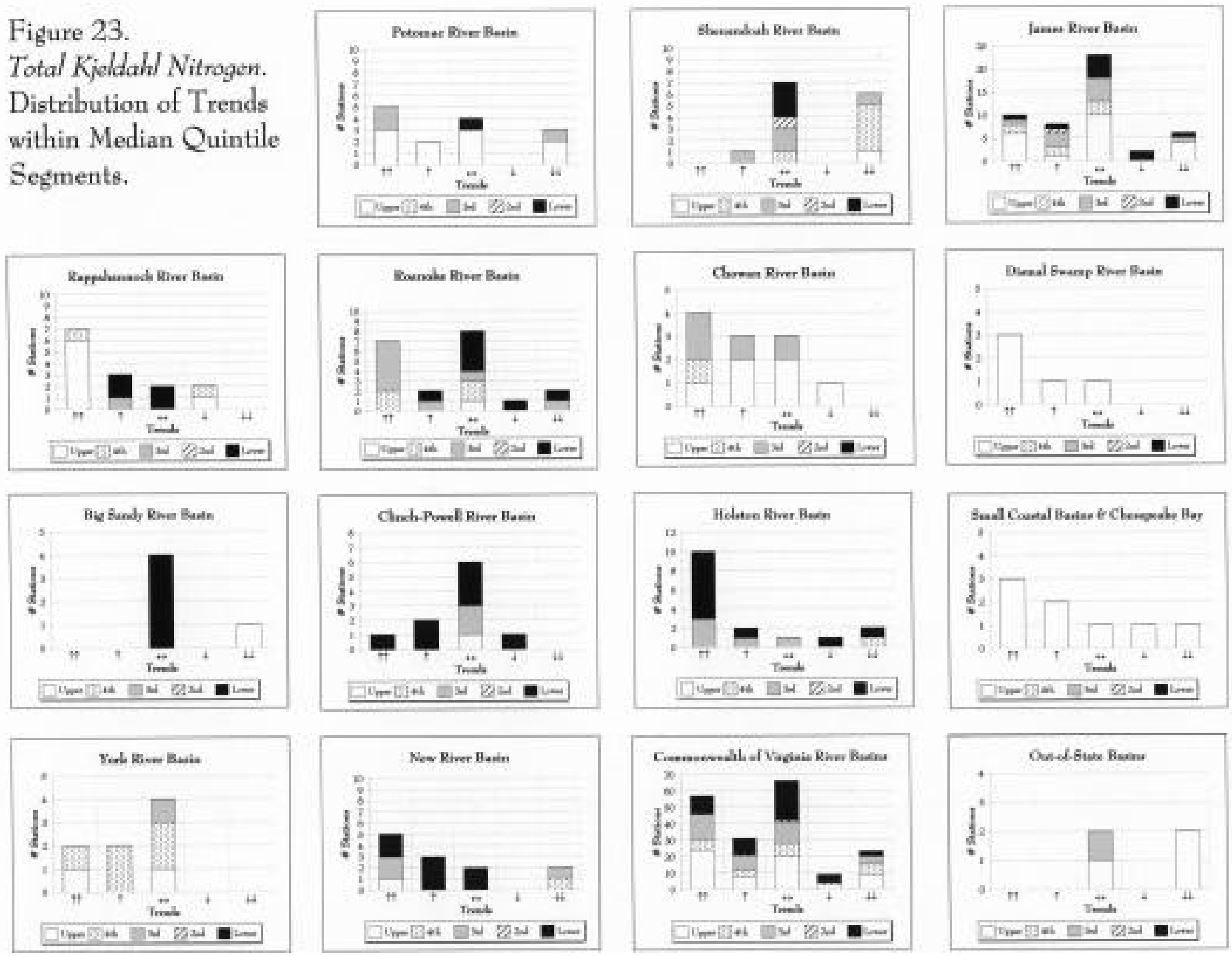


Figure 23.
Total Kjeldahl Nitrogen.
Distribution of Trends within Median Quintile Segments.



Total Phosphorus (TP): Almost half (48 percent) of the monitoring stations exhibited significant or apparent TP trends (Table 14, Figure 24). Declining trends (significant and apparent) outnumbered increasing trends (significant and apparent) by about a 3-to-1 margin. Declining trends were prevalent in southwestern Virginia's *Big Sandy* and *Clinch-Powell* basins, and along the South Fork of the Shenandoah River in the *Shenandoah* basin. In the *James River* basin, declining trends (significant and apparent) outnumbered increasing trends (significant and apparent) by almost a 3-to-1 margin. Increasing trends were observed in eastern portions of the state (Richmond area and further east), including three in the lower *Rappahannock* basin, while declining trends tended to occur along the North Carolina border.

Most of TP medians were classified as being in the 3rd (middle) quintile-segment because detection-limited values of 0.10 mg/l were very common, but analytical procedures capable of yielding values less than .10 mg/l were also utilized during some time periods (Figures 25, 26). A few upper quintile-segment medians were scattered throughout the state. Several lower-segment medians were observed in eastern Virginia.

Table 14. Summary of total phosphorus (TP) trends

Basin	Total Stations	Increasing Trends		No Sig or App.	Declining Trends	
		Sig.†	App.	Trend	App.	Sig.
1A - Potomac	14	0	2	8	0	4
1B - Shenandoah	14	1	0	5	3	5
2 - James	50	3	4	26	8	9
3 - Rappahannock	14	3	1	9	0	1
4 - Roanoke	20	1	1	10	3	5
5A - Chowan	11	0	0	6	0	5
5B - Dismal Swamp	5	0	0	3	1	1
6A - Big Sandy	5	0	0	2	2	1
6B - Clinch-Powell	10	0	0	2	5	3
6C - Holston	16	0	1	13	1	1
7 - Coastal Basins	8	1	0	3	3	1
8 - York	8	4	0	0	3	1
9 - New	12	0	0	9	1	2
Virginia Totals	187	13	9	96	30	39
Out-of-State	4	0	0	2	0	2

†Sig. = significant trend ($P < 0.01$)
App. = apparent trend ($0.01 < P < 0.10$)
No Sig. or App. Trend = no significant or apparent trend ($P > 0.10$)

Figure 24. Total Phosphorus Trends

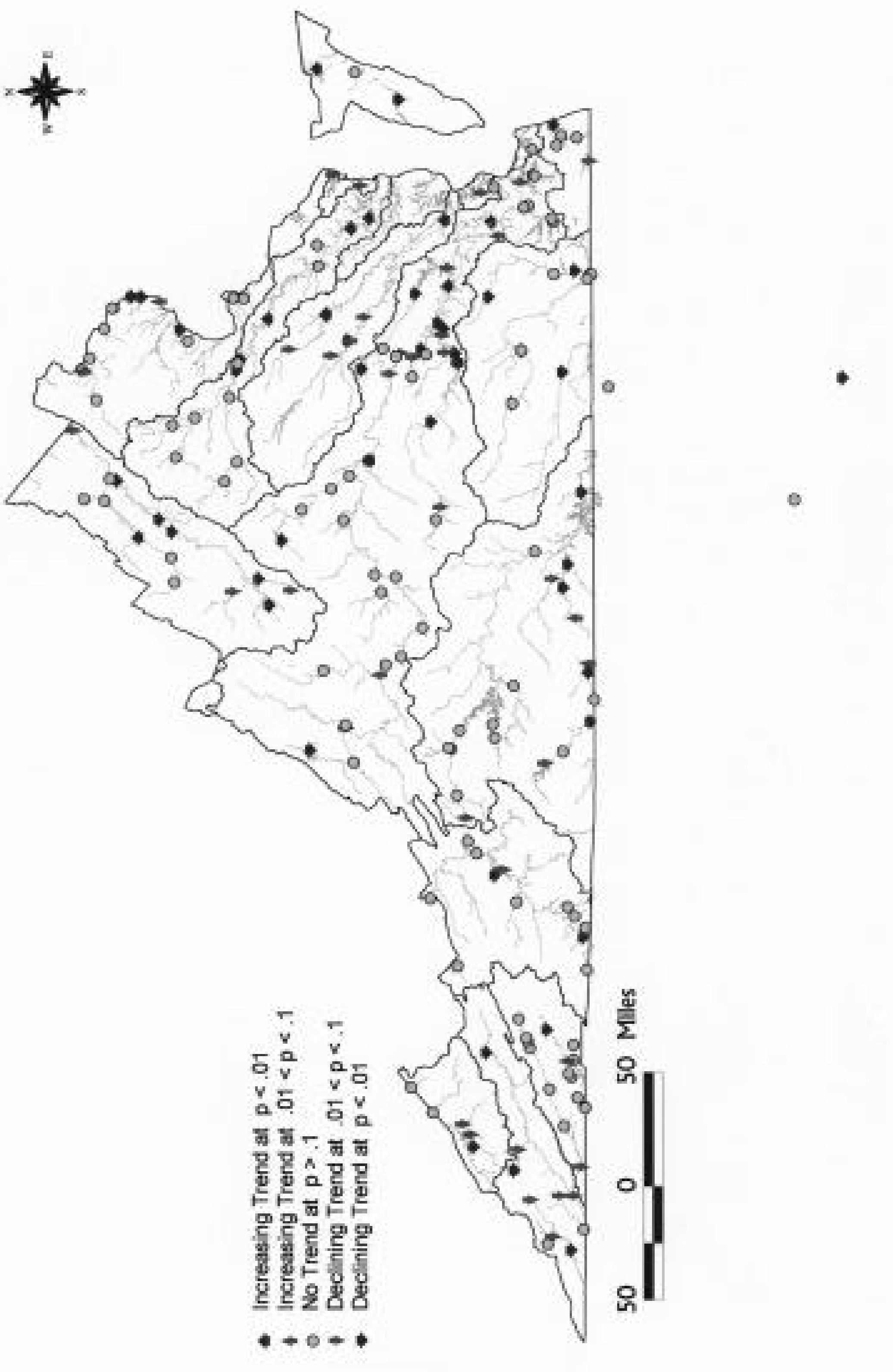


Figure 25. Total Phosphorus Medians

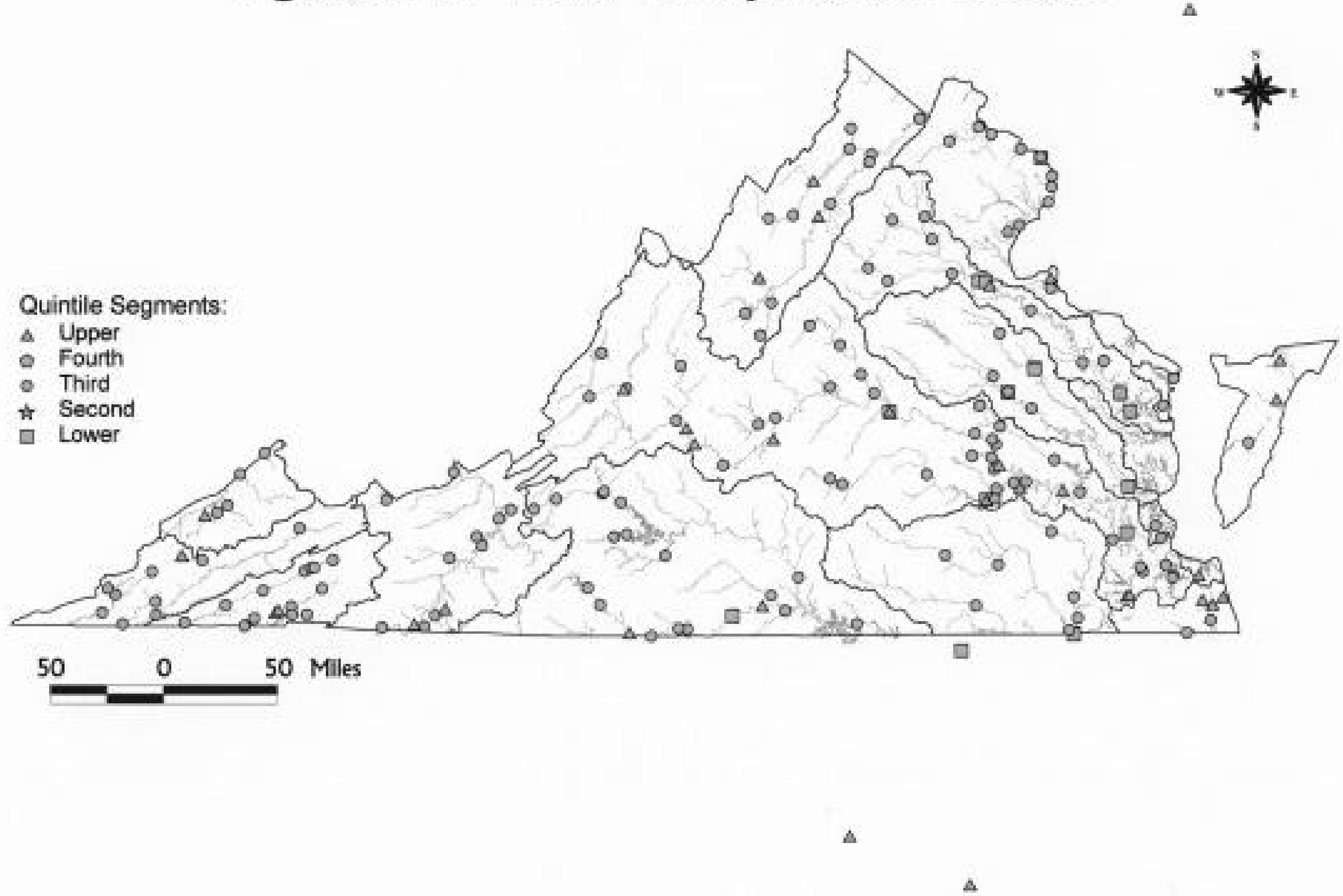
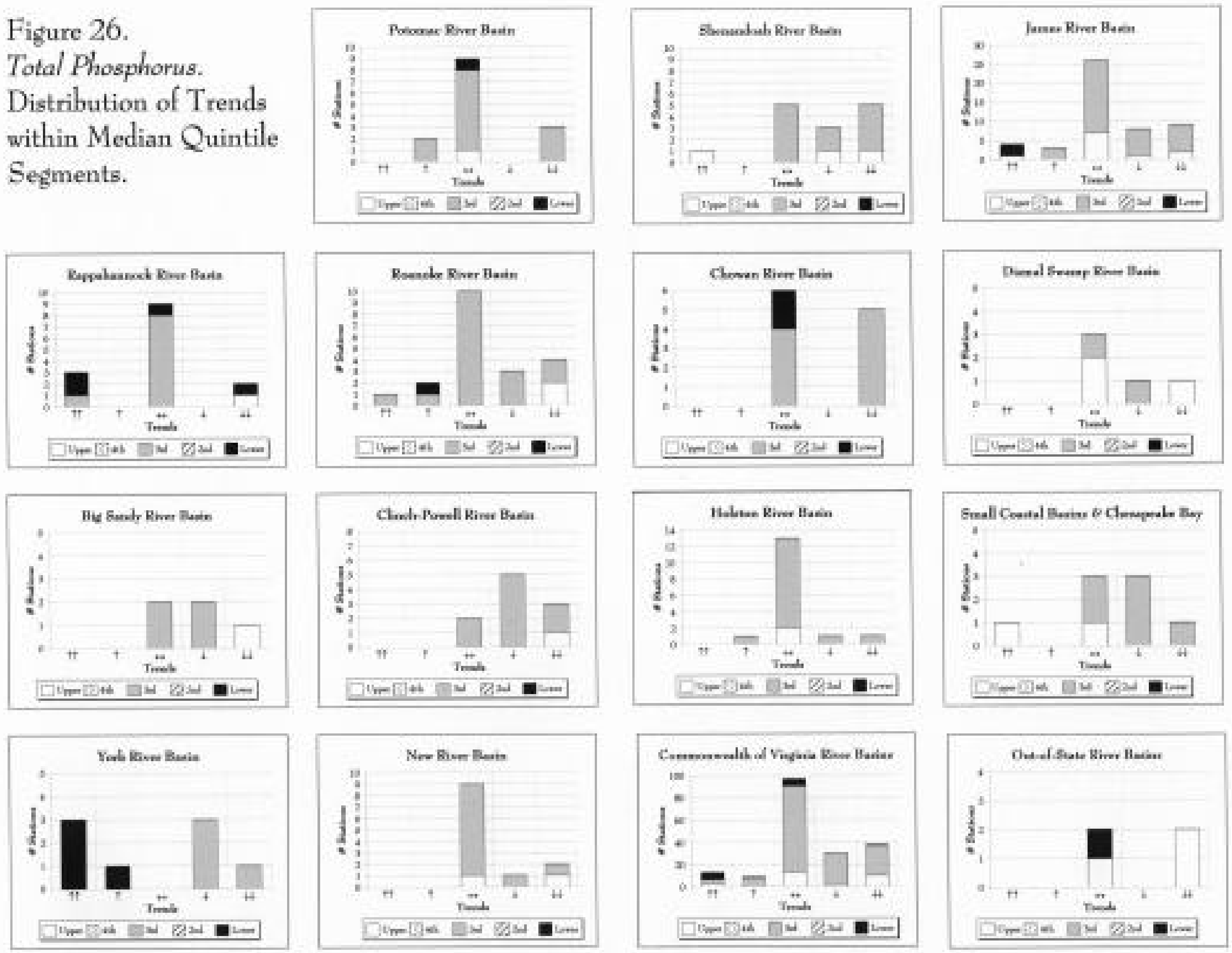


Figure 26.
Total Phosphorus.
Distribution of Trends within Median Quintile Segments.



Fecal Coliforms (FC): Almost half (45%) of the stations exhibited apparent or significant FC trends (Table 15, Figure 27). Declining FC trends (significant and apparent) outnumbered increasing trends by roughly a 5-to-3 margin. Declining FC trends were prevalent in the southwestern Virginia's *Big Sandy, Clinch-Powell,* and *Holston* basins, and in the upper *New* River basin. In all areas along the North Carolina border west of the *Dismal Swamp* basin, declining trends were predominant. Increasing trends occurred in the *James* basin near Richmond. Increasing trends (significant and apparent) occurred at half of all stations in the *Potomac* basin, while no declining trends were present.

Relatively high (upper and fourth quintile-segment) FC medians were prevalent in southwestern and southern Virginia in the *Big Sandy, Clinch-Powell,* and *Holston* basins, and in the upper *New* River and upper *Roanoke* basins (Figures 28, 29). Again, because a high-proportion of total observations occurred at or near detection limits, the majority of observations were classified as being in the third (or middle) quintile-segment. In southwestern Virginia, declining trends tended to occur at stations with relatively high medians.

Table 15. Summary of fecal coliforms (FC) trends

Basin	Total Stations	Increasing Trends		No Sig or App. Trend	Declining Trends	
		Sig.†	App.		App.	Sig.
1A - Potomac	14	2	5	7	0	0
1B - Shenandoah	14	2	1	9	2	0
2 - James	48	2	6	34	3	3
3 - Rappahannock	12	1	1	9	1	0
4 - Roanoke	19	3	1	10	1	4
5A - Chowan	9	0	0	6	1	2
5B - Dismal Swamp	5	0	1	4	0	0
6A - Big Sandy	5	0	0	1	0	4
6B - Clinch-Powell	10	0	0	0	0	10
6C - Holston	16	0	0	2	1	13
7 - Coastal Basins	8	2	1	5	0	0
8 - York	7	0	1	6	0	0
9 - New	12	0	0	6	1	5
Virginia Totals	179	12	17	99	10	41
Out-of-State	1	0	0	0	1	0

†Sig. = significant trend (P < 0.01)
App. = apparent trend (0.01 < P < 0.10)
No Sig. or App. Trend = no significant or apparent trend (P > 0.10)

Figure 27. Fecal Coliform Trends

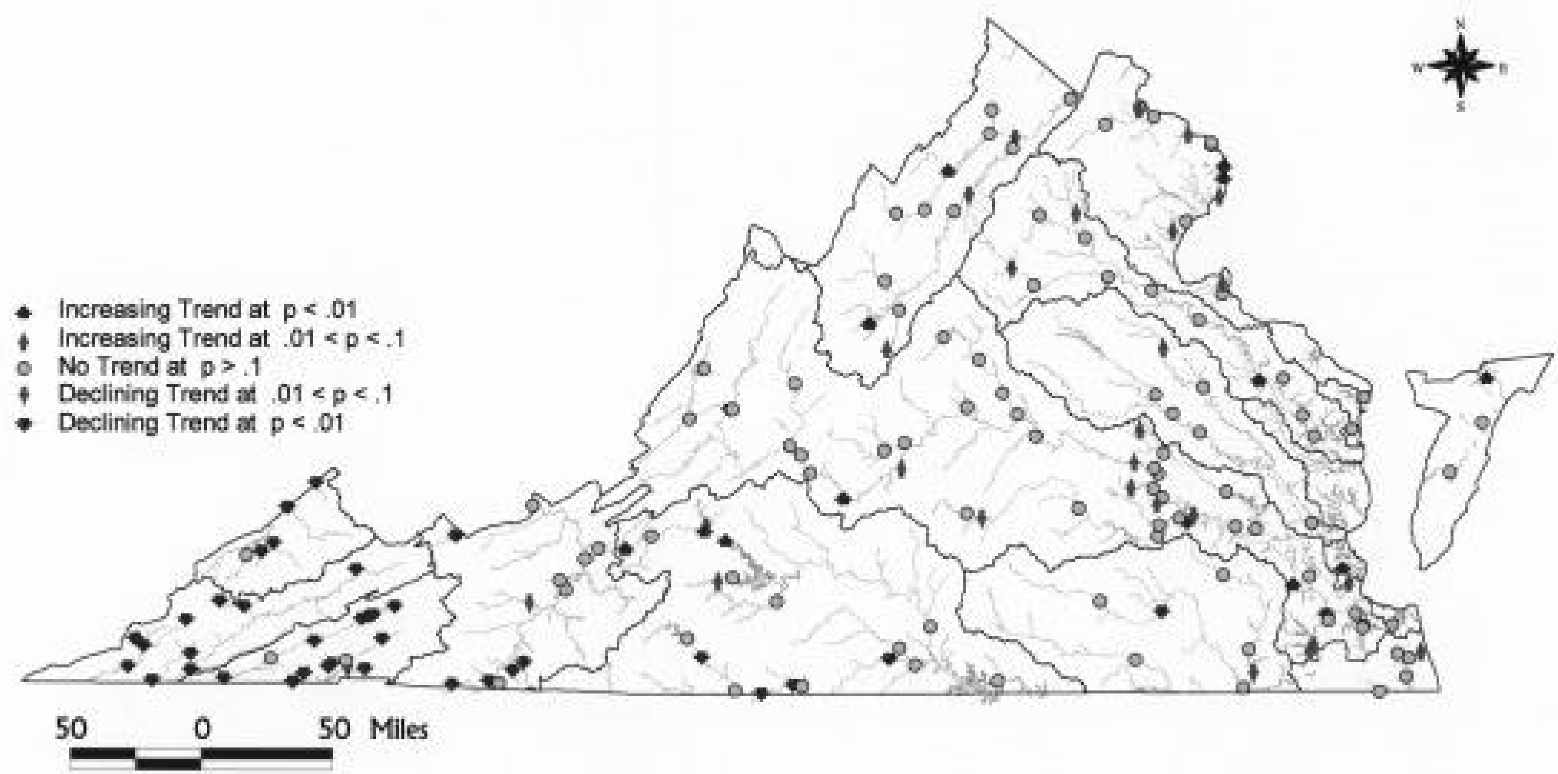


Figure 28. Fecal Coliform Medians

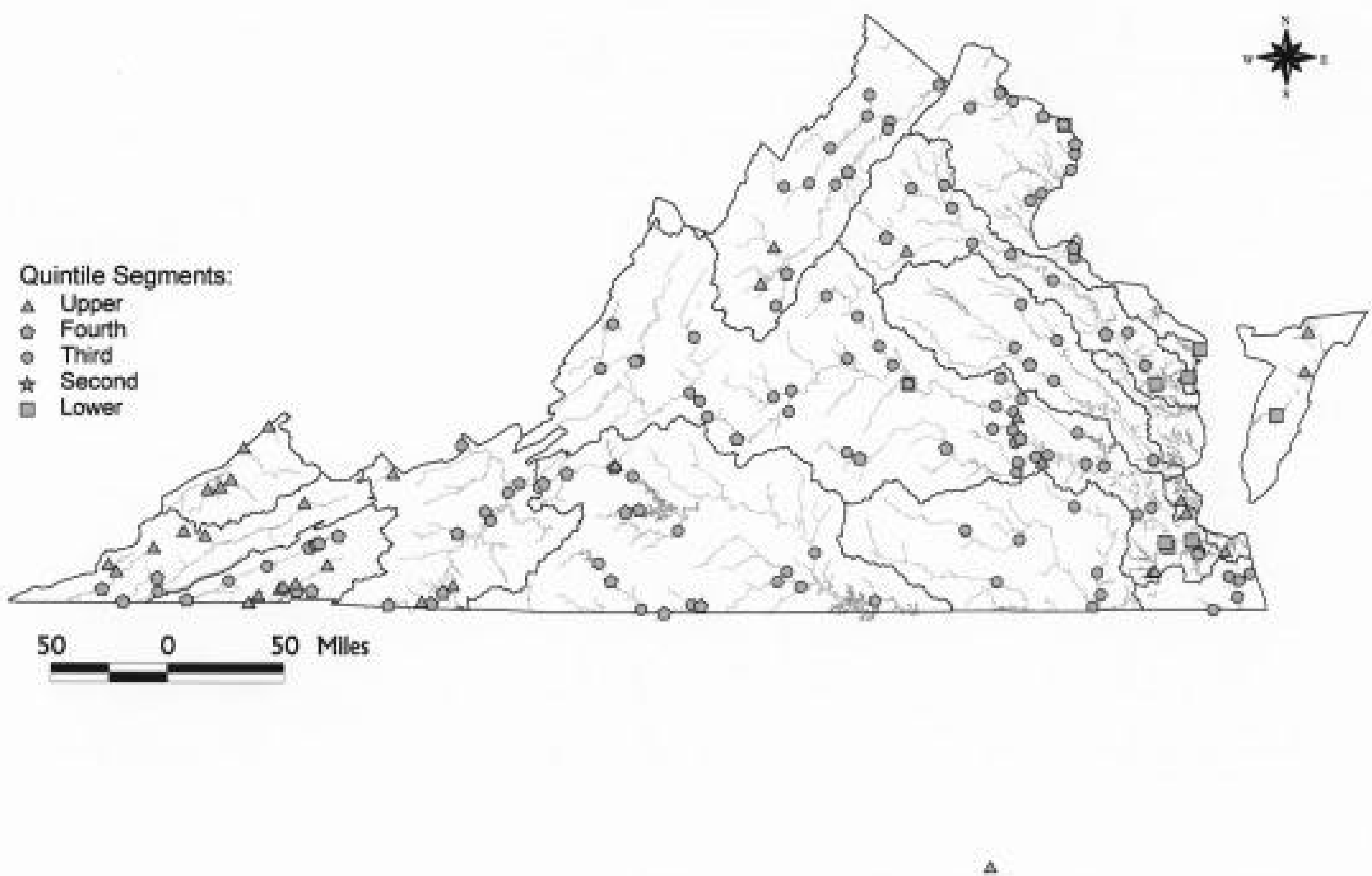
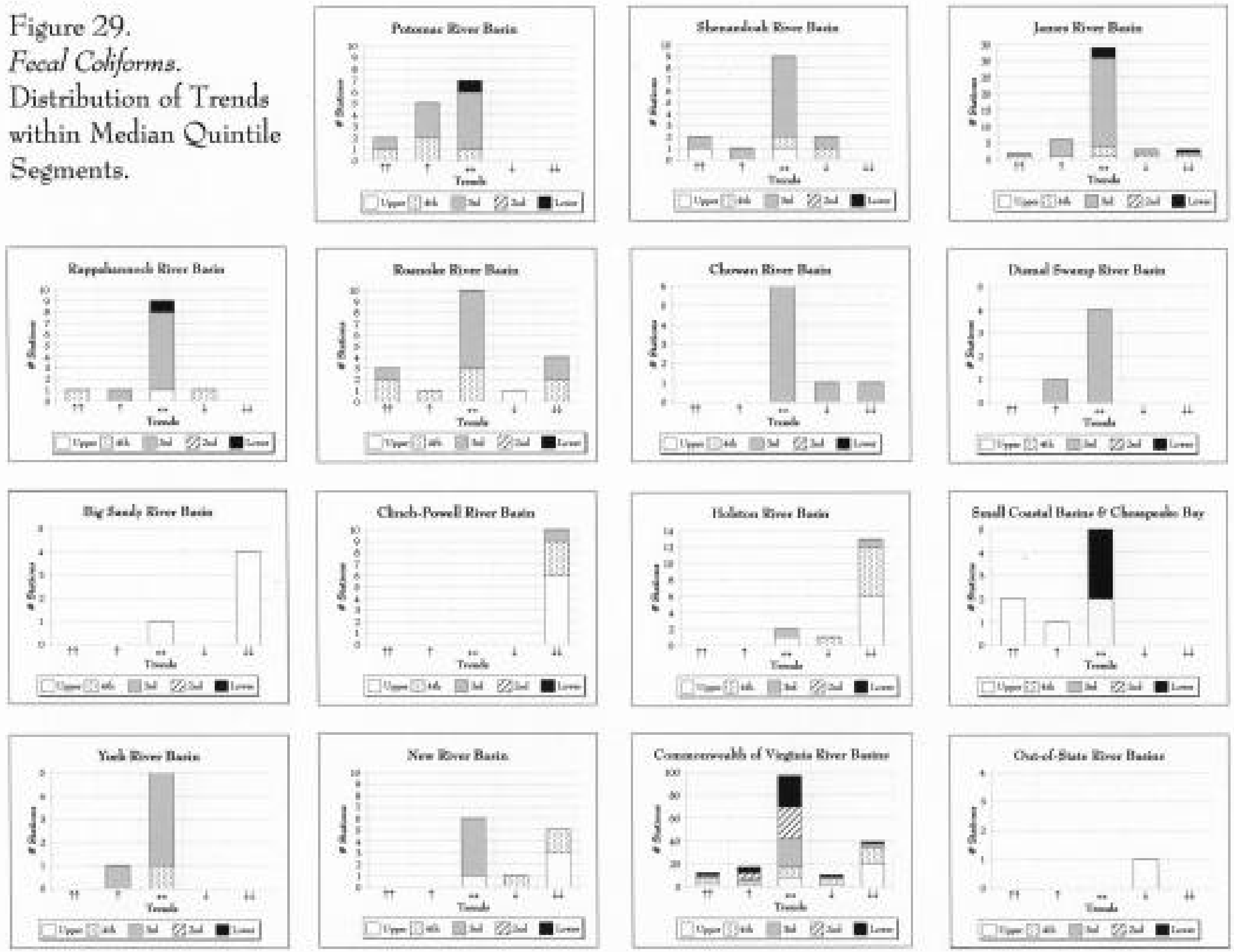


Figure 29.
Fecal Coliforms.
Distribution of Trends within Median Quintile Segments.



Interpretation Issues

Several issues were confronted during the conduct of this research.

NN Data: As described above, we developed the "epsilon method" for handling NN data. We were unable to find any precedent for handling data of this type, and believe the method that we developed to be reliable.

Analytical Precision: Another issue concerns varying analytical precision of data collected during various time periods. The seasonal Kendall procedure requires comparison of measurements from different dates to one another so as to determine the larger of each set of pairs. In an ideal situation, the range of uncertainty associated with each value, and probability distribution within that range, should be considered. We did make a range-adjustment for pH, as described above, but were unable to incorporate any similar adjustment into analysis of the other variables. Overall, we do not believe that this problem affected the results of our analyses because any minor errors that may have resulted from inability to incorporate precision into the analysis would be randomly distributed throughout the time-periods analyzed.

Zero Slopes: A third issue has to do with the prevalence of analyses where significant or apparent trends were found to be present but the best-estimate of median-change per year (slope) is zero. As described above, this condition typically occurs in cases where many pairs of observations are interpreted as being tied (*i.e.*, insufficient evidence is present to allow determination of which is the higher value). In these data sets, this condition typically occurs when a large number of observations are at lower detection limits, but higher values of the water-quality constituent are detected from time to time. This condition was prevalent in analytical results for TP (60 % of all significant and apparent trends), BOD (57 percent), FC (54 %), TKN (50 %), and NFR (44 percent) (Table 16). In such cases, a statistically significant tau can indicate a difference in the frequency with which high values were observed in the two halves of the time series. In other words, this situation can indicate that the instances of higher-than-detection-limit levels are not uniformly distributed in time.

Table 16. Summary of trends for water quality parameters (Virginia only)

Trend	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
	- *% of total stations* -								
Sig Inc†	22‡	0	23	11	4	25	31	7	7
App Inc	10	1	5	6	4	6	17	5	10
No Trend	45	38	29	64	43	49	35	52	55
App Dec	7	17	10	12	20	8	5	16	6
Sig Dec	16	44	33	7	29	12	12	20	22
	- *number of stations* -								
Sig Inc†	39	0	43	20	7	45	57	13	12
App Inc	18	1	10	11	7	12	31	9	17
No Trend	86	71	54	110	80	92	68	96	99
App Dec	13	28	20	21	37	14	9	30	10
Sig Dec	31	85	60	13	53	22	22	39	41
Total	187	185	187	175	184	185	187	187	179
	- - - - - - - - - - - - *number of stations with zero slope estimate* - - - - - - - - - - - -								
Sig Inc	1	0	0	10	0	1	24	2	8
App Inc	0	1	0	0	1	0	24	7	15
App Dec	0	27	0	0	30	2	6	29	8
Sig Dec	0	37	0	0	15	1	5	29	12

†Sig Inc = significant increasing trend ($p<0.01$)
App Inc = apparent increasing trend ($0.01<p<0.1$)
No Trend = no apparent trend ($p>0.1$)
App Dec = apparent declining trend ($0.01<p<0.1$)
Sig Dec = significant declining trend ($p<0.01$)
‡values within a column sum to 100%

Lack of Flow Data: Without flow data, we are unable to determine whether detected trends were the direct result of actual changes in water quality, or if they were an indirect result of differences in the distribution of high (or low) flow-volumes-at-sampling throughout the monitoring period. The accuracy of our findings is dependent upon the assumption that variations of flow-volume are randomly distributed throughout the monitoring period. This assumption is especially critical for those instances where significant or apparent trends were recognized in combination with zero slope.

Monitoring Station Locations: We have no basis for evaluating the extent to which the monitoring stations analyzed may or may not collectively represent statewide water quality. Whereas some monitoring stations may be located such that watershed characteristics are the predominant influence on water quality, others are located such that point-source discharges are the predominant influence. Such differences have not been incorporated into our analysis. Therefore, simple numerical comparisons of increasing and decreasing trends cannot be interpreted as direct representations of overall change in statewide water quality.

Varying Time Periods and Numbers of Observations: Because the time periods analyzed were based on data availability, rather than a fixed period, not all trends represent change over the same time period. The fact that broad gaps of data coverage occurred for some variables at some stations between the starting and ending dates must also be considered in comparing findings of trend vs. no-trend among two or more stations.

Lack of Analysis for Non-Monotonic Trends: These analyses test only for the existence of a monotonic trend over the entire period covered by the data set. Seasonal Kendall Analysis does not test for the possibility that a “change point” during the period analyzed may have canceled out short-term trends. For example, if a data set were to exhibit an increasing trend during the beginning of the period analyzed, and a declining trend during the latter stages of that period, the result reported here would, in all likelihood, be no significant or apparent trend. The question of non-monotonic trend detection is being addressed by current research.

Conclusions

On a statewide basis, significant and apparent trends indicating water quality improvement outnumbered significant and apparent trends indicating water-quality deterioration for BOD, TP, FC, NFR, and DO. For BOD, NFR, and TP, trends representing water-quality improvement outnumbered trends representing water-quality deterioration by ratios exceeding 3:1. For BOD, declining trends representing water-quality improvement were predominant statewide.

For both NN and TKN, increasing trends outnumbered declining trends; increasing levels of nitrogen are generally interpreted to indicate deteriorating water quality. On a statewide basis, there is a tendency for increasing NN trends to occur at stations with relatively high medians.

Declining pH trends outnumbered increasing pH trends by a slight margin. Excluding coalfield stations (where acid-mine-drainage treatment may be responsible for the predominance of increasing pH trends), declining pH trends outnumbered increasing trends by a margin of nearly 2-to-1. Increasing TR trends and decreasing TR trends occurred in approximately equal numbers.

A number of regional patterns were observed, including the following:

?? Relatively high DO and pH medians tend to occur in western Virginia, and relatively low DO and pH medians tend to occur in eastern Virginia. Relatively high TR and NFR medians tend to occur in eastern Virginia areas.

?? Declining pH trends were prevalent in the Holston basin and in eastern Virginia close to the Chesapeake Bay.

?? Increasing pH and TR trends were prevalent in coalfield areas (the *Big Sandy* basin and the upper *Powell*); coalfield areas also exhibited relatively high pH and TR medians.

?? Declining NFR trends were prevalent in western Virginia's *Big Sandy, Clinch-Powell*, and *Holston* basins, as well as the upper *Potomac* and *Shenandoah* basins, and throughout the *James* basin.

?? Increasing NN trends are prevalent in northwestern Virginia, including the *Shenandoah*, upper *Potomac*, and upper *Rappahannock* basins, while increasing TKN trends are prevalent in eastern Virginia. Both increasing NN and TKN trends are prevalent in the *Holston* and upper *Rappahannock* basins.

?? Relatively high NN medians tend to occur in western Virginia, while relatively low NN medians tend to occur in the eastern part of the state. This pattern is reversed for TKN medians.

?? Throughout the state, there is a tendency for increasing NN trends to occur at stations with relatively high medians. In other words, the analysis revealed a tendency for NN concentrations to increase at locations where median NN levels are relatively high.

?? Declining TP trends were prevalent in the southwestern Virginia's *Big Sandy* and *Clinch-Powell* basins, and along the South Fork of the Shenandoah River in the *Shenandoah* basin. Eight of the state's 13 significantly increasing TP trends were located in eastern Virginia.

?? Declining FC trends were prevalent in the southwestern Virginia's *Big Sandy, Clinch-Powell*, and *Holston* basins, and in the upper *New* River basin. Most of the southwestern Virginia stations exhibiting significant or apparent declining FC trends were also characterized by relatively high FC medians.

Several methodological issues are also present. The best estimate of slope was found to be zero for numerous variables and stations exhibiting significant or apparent BOD, NFR, TKN, TP, and FC trends, indicating that a key factor in trend detection was a changing incidence of relatively high values for these variables. Flow data and information on the precision of analytical measurements were unavailable; therefore, these factors were not considered in conducting seasonal Kendall analysis. The seasonal Kendall's technique is capable of detecting only for monotonic trends; therefore, any non-monotonic patterns of water-quality change that may have been present -- for example, if two segments of a data set were to exhibit differing patterns of change -- would not have been detected by these analysis.

Because of uncertainties regarding the ability of the monitoring stations chosen to adequately represent statewide water quality, variations in periods of data coverage, and the methodological issues described above, simple numerical comparisons of increasing and decreasing trends cannot be interpreted as a direct representation of general statewide change in water quality. However, study results do provide evidence of potential long-term water-quality improvement with respect to DO, BOD, NFR, TP, and FC, while results for both nitrogen variables (NN and TKN) provide evidence for potential water-quality deterioration with respect to N.

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Appendix A. Data Summary

Data in the tables that follow summarize trend analysis results for each water-quality parameter at each monitoring station. For each additional detail, see http://www.vwrrc.vt.edu/wq97.

Table A-1. Monitoring Stations And Locations.

Basin / Station No.	Location	County or City
1A POTOMAC		
01646580	POTOMAC, POTOMAC RI AT CHAIN BRIDG	ARLINGTON
1ABRB002.15	BROAD RUN , RT. 7 BRIDGE	LOUDOUN
1ADIF000.86	DIFFICULT RUN , ROUTE 193 BRIDGE	FAIRFAX
1AFOU000.19	FOURMILE RUN , GEO WASHINGTON PKWY BRIDGE	ARLINGTON
1AGOO002.38	GOOSE CREEK , ROUTE BRIDGE	LOUDOUN
1AGOO022.44	GOOSE CREEK , RT. 734 BRIDGE	LOUDOUN
1AHUT000.01	HUNTING CREEK , GEORGE WASH.MEM.PKWY	ALEXANDRIA
1ALIF000.19	LITTLE HUNTING CR , G. WASHINGTON PKWY BRIDGE	FAIRFAX
1ANEA000.57	NEABSCO BAY , MIDWAY INTO BAY	PRINCE WILLIAM
1APIM000.15	PIMMIT RUN , RT. 120 BRIDGE (UNDER CHAIN BRIDGE), GLEBE RD	ARLINGTON
1AQUA004.46	QUANTICO CREEK , RT. 1 (BUSINESS) BRIDGE	PRINCE WILLIAM
1ATUS000.37	TUSCARORA CREEK , ROUTE 653 BRIDGE	LOUDOUN
1AUMC004.43	UPPER MACHODOC CK , ROUTE 218 BRIDGE	KING GEORGE
1AWLL001.30	WILLIAMS CREEK , RTE 206 BRIDGE NEAR DAHLGREN	KING GEORGE
1B SHENANDOAH		
1BCDR013.29	CEDAR CREEK, ROUTE 628 BRIDGE	SHENANDOAH
1BHKS000.96	HAWKSBILL CREEK , ROUTE 648 BRIDGE BELOW LURAY	PAGE
1BLEW002.91	LEWIS CREEK , APPROX. 0.3 MILES BELOW RT. 275 BR.	AUGUSTA
1BNFS000.57	N FORK SHENANDOAH , APPROX. 0.1 MILE BELOW RT. 340/522 BRIDGE	WARREN
1BNFS010.34	N FORK SHENANDOAH , RT. 55 BRIDGE WARREN/SHENANDOAH COUNTY	WARREN
1BNFS081.42	N FORK SHENANDOAH , RT. 617/953 BRIDGE, W OF NEW MARKET	SHENANDOAH

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
1B SHENANDOAH (Continued)		
1BNFS093.53	N FORK SHANANDOAH , ROUTE 259 BRIDGE	ROCKINGHAM
1BNTH014.08	NORTH RIVER , RT. 693 AT QUARRY DOWNSTREAM FROM GAGING STAT	ROCKINGHAM
1BSHN022.63	SHENANDOAH RIVER , RT. 7 BRIDGE, CASTLEMANS FERRY BRIDGE	CLARKE
1BSSF003.56	S FORK SHENANDOAH , RT. 619 BRIDGE AT GAGING STATION	WARREN
1BSSF054.20	S FORK SHENANDOAH , RT. 211 BRIDGE, E OF NEW MARKET	PAGE
1BSTH007.80	SOUTH RIVER , RT. 778 AT HARRISONBURG	AUGUSTA
1BSTH027.85	SOUTH RIVER , ROUTE 664 BRIDGE - CITY OF WAYNESBORO	WAYNESBORO
1BSTY001.22	STONY CREEK , RT. 11 BRIDGE	SHENANDOAH
2 JAMES		
02035000	JAMES, JAMES RI AT CARTERSVILLE	GOOCHLAND
02041650	APPOMATTOX , APPOMATTOX RI AT MATOACA	CHESTERFIELD
2-ALM000.42	ALMOND CREEK , RT. 5 BRIDGE	RICHMOND
2-ALM000.42	ALMOND CREEK , RT. 5 BRIDGE	RICHMOND
2-APP001.53	APPOMATTOX RIVER , BUOY 8	HOPEWELL
2-APP012.79	APPOMATTOX RIVER , RT. 36 BRIDGE	CHESTERFIELD
2-APP016.38	APPOMATTOX RIVER , ROUTE 600 BRIDGE	CHESTERFIELD
2-APP050.23	APPOMATTOX RIVER , RT. 360 GOODES BRIDGE	CHESTERFIELD
2-APP110.93	APPOMATTOX RIVER , RT.45 BRIDGE AT FARMVILLE	PRINCE EDWARD
2-APP118.04	APPOMATTOX RIVER , RT.15 BRIDGE W OF FARMVILLE	PRINCE EDWARD
2-BEN001.42	BENNETT CREEK , RT. 17 BRIDGE W OF CHESAPEAKE	SUFFOLK
2-BLY000.65	BAILEY CREEK , RT. 10 BRIDGE	HOPEWELL

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
2 JAMES (Continued)		
2-BUF002.10	BUFFALO RIVER , RT. 657 AT GAGING STATION	NELSON
2-CHK002.17	CHICKAHOMINY RI. , RT. 5 BRIDGE	CHARLES CITY
2-CHK032.77	CHICKAHOMINY RI. , RT. 155 BRIDGE	CHARLES CITY
2-CHK062.57	CHICKAHOMINY RI. , RT. 360 BRIDGE	HENRICO
2-CHK076.59	CHICKAHOMINY RI. , RT. 625 BRIDGE	HENRICO
2-CRE002.37	CEDAR CREEK , RT. 605 BRIDGE	BATH
2-CWP002.58	COWPASTURE RIVER , RT. 633 BRIDGE, E OF IRON GATE	ALLEGHANY
2-EBE000.40	E BRANCH ELIZABETH RI , ALT RT. 58/460 BRIDGE	NORFOLK
2-FAC000.85	FALLING CREEK , RT. 1 BRIDGE	CHESTERFIELD
2-FAC012.96	FALLING CREEK , RT. 360 BRIDGE	CHESTERFIELD
2-JKS000.38	JACKSON RIVER , RT. 727 IRON GATE	BOTETOURT
2-JMS021.04	JAMES RIVER , BUOY 12	NEWPORT NEWS
2-JMS055.94	JAMES RIVER , BRANDON PT., BUOY 74	CHARLES CITY
2-JMS074.44	JAMES RIVER , RT. 156 BRIDGE BELOW HOPEWELL	CHARLES CITY
2-JMS099.30	JAMES RIVER , BUOY 157	CHESTERFIELD
2-JMS110.30	JAMES RIVER , RT. 360 BRIDGE	RICHMOND
2-JMS117.35	JAMES RIVER , RT. 147 BRIDGE	HENRICO
2-JMS157.28	JAMES RIVER , RT. 45 BRIDGE AT CARTERSVILLE	CUMBERLAND
2-JMS189.31	JAMES RIVER , DOWNSTREAM APPROX 0.2 MILE BELOW RT. 20 BRIDG	FLUVANNA
2-JMS229.14	JAMES RIVER , RT. 60 AT BENT CREEK	APPOMATTOX
2-JMS258.54	JAMES RIVER , RT. 29	LYNCHBURG
2-JMS275.75	JAMES RIVER , BELOW BIG ISLAND	AMHERST
2-JMS282.28	JAMES RIVER , RT. 501 BRIDGE, SE OF GLASGOW	BEDFORD

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
2 JAMES (Continued)		
2-LAF000.00	LAFAYETTE RIVER , BUOY 2-BETWEEN TANNER PT & LAMBERTS PT(MOUTH)	NORFOLK
2-MCM005.12	MECHUMS RIVER , RT. 614 BRIDGE, W OF CHARLOTTESVILLE	ALBEMARLE
2-MRY000.46	MAURY RIVER , RT. 130 BRIDGE AT GLASGOW	ROCKBRIDGE
2-MRY038.10	MAURY RIVER , DOWNSTREAM OF RT. 39 BR. N OF ROCKBRIDGE BATH	ROCKBRIDGE
2-NAN002.77	NANSEMOND RIVER , ROUTE 17 BRIDGE	SUFFOLK
2-NAN019.14	NANSEMOND RIVER , SDH 22B	SUFFOLK
2-PCT002.46	PROCTORS CREEK , RT. 1 BRIDGE	CHESTERFIELD
2-PGN010.07	PAGAN RIVER , RT. 677 BRIDGE, NW OF SMITHFIELD	ISLE OF WIGHT
2-POT000.12	POTTS CREEK , RT. 18 BRIDGE	COVINGTON
2-RVN001.64	RIVANNA RIVER , UPSTREAM OF RT 6 BRIDGE AT COLUMBIA	FLUVANNA
2-RVN015.97	RIVANNA RIVER , UPSTREAM OF RT. 15 BRIDGE	FLUVANNA
2-RVN033.65	RIVANNA RIVER , APPROXIMATELY 0.2 MI. DOWNSTREAM RT. 729 BRIDGE	ALBEMARLE
2-SBE001.53	S BRANCH ELIZABETH , ACROSS FROM NAVAL BASE	NORFOLK
2-SFT004.92	SWIFT CREEK , RT. 1 BRIDGE	CHESTERFIELD
2-SGL001.00	SHINGLE CREEK , RT. 642, WILROY RD. BRIDGE	SUFFOLK
2-TYE000.30	TYE RIVER , RT. 626 BRIDGE, ABOVE CONFL. WITH JAMES RIVER	NELSON
3 RAPPAHANOCK		
1668000	RAPPAHANNOCK RI., RAPP R NEAR FREDERICKSBURG	SPOTSYLVANIA
3-CLB000.50	CLAIBORNE RUN , RT. 3 BRIDGE	STAFFORD

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
3 RAPPAHANOCK (Continued)		
3-HOK000.74	HOSKINS CREEK , RT. 360 BRIDGE BELOW TAPPAHANNOCK STP	ESSEX
3-LDR000.70	LITTLE DARK RUN , RT. 680 (FORD) NE OF MADISON, BELOW MAD. STP	MADISON
3-RAP006.53	RAPIDAN RIVER , RT. 610 BRIDGE	CULPEPER
3-ROB001.90	ROBINSON RIVER , RT. 614 BRIDGE	CULPEPPER
3-RPP017.72	RAPPAHANNOCK RI. , BUOY 8	MIDDLESEX
3-RPP025.52	RAPPAHANNOCK RI. , BUOY 11	MIDDLESEX
3-RPP080.19	RAPPAHANNOCK RI. , RT. 301 BRDG AT PORT ROYAL	CAROLINE
3-RPP110.57	RAPPAHANNOCK RI. , ROUTE 1, FREDERICKBURG	FREDERICKSBURG
3-RPP147.10	RAPPAHANNOCK RI. , RT. 15/29 BRIDGE CULPEPER/FAUQUIER CO.	CULPEPER
3-THO006.50	THORNTON RIVER , RT. 729 BRIDGE	RAPPAHANNOCK
3-TOT005.11	TOTUSKEY CREEK , RT. 3 BRIDGE AT TOTUSKEY BRIDGE	RICHMOND
4A ROANOKE		
02075500	DAN RIVER, DAN RIVER AT PACES	HALIFAX
4ABAN005.58	BANNISTER RIVER , ROUTE 360 BRIDGE NE OF S BOSTON	HALIFAX
4ABWR019.75	BLACKWATER RIVER , SMITH MTN.LAKE,BROOKS MILL BR.RT.834 FRANKLN	FRANKLIN
4ABWR032.32	BLACKWATER RIVER , RT. 122 BRIDGE AT GAGE (FRANKLIN CO)	FRANKLIN
4ADAN015.30	DAN RIVER , RT. 501 ABOVE TOWN OF S. BOSTON	HALIFAX
4ADAN055.69	DAN RIVER , BRANTLEY STEAM PLANT	DANVILLE
4ADAN059.80	DAN RIVER , RT. 29 ALTERNATE AT DANVILLE	DANVILLE

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
4A ROANOKE (Continued)		
4ADAN075.22	DAN RIVER , RT. 880 BRIDGE AT STATE LINE	PITTSYLVANIA
4AHYC002.70	HYCO RIVER , RT. 58 BRIDGE NEAR ENTRANCE TO KERR LAKE	MECKLENBURG
4APGG008.42	PIGG RIVER , RT. 40 BRIDGE, NEAR GAGING STATION	PITTSYLVANIA
4ARNF013.66	N FK ROANOKE RIVER , ROUTE 603 BRIDGE NEAR ELLETT	MONTGOMERY
4AROA018.04	ROANOKE RIVER , GASTON RESERVOIR, ROUTE 4 BRIDGE AT KERR DAM	MECKLENBURG
4AROA059.12	ROANOKE RIVER , ROUTE 360 BRIDGE, EAST OF CLOVER	HALIFAX
4AROA192.55	ROANOKE RIVER , SMITH MTN. LAKE, HARDYS FORD	BEDFORD
4AROA202.20	ROANOKE RIVER , 14TH. ST. BRIDGE ABOVE ROANOKE STP	ROANOKE
4AROA227.42	ROANOKE RIVER , RT. 773 AT GAGING STA. IN LAFAYEETTE	MONTGOMERY
4ASRE007.90	SMITH RIVER , RT. 622 BRIDGE, MORGAN FORD BRIDGE	HENRY
4ASRE033.19	SMITH RIVER , RT. 701 BELOW FIELDCREST MILL	HENRY
4ASRE043.54	SMITH RIVER , RT. 674 BR ABOVE TOWN CREEK	HENRY
4ATKR000.69	TINKER CREEK , RT. 24 BRIDGE ABOVE VINTON	ROANOKE
5A CHOWAN		
5ABLW000.27	BLACKWATER RIVER, TRANSECT #1	SOUTHAMPTON
5ABLW009.14	BLACKWATER RIVER , RT. 189 BRIDGE, S OF FRANKLIN	SOUTHAMPTON
5ABLW022.84	BLACKWATER RIVER , RT.611 BR,JOYNER'S BR, N OF FRANKLIN	SOUTHAMPTON
5ABLW074.66	BLACKWATER RIVER, RT. 40 BRIDGE, NE OF WAVERLY	SUSSEX

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
5A CHOWAN (Continued)		
5AMHN052.34	MEHERRIN RIVER , RT. 301 BRIDGE IN EMPORIA AT GAGING STATION	EMPORIA
5ANTW000.14	NOTTOWAY RIVER , TRANSECT #2	SOUTHAMPTON
5ANTW003.30	NOTTOWAY RIVER , RT. 258 BRIDGE SW OF FRANKLIN	SOUTHAMPTON
5ANTW075.48	NOTTOWAY RIVER , RT. 301 BRIDGE S OF STONY CRK	SUSSEX
5ANTW078.20	NOTTOWAY RIVER , RT. 301 BRIDGE S OF STONY CRK	SUSSEX
5ANTW105.67	NOTTOWAY RIVER , RT. 1 BRIDGE, SW OF MCKENNEY	DINWIDDIE
5ANTW109.02	NOTTOWAY RIVER , RT. 1 BRIDGE, S OF MCKENNEY	DINWIDDIE
5B DISMAL SWAMP		
5BHPC001.46	HELL POINT CRK, RT. 629 BRIDGE NEAR SANDBRIDGE	VIRGINIA BEACH
5BNLR005.56	N LANDING RIVER , NEAR OLD PUNGO FERRY, RT. 190 BRIDGE	VIRGINIA BEACH
5BNLR013.61	N LANDING RIVER , RT. 165 BRIDGE	VIRGINIA BEACH
5BNTW011.90	NORTHWEST RIVER , RT. 168/170 BRIDGE	CHESAPEAKE
5BWNC001.73	WEST NECK CREEK , RT. 603 BRIDGE	VIRGINIA BEACH
6A BIG SANDY		
6AHLY001.67	HOLLY CREEK, OFF RT. 607, NE OF CLINTWOOD BELOW STP	DICKENSON
6AKOX008.11	KNOX CREEK , RT. 697 AT STATE LINE	BUCHANAN
6ALEV130.00	LEVISA FORK , RT. 460 AT STATE LINE	BUCHANAN
6AMCR007.46	MCCLURE RIVER , RT. 63 BR N OF CLINCH	DICKENSON
6ARSS025.40	RUSSELL FORK , RT. 83 BRIDGE AT GAGING STATION BELOW HAYSI	DICKENSON

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
6B CLINCH-POWELL		
6BBER001.14	BEAR CREEK, OFF RT. 681 BELOW TOWN OF WISE STP	WISE
6BCLN211.00	CLINCH RIVER , RT. 23/58 BRIDGE, SPEERS FERRY 9 MILES FROM STATELINE	SCOTT
6BCLN315.11	CLINCH RIVER , RT. 723 BRIDGE & BELOW RICHLANDS STP	TAZEWELL
6BGUE006.50	GUEST RIVER , RT. 72 BRIDGE S OF COEBURN, AT GAGING STATION	WISE
6BNFC003.80	N FORK CLINCH RI. , RT. 621 NEAR DONA	SCOTT
6BPOW143.53	POWELL RIVER , RT. 70 AT SEWELL BRIDGE S. OF JONESVILLE	LEE
6BPOW180.78	POWELL RIVER , IN BIG STONE GAP IN GAGING STATION	WISE
6BPWL001.49	N FORK POWELL RIVER , RT. 630 BRIDGE, S PENNINGTON GAP, BELOW STP	LEE
6BSRA001.11	STRAIGHT CREEK , RT. 352 APPROX 1 MI S OF ST. CHARLES	LEE
6BSTO004.56	STOCK CREEK , RT. 650 BRIDGE BELOW FOOTE MINERAL	SCOTT
6C HOLSTON		
6CBEV015.27	BEAVER CREEK, STATE STREET & 7TH IN BRISTOL, VA-TENN LINE	BRISTOL
6CBEV021.07	BEAVER CREEK , BELOW DAIRYMAN OFF RT. 11 ABOVE BRISTOL	WASHINGTON
6CBVD000.07	BEAVERDAM CREEK , RT. 58 BRIDGE IN DAMASCUS, RAW SEWAGE	WASHINGTON
6CLTL000.26	LITTLE CREEK , STATE STREET BRIDGE IN BRISTOL, VA-TENN LINE	BRISTOL
6CMFH005.00	MID FORK HOLSTON RIVE , RT. 58 BRIDGE E OF ABINGDON	WASHINGTON

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
6C HOLSTON (Continued)		
6CMFH026.00	MID FORK HOLSTON RIVE , OFF RT. 608 WASHIGTON, SMYTH CO. LINE	WASHINGTON
6CNFH008.78	N. FORK HOLSTON RIVER , RT. 23 BRIDGE BELOW WEBER CITY	SCOTT
6CNFH039.18	N. FORK HOLSTON RIVER , RT. 615 BRIDGE AT MENDOTA AT GAGING STATION	WASHINGTON
6CNFH059.65	N. FORK HOLSTON RIVER , RT. 19 BRIDGE SE HOLSTON	WASHINGTON
6CNFH080.43	N. FORK HOLSTON RIVER , BELOW SALTVILLE AT OLIN MATHIESON GAGING STAT	WASHINGTON
6CNFH083.32	N. FORK HOLSTON RIVER , BRIDGE AT OLIN PLANT, RT. 613 BRIDGE, SALTVIL	SMYTH
6CNFH085.20	N. FORK HOLSTON RIVER , RT. 91 BRIDGE ABOVE SALTVILLE	SMYTH
6CNFH097.67	N. FORK HOLSTON RIVER , AT OLD RICH-VALLEY HIGH SCHOOL	SMYTH
6CSFH073.62	S FORK HOLSTON RIVER , S FORK HOLSTON RI AT ALVARADO BRIDGE, RT. 710	WASHINGTON
6CWLF001.46	WOLF CREEK , RT. 75 AT GREEN SPRING	WASHINGTON
6CWLF006.55	WOLF CREEK , OFF RT. 75 3/4 MI. BELOW STP	WASHINGTON
7 SMALL COASTAL WATERSHEDS AND CHESAPEAKE BAY		
7-BRK004.14	BRICK KILN CREEK, RT. 134 BRIDGE	HAMPTON
7-COC001.61	COCKRELL CREEK , DOCK AT END MAIN ST., REEDVILLE	NORTHUMBERLA ND
7-HLD002.67	HOLDENS CREEK , RT. 701 BRIDGE	ACCOMACK
7-IND002.26	INDIAN CREEK , OPPOSITE KILMARNOCK WHARF	LANCASTER
7-NEW001.92	NEWMARKET CREEK , RT. 134 BRIDGE	HAMPTON

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
7 SMALL COASTAL WATERSHEDS AND CHESAPEAKE BAY (Continued)		
7-PAR003.09	PARKER CREEK , PERDUE, INC. STA #3, TR. 744 - RECOVERY	ACCOMACK
7-PRT001.30	PARTING CREEK , END OF RT. 183	NORTHAMPTON
7-THA000.76	THALIA CREEK , RT. 58 BRIDGE	VIRGINIA BEACH
8 YORK		
01673000	PAMUNKEY, PAMUNKEY RI NEAR HANOVER	HANOVER
01674500	MATTAPONI , MATTAPONI RI NR BEULAHVIL	KING AND QUEEN
8-MPN054.17	MATTAPONI RIVER , RT. 628 BRIDGE	KING AND QUEEN
8-MPN094.79	MATTAPONI RIVER , RT. 605 BRIDGE	CAROLINE
8-NAR005.42	NORTH ANNA RIVER , STA.1 - RT. 30 BR (MORRIS BRIDGE)	HANOVER
8-PMK056.87	PAMUNKEY RIVER , RT. 360 BRIDGE NEAR OLD CHURCH	HANOVER
8-PMK082.34	PAMUNKEY RIVER , RT. 614 BRIDGE	HANOVER
8-YRK011.14	YORK RIVER , BUOY 34	GLOUCESTER
9 NEW		
9-BST029.71	BLUESTONE RIVER, RT. 650 BRIDGE ABOVE WATER TREATMENT PLANT	TAZEWELL
9-CST010.45	CHESTNUT CREEK , RT. 721 BRIDGE N OF GALAX, BELOW STP	GALAX
9-LVR001.34	LITTLE RIVER , T. 626 BRIDGE NEAR VA. -N.C. STATE LINE	GRAYSON
9-NEW030.15	NEW RIVER , RT. 460 BRIDGE AT GLEN LYN	GILES
9-NEW081.72	NEW RIVER , RT. 11 BRIDGE AT RADFORD	PULASKI
9-NEW098.32	NEW RIVER , CLAYTOR LAKE DOWNSTREAM FROM S END OF RT. 672	PULASKI

Table A-1. Monitoring Stations And Locations (Continued).

Basin / Station No.	Location	County or City
9 NEW (Continued)		
9-NEW148.23	NEW RIVER , RT. 58/221 BRIDGE W OF GALAX AT GAGING STATION	GRAYSON
9-NEW187.46	NEW RIVER , OFF RT. 58 AT MOUTH OF WILSON OR RT. 93 BRIDGE	GRAYSON
9-PBC002.69	PEACHBOTTOM CREEK , RT. 697 BRIDGE BELOW INDEPENDENCE STP	GRAYSON
9-PKC004.65	PEAK CREEK , RT. 100 BRIDGE EAST OF PULASKI	PULASKI
9-RDC009.00	REED CREEK , RT. 619 AT GAGING STATION	WYTHE
9-STE002.41	STROUBLES CREEK , RT. 659 BRIDGE NEAR RADFORD AMMUNITION PLANT	MONTGOMERY
99 OUT OF STATE		
01578310	SUSQUEHANNA, SUSQUEHANNA RI AT CONOWIN	HARTFORD, MD
02080500	ROANOKE , ROANOKE RI AT ROAN RAPIDS	HALIFAX, NC
02087570	NEUSE RIVER , NEUSE RIVER AT SMITHFIELD	JOHNSTON, NC
02089500	NEUSE RIVER , NEUSE RIVER AT KINSTON	LENOIR, NC

Table A-2. Values of Seasonal Kendall's Tau

Basin 1A Potomac									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
01646580	-0.32**		-0.13?	-0.33	-0.33	0.41**	-0.15?	-0.18*	0.45
1ABRB002.15	-0.16*	-0.02	-0.17**	0.31*	0.03	0.00	0.07	0.10	0.09
1ADIF000.86	-0.18**	-0.03	0.14*	0.20?	-0.15?	0.41**	0.17*	-0.30	0.11?
1AFOU000.19	-0.02	-0.33**	-0.23**	0.15?	-0.31**	0.21**	-0.26**	-0.75**	0.27**
1AGOO002.38	-0.08?	-0.17*	-0.11?	-0.21*	-0.12?	-0.04	0.05	0.01	0.02
1AGOO022.44	-0.05	-0.00	-0.03	-0.10	-0.13?	-0.11?	0.21**	-0.22	-0.04
1AHUT000.01	0.06	-0.31**	-0.15*	0.24*	-0.29**	-0.04	0.25**	-0.54**	0.32**
1ALIF000.19	0.05	-0.21**	-0.11?	-0.16?	0.13*	0.14*	-0.19**	0.22?	0.19?
1ANEA000.57	-0.08	-0.33**	-0.24**	0.14	-0.09	0.36**	0.10?	-0.30*	0.09
1APIM000.15	0.03	-0.08	-0.06	0.07	-0.40**	0.16*	0.11?	-0.27	-0.08
1AQUA004.46	-0.09?	-0.04	0.18**	-0.18?	-0.20?	0.00	-0.01	0.51	0.20?
1ATUS000.37	-0.01	-0.04	-0.16*	-0.16	-0.26**	0.24**	-0.00	0.17?	0.16?
1AUMC004.43	-0.19**	-0.05	-0.12?	0.01	-0.07	0.01	0.57**	0.15	0.07
1AWLL001.30	-0.17**	-0.03	-0.19**	0.03	-0.02	0.09	0.45**	-0.12	0.17?

? indicates .01 < P < .10 - Trend may be present, but statistical significance trend is questionable.
* indicates .001 < P <.01 - Trend is statistically statistically significant.
** indicates P < .001 - Trend is highly statistically significant.

Table A-2. Values of Seasonal Kendall's Tau (continued)

				Basin 1B Shenandoah					
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
1BCDR013.29	0.05	-0.27?	0.03	-0.14	-0.17	0.01	-0.11	-0.49	0.06
1BHKS000.96	0.29**	-0.46**	0.19**	-0.19*	-0.31**	0.11?	-0.40**	-0.33**	-0.10?
1BLEW002.91	0.24**	-0.55**	-0.19**	-0.04	-0.07	-0.51**	-0.51**	-0.79**	0.48**
1BNFS000.57	-0.01	-0.24*	-0.11?	-0.19	-0.09	0.30**	0.04	-0.07	-0.18?
1BNFS010.34	-0.09?	-0.24*	-0.23**	-0.14	-0.07	0.28**	0.14?	0.18	-0.02
1BNFS081.42	0.06	-0.36**	-0.08?	0.07	-0.15	0.31**	-0.04	0.10	-0.03
1BNFS093.53	0.07	-0.04	0.26**	0.27	-0.11	0.07	0.02	-0.25	0.12
1BNTH014.08	0.08	-0.06	-0.00	0.14	-0.18*	0.27**	0.03	-0.15?	0.02
1BSHN022.63	-0.08?	-0.50**	-0.12*	-0.53**	-0.15?	0.20**	-0.25**	-0.25?	-0.01
1BSSF003.56	-0.12*	-0.33**	-0.12?	-0.10	-0.19?	0.10?	-0.17*	-0.27*	0.01
1BSSF054.20	0.03	-0.32**	-0.13*	-0.35?	-0.17?	0.15*	-0.32**	-0.34**	0.09
1BSTH007.80	0.09?	-0.23*	0.06	-0.40?	-0.04	-0.26**	-0.50**	-0.45**	-0.04
1BSTH027.85	0.02	0.10	-0.17**	0.45?	-0.17?	0.08	0.00	-0.31?	0.11?
1BSTY001.22	0.04	-0.24?	-0.08	0.10	-0.30**	0.52**	0.04	0.43**	0.20*

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 2 James River									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
02035000	0.03	0.13	0.23**		0.02	-0.06	0.03	0.24**	0.14
02041650	-0.29**	-1.00	0.16?	.	-0.16	-0.10	0.05	0.17?	.
2-ALM000.42	0.10?	-0.27**	-0.27**	-0.21*	-0.30**	-0.05	-0.07	-0.25?	-0.09
2-APP001.53	0.14*	-0.10?	-0.01	-0.18	0.16*	0.05	0.37**	0.13?	0.02
2-APP012.79	0.11*	-0.05	-0.10?	-0.13?	-0.16*	0.08	0.12?	-0.51*	0.07
2-APP016.38	0.20?	-1.00	0.04		-0.18		-0.14	-0.07	
2-APP050.23	0.11?	-0.07	-0.10?	-0.09	-0.03	0.26**	0.14?	-0.39**	0.03
2-APP110.93	-0.02	-0.19?	0.18**	-0.03	-0.12?	-0.03	0.11?	-0.63?	-0.12?
2-APP118.04	0.10?	0.07	-0.05	0.05	0.07	0.08	0.18*	-0.26	0.01
2-BEN001.42	0.00	-0.06	-0.04	-0.11	-0.14?	-0.20*	0.27**	-0.06	0.03
2-BLY000.65	0.36**	-0.35**	-0.36**	-0.59**	-0.21**	0.16**	-0.28**	-0.22**	-0.17*
2-BUF002.10	0.13*	-0.17?	0.22**	-0.32?	-0.17*	-0.04	0.06	-0.06	-0.03
2-CHK002.17	0.15*	0.08	-0.01	-0.08	0.11?	-0.39**	0.36**	-0.25?	-0.24
2-CHK032.77	0.08?	-0.14?	-0.06	0.03	-0.18*	-0.20	0.05	-0.56**	0.10
2-CHK062.57	-0.18**	-0.11	0.02	-0.15?	-0.26**	-0.17?	-0.06	0.00	0.05
2-CHK076.59	0.01	-0.33**	0.06	0.41**	-0.13*	0.47**	-0.02	-0.65**	0.14?
2-CRE002.37	0.15*	-0.26?	-0.24**	-0.06	-0.17?	-0.01	0.01	-0.50**	0.03
2-CWP002.58	-0.08	-0.32?	0.05	1.00	-0.29?	0.02	-0.31**	-0.16	0.20
2-EBE000.40	-0.02	-0.17?	-0.29**	0.03	-0.30**	-0.05	0.10	-0.12	-0.02
2-FAC000.85	0.16**	-0.01	0.04	-0.26?	-0.21?	0.23*	0.16*	-0.58?	0.06
2-FAC012.96	0.04	-0.15?	0.26**	-0.67?	-0.23*	-0.07	0.08	0.00	0.15?
2-JKS000.38	0.20**	-0.19*	0.25**	0.24*	-0.12?	-0.37**	-0.06	-0.12?	-0.35**

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 2 James River (continued)									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
2-JMS021.04	-0.32**	0.16	-0.30**	-0.50	0.27**	-0.20?	0.37**	0.47**	-0.25
2-JMS055.94	0.25**	-0.35?	-0.02	-1.00	0.32**	-0.06	0.17?	0.29**	-0.24
2-JMS074.44	0.29**	-0.33**	0.01	-0.04	-0.13?	-0.32**	-0.26**	-0.29**	-0.21?
2-JMS099.30	0.32**	-0.26?	0.07	-0.17	-0.02	-0.25?	0.00	-0.47**	-0.01
2-JMS110.30	0.25**	-0.01	-0.00	-0.11	-0.03	-0.20**	0.11?	-0.06	0.05
2-JMS117.35	0.16**	-0.06	-0.01	-0.01	-0.06	-0.32**	0.06	-0.16?	0.16?
2-JMS157.28	0.09?	0.04	-0.04	-0.07	0.12?	0.01	0.25**	-0.03	-0.10
2-JMS189.31	-0.03	-0.18?	-0.04	-0.29?	-0.10	-0.06	0.00	0.03	-0.01
2-JMS229.14	0.18**	-0.11?	0.15**	0.08	-0.00	-0.03	0.12?	0.06	0.13?
2-JMS258.54	0.17**	-0.12?	0.08?	-0.06	-0.04	0.17*	0.20**	-0.00	0.19**
2-JMS275.75	0.29**	-0.20*	0.12*	0.00	-0.04	0.04	0.06	-0.08	0.02
2-JMS282.28	0.01	-0.01	0.06	-0.03	0.02	-0.08	0.15*	-0.02	0.05
2-LAF000.00	0.15*	-0.14	-0.26**	0.07	-0.24**	-0.20*	0.10	-0.30?	-0.13
2-MCM005.12	0.02	-0.43**	0.21**	-0.21	0.05	-0.27**	-0.07	-0.35*	-0.02
2-MRY000.46	-0.03	-0.27**	-0.03	-0.04	-0.13?	0.01	-0.05	0.21?	0.08
2-MRY038.10	0.15**	-0.36**	0.12?	-0.31**	-0.20?	0.16?	-0.09	-0.07	0.12
2-NAN002.77	0.03	-0.06	-0.28**	-0.20?	-0.19*	-0.23*	0.40**	-0.12	-0.26*
2-NAN019.14	0.15**	-0.18*	0.01	-0.08	-0.16*	-0.39**	0.02	0.12	0.12?
2-PCT002.46	0.29**	-0.20?	0.23**	-0.03	0.09	-0.14?	-0.19*	-0.01	0.17?
2-PGN010.07	-0.25**	-0.36**	-0.33**	0.17?	0.29**	0.25**	0.17*	0.23?	0.25**
2-POT000.12	-0.07	-0.39*	0.18**		-0.23	-0.05	-0.20?	1.00	0.06
2-RVN001.64	0.06	-0.48**	0.24**	-0.12	-0.01	0.02	-0.03	-0.04	-0.02

Table A-2. Values of Seasonal Kendall's Tau (continued)

				Basin 2 James River (continued)					
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
2-RVN015.97	0.03	-0.36**	0.25**	0.27	-0.04	-0.01	-0.17*	-0.00	-0.01
2-RVN033.65	0.10?	-0.53**	0.22**	-0.07	-0.12?	0.27**	-0.28**	0.00	-0.03
2-SBE001.53	0.02	-0.14	-0.29**	-0.12	-0.31**	-0.01	0.08	-0.10	-0.00
2-SFT004.92	0.08?	-0.03	0.00	-0.35*	0.03	0.33*	0.15?	-0.74?	0.05
2-SGL001.00	0.23**	-0.28**	-0.01	0.01	0.00	-0.37**	-0.08	-0.04	-0.10?
2-TYE000.30	0.21**	0.00	0.38**	-0.32?	-0.20?	-0.03	-0.15?	0.11	0.05

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

				Basin 3 Rappahanock River					
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
01668000	-0.18*	-0.20	0.23**	.	-0.18	-0.25	0.04	0.17?	
3-CLB000.50	-0.03	-0.04	0.31**	-0.30*	-0.22**	0.04	0.18**	-0.46**	0.03
3-GRT001.70	-0.07	-0.11	0.03	0.01	-0.14?	0.22**	0.25**	0.05	0.21?
3-HOK000.74	0.03	-0.07	-0.04	-0.18?	0.06	-0.14?	0.35**	0.05	0.22**
3-LDR000.70	0.08	-0.20?	0.19**	-0.09	-0.22*	0.14?	0.08	-0.14	-0.14?
3-RAP006.53	-0.03	-0.16?	-0.03	0.00	-0.03	-0.01	0.15?	-0.04	0.02
3-ROB001.90	0.02	0.04	0.03	0.13	-0.01	0.01	0.11?	0.34	-0.09
3-RPP017.72	-0.46**	-0.26*	-0.33**	-1.00	-0.04	-0.02	0.50**	0.30*	-0.17
3-RPP025.52	-0.42**	0.08	-0.29**	-1.00	-0.04	-0.11	0.52**	0.47**	-1.00
3-RPP080.19	-0.10?	-0.16?	-0.14?	0.26	0.30**	-0.09	0.36**	0.34**	0.19
3-RPP110.57	0.01	-0.18	-0.15?		-0.19?		-0.21?	0.01	
3-RPP147.10	0.02	-0.24?	0.09?	-0.12	-0.08	-0.08	0.04	0.09	0.02
3-THO006.50	-0.01	-0.26**	-0.04	-0.06	-0.12	-0.12?	0.15?	0.33	0.09
3-TOT005.11	-0.04	-0.01	0.11?	-0.11	0.01	0.13	0.42**	0.06	0.10

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 4A Roanoke River									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
02075500	-0.02		0.05			-0.04	0.00	-0.34**	
4ABAN005.58	-0.13*	0.08	-0.13*	0.00	0.11?	0.25**	0.29**	-0.16?	-0.04
4ABWR019.75	0.11?	-0.02	0.38**	-0.13	-0.02	0.19**	0.12?	-0.15	0.04
4ABWR032.32	-0.06	-0.26?	0.18?	-0.01	0.08	0.28**	0.35**	-0.13	0.19?
4ADAN015.30	0.12*	0.03	-0.08?	0.21*	0.04	0.01	0.28**	-0.21*	-0.19*
4ADAN055.69	0.24**	-0.62**	-0.27**	-0.03	-0.28**	0.00	-0.40**	0.32?	-0.08
4ADAN059.80	-0.11?	-0.36**	-0.01	-0.03	-0.25**	0.18?	0.01	0.41*	-0.32**
4ADAN075.22	0.13*	0.02	0.38**	0.03	-0.08?	0.08	0.21**	-0.04	-0.23**
4AHYC002.70	-0.05	0.04	-0.22**	-0.02	0.00	0.02	0.29**	-0.34**	0.10
4APGG008.42	-0.08	-0.42**	0.05	0.00	-0.16?	-0.03	-0.12	0.00	-0.12
4ARNF013.66	-0.07	-0.24?	-0.27**	-1.00	-0.10	-0.07	-0.03	-0.25?	0.22**
4AROA018.04	-0.14*	-0.11	-0.22**	0.09	-0.04	0.15?	0.20*	-0.62**	-0.36
4AROA059.12	0.04	0.10	-0.13*	0.08	0.06	0.18*	0.25**	-0.16	-0.01
4AROA192.55	0.05	-0.04	-0.03	0.02	0.07	-0.01	0.04	0.12	0.26**
4AROA202.20	0.01	-0.03	-0.14*	-0.01	-0.08	0.17**	0.07	0.29	0.22**
4AROA227.42	-0.03	-0.06	-0.22**	0.10	-0.02	0.07	0.10?	0.12	-0.05
4ASRE007.90	0.18**	-0.11	0.45**	0.14?	-0.02	-0.07	-0.08	-0.42**	-0.09
4ASRE033.19	0.14*	-0.52**	0.06	-0.43**	-0.29**	-0.02	-0.30**	-0.23	-0.29**
4ASRE043.54	-0.06	-0.24?	0.26**	-0.29**	-0.10	0.09	-0.09	-0.83?	0.10
4ATKR000.69	0.15**	-0.37**	-0.19**	0.01	-0.22**	0.09?	-0.11?	0.15	-0.09?

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 5A Chowan River									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
5ABLW000.27	-0.25?	-0.25	-0.24?	.		-0.01	0.12	0.05	.
5ABLW009.14	-0.06	-0.45**	-0.02	0.04	-0.47**	-0.06	-0.06	-0.35*	-0.18?
5ABLW022.84	-0.05	-0.23**	-0.19**	-0.06	-0.37**	-0.10	0.14*	0.00	0.12
5ABLW074.66	-0.08?	-0.09?	-0.16**	-0.07	-0.25**	-0.20**	-0.08?	-0.49**	-0.02
5AMHN052.34	-0.30**	-0.06	-0.28**	-0.14?	0.09?	0.18?	0.30**	-0.60**	-0.06
5ANTW000.14	-0.34*	-0.69*	-0.27?			0.02	0.20?	-0.11	
5ANTW003.30	-0.08	-0.18?	-0.01	0.10?	-0.33**	0.04	0.12?	0.12	-0.10
5ANTW075.48	0.18**	-0.32*	0.17*	-0.31	-0.20?	-0.02	0.03	0.11	-0.24*
5ANTW078.20	0.06	-0.15?	-0.16**	-0.09	-0.13?	-0.01	0.15*	-0.50*	-0.23*
5ANTW105.67	0.11?	-0.13	0.19**	-0.33	-0.04	-0.07	0.17?	-0.18	-0.09
5ANTW109.02	-0.00	-0.07	-0.14*	-0.01	-0.04	0.04	0.28**	-0.52**	-0.08

Basin 5B Dismal Swamp River , Seasonal Kendall Tau									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
5BHPC001.46	0.00	-0.20**	0.12?	-0.04	-0.05	-0.33**	0.11?	-0.19*	0.15?
5BNLR005.56	-0.01	0.20?	-0.19**	0.39**	0.08	-0.03	0.48**	-0.03	0.09
5BNLR013.61	0.02	0.02	0.08	0.33**	-0.20**	-0.17*	0.29**	0.02	0.04
5BNTW011.90	-0.11?	-0.31**	-0.07	0.26*	-0.31**	-0.07	-0.02	-0.20?	-0.02
5BWNC001.73	0.21**	0.08	0.21**	0.31**	0.10?	-0.19?	0.22**	0.00	-0.05

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 6A Big Sandy

Station	DO	BOD	PH	TR	NFR	NN	TKN	TP	FC
6AHLY001.67	0.00	-0.33**	0.32**	-0.04	-0.32**	-0.27**	-0.18*	-0.34**	-0.03
6AKOX008.11	0.05	-0.41**	0.22**	0.16*	-0.28**	-0.20*	-0.02	-0.17	-0.45**
6ALEV130.00	0.16**	-0.22*	0.32**	0.06	-0.34**	-0.14?	0.01	-0.35	-0.33**
6AMCR007.46	0.01	-0.40**	0.13?	0.28**	-0.33**	-0.11	-0.09	-0.53?	-0.30**
6ARSS025.40	-0.03	-0.43**	0.01	0.18**	-0.13?	-0.01	0.03	-0.50?	-0.44**

Basin 6B Clinch-Powell

Station	DO	BOD	PH	TR	NFR	NN	TKN	TP	FC
6BBER001.14	0.12?	-0.33**	0.53**	0.58**	-0.36**	0.29**	0.08	-0.26**	-0.62**
6BCLN211.00	-0.10?	-0.35**	-0.31**	0.08	-0.21**	-0.03	0.27**	-0.58?	-0.38**
6BCLN315.11	-0.05	-0.29**	-0.27**	-0.00	-0.29**	-0.02	-0.03	-0.41**	-0.39**
6BGUE006.50	-0.03	-0.31**	0.13?	0.29**	-0.22**	0.08	0.08	-0.30?	-0.23**
6BNFC003.80	-0.33**	-0.34**	-0.19**	0.13?	0.04	-0.01	0.04	-0.43	-0.18*
6BPOW143.53	-0.15*	-0.33**	-0.10?	0.16*	-0.20*	0.05	0.14?	-0.48*	-0.38**
6BPOW180.78	0.10?	-0.42**	0.10?	0.26**	-0.31**	0.18*	-0.11?	-0.36?	-0.36**
6BPWL001.49	0.04	-0.28**	0.20**	0.07	-0.36**	0.07	-0.04	-0.36?	-0.30**
6BSRA001.11	0.02	-0.46**	0.15*	0.33**	-0.32**	0.14?	0.01	-0.29	-0.33**
6BSTO004.56	0.10?	-0.64**	0.08	-0.12?	-0.20?	0.04	0.21?	-0.60?	-0.24**

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 6C Holston									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
6CBEV015.27	0.08?	-0.34**	-0.29**	0.09?	0.02	0.23**	0.14?	-0.12	-0.23**
6CBEV021.07	-0.03	-0.04	-0.39**	0.19**	0.12?	0.19**	0.28**	-0.08	-0.28**
6CBVD000.07	0.16**	-0.55**	0.19**	-0.40**	-0.44**	-0.06	-0.28**	-0.60	-0.49**
6CLTL000.26	0.10?	-0.41**	-0.22**	0.01	-0.15?	0.16*	-0.01	0.01	-0.23*
6CMFH005.00	-0.18**	-0.23*	-0.21**	0.13?	-0.01	0.22**	0.30**	0.26?	-0.04
6CMFH026.00	-0.13*	-0.54**	-0.22**	0.08	-0.15*	0.12?	0.19*	-0.34**	-0.22**
6CNFH008.78	-0.16**	-0.47**	-0.33**	-0.19?	0.20?	-0.14?	0.19*	-0.39?	-0.28**
6CNFH039.18	-0.23**	-0.26*	-0.24**	-0.11?	-0.11	-0.11?	0.30**	-0.35	-0.10
6CNFH059.65	-0.11?	-0.47**	-0.32**	-0.37**	-0.27*	-0.09	0.28**	-0.24	-0.18*
6CNFH080.43	0.13*	-0.21*	-0.21**	-0.21**	-0.17?	0.00	0.18*	-0.33	-0.32**
6CNFH083.32	0.00	-0.53**	-0.28**	-0.08	-0.20?	0.03	0.16?	-0.17	-0.34**
6CNFH085.20	0.01	-0.45**	-0.07	-0.09	-0.21?	0.04	0.21*	-0.16	-0.16*
6CNFH097.67	-0.01	-0.28**	-0.13?	0.11	-0.01	0.12?	0.26**	-0.60	-0.25**
6CSFH073.62	-0.07	-0.23*	-0.06	0.02	-0.15	0.23*	-0.14?	0.12	-0.15?
6CWLF001.46	0.01	-0.23*	-0.27**	0.12?	0.05	0.38**	0.29**	0.04	-0.26**
6CWLF006.55	0.18**	-0.26**	-0.17*	0.06	-0.13?	0.21**	-0.18*	-0.05	-0.30**

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 7 Small Coastal Basins, Chesapeake Bay									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
7-BRK004.14	-0.19**	-0.08	-0.01	-0.15?	-0.13?	-0.02	0.15?	-0.26?	0.28**
7-COC001.61	0.02	-0.36**	-0.35**	-0.08	-0.20*	0.10	0.17?	-0.41?	0.09
7-HLD002.67	0.17**	-0.02	0.17**	0.06	0.15*	0.50**	-0.12?	0.80**	0.31**
7-IND002.26	0.05	-0.07	-0.38**	-0.01	-0.28**	-0.03	0.35**	-0.32?	-0.11
7-NEW001.92	-0.04	-0.18*	0.06	-0.08	-0.09	-0.15?	0.35**	-0.02	0.13?
7-PAR003.09	0.45**	-0.52**	0.26**	0.26**	-0.14?	0.53**	-0.51**	0.07	0.05
7-PRT001.30	0.01	-0.36**	-0.22**	-0.06	-0.40**	-0.34*	-0.09	-0.48**	0.11
7-THA000.76	-0.01	-0.23**	-0.09?	0.15?	-0.22**	-0.20?	0.27**	0.03	0.06

Basin 8. York River									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
01673000	-0.13?	1.00	0.17**		0.02	0.14	-0.00	0.19*	0.50
01674500	-0.19*	1.00	0.05		-0.20	-0.50?	0.03	0.22*	
8-MPN054.17	-0.19*	-0.16	-0.27**		0.02	-0.50	-0.05	0.26*	0.33
8-MPN094.79	-0.15*	-0.01	-0.02	-0.11	-0.02	0.02	0.22**	-0.57?	0.21?
8-NAR005.42	-0.05	-0.13	-0.23**	-0.02	-0.22?	-0.04	0.04	-0.53?	-0.11
8-PMK056.87	-0.04	-0.21?	-0.11?	-0.08	-0.10	0.34**	0.12?	-0.43?	-0.05
8-PMK082.34	-0.06	-0.06	-0.13?	0.20	0.05	0.01	0.14?	-0.26*	-0.12
8-YRK011.14	-0.36**	-0.13	-0.37**	1.00	0.06	-0.03	0.54**	0.48**	-0.40

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 9 New River									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
9-BST029.71	-0.09?	-0.21*	-0.14*	-0.01	0.01	0.18*	0.30**	-0.08	-0.20**
9-CST010.45	-0.01	-0.10	0.19**	-0.03	-0.15?	0.34**	0.15*	-0.05	-0.28**
9-LVR001.34	-0.14*	-0.32**	0.01	-0.09	0.04	0.51**	0.16?	-0.18	-0.02
9-NEW030.15	0.14*	-0.07	0.24**	-0.21?	-0.18*	-0.17**	0.22**	0.10	-0.06
9-NEW081.72	0.01	-0.10	0.36**	0.23*	-0.15?	0.43**	0.02	-0.21	-0.00
9-NEW098.32	-0.04	0.02	0.24**	0.08	-0.09	0.22**	0.36**	-0.50?	0.07
9-NEW148.23	-0.12*	-0.34**	-0.04	0.00	0.07	0.09	0.13?	-0.12	-0.18*
9-NEW187.46	-0.19**	-0.47**	-0.11?	-0.12?	-0.01	-0.21**	0.12?	-0.20	-0.24**
9-PBC002.69	-0.02	-0.15?	-0.01	0.00	0.02	0.05	0.44**	-0.30**	-0.22**
9-PKC004.65	0.08?	-0.43**	0.19**	-0.20?	-0.26**	-0.00	-0.33**	-0.49**	-0.03
9-RDC009.00	0.06	-0.30**	-0.18**	-0.03	-0.05	0.10?	0.09	-0.21	-0.14?
9-STE002.41	0.09?	-0.35*	-0.07	-1.00	-0.08	-0.22**	-0.16*	0.18	0.10

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-2. Values of Seasonal Kendall's Tau (continued)

Basin 99 USGS - Out of State									
Station	**DO**	**BOD**	**PH**	**TR**	**NFR**	**NN**	**TKN**	**TP**	**FC**
01578310	-0.02		-0.28**	0.40		0.15	-0.31**	-0.10	
02080500	-0.11		0.03			-0.01	-0.01	-0.11	
02087570	0.16		0.45**			0.46*	-0.55**	-0.10	
02089500	0.00	0.33	0.18*			0.22?	-0.23*	-0.31**	-0.80?

? indicates .01 < P < .10 ; * indicates .001 < P <.01; ** indicates P < .001

Table A-3. Estimates of Slope (units/year).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
1A Potomac									
01646580	-0.52 *		-0.01 ?	0.00	-1.33	0.037 *	-0.007 ?	-0.001 *	146
1ABRB002.15	-0.38 *	0.00	-0.01 *	3.13 *	0.00	0.000	0.000	0.000	0
1ADIF000.86	-0.27 *	0.00	0.01 *	1.50 ?	0.00 ?	0.023 *	0.000 *	0.000	0 ?
1AFOU000.19	-0.04	-0.18 *	-0.02 *	1.53 ?	-0.67 *	0.073 *	-0.276 *	-0.017 *	0 *
1AGOO002.38	-0.13 ?	0.00 *	-0.01 ?	-2.93 *	0.00 ?	-0.005	0.000	0.000	0
1AGOO022.44	-0.11	0.00	0.00	-0.50	0.00 ?	-0.007 ?	0.000 *	0.000	0
1AHUT000.01	0.15	-0.30 *	-0.01 *	4.02 *	-0.61 *	-0.002	0.326 *	0.000 *	0 *
1ALIF000.19	0.15	-0.08 *	-0.01 ?	-1.33 ?	0.35 *	0.010 *	-0.033 *	0.000 ?	0 ?
1ANEA000.57	-0.43	-0.10 *	-0.04 *	2.54	-0.54	0.035 *	0.007 ?	0.000 *	0
1APIM000.15	0.05	0.00	0.00	1.00	0.00 *	0.016 *	0.000 ?	0.000	0
1AQUA004.46	-0.14 ?	0.00	0.01 *	-1.14 ?	0.00 ?	0.000	0.000	0.000	0 ?
1ATUS000.37	-0.01	0.00	-0.01 *	-1.62	-0.25 *	0.084 *	0.000	0.000 ?	0 ?
1AUMC004.43	-0.67 *	0.00	-0.01 ?	12.50	-0.17	0.000	0.035 *	0.000	0
1AWLL001.30	-0.74 *	0.00	-0.02 *	20.53	0.00	0.000	0.038 *	0.000	0 ?
1B Shenandoah									
1BCDR013.29	0.08	0.00 ?	0.00	-1.48	0.00	0.000	0.000	0.000	0
1BHKS000.96	0.67 *	0.00 *	0.02 *	-2.32 *	0.00 *	0.008 ?	-0.014 *	0.000 *	0 ?
1BLEW002.91	0.47 *	-0.08 *	-0.01 *	-0.36	0.00	-0.058 *	-0.044 *	0.000 *	50 *
1BNFS000.57	-0.01	0.00 *	-0.01 ?	-0.75	0.00	0.025 *	0.000	0.000	0 ?
1BNFS010.34	-0.22 ?	0.00 *	-0.02 *	-0.31	0.00	0.032 *	0.000 ?	0.000	0
1BNFS081.42	0.16	0.00 *	-0.01 ?	0.40	0.00	0.041 *	0.000	0.000	0
1BNFS093.53	0.14	0.00	0.03 *	0.96	0.00	0.003	0.000	0.000	0
1BNTH014.08	0.22	0.00	0.00	1.81	-0.13 *	0.074 *	0.000	0.000 ?	0
1BSHN022.63	-0.18 ?	-0.03 *	-0.01 *	-4.63 *	0.00 ?	0.015 *	-0.006 *	0.000 ?	0
1BSSF003.56	-0.30 *	0.00 *	-0.01 ?	-0.50	0.00 ?	0.008 ?	0.000 *	0.000 *	0
1BSSF054.20	0.06	0.00 *	-0.01 *	-2.37 ?	0.00 ?	0.014 *	-0.011 *	0.000 *	0
1BSTH007.80	0.19 ?	0.00 *	0.00	-3.42 ?	0.00	-0.043 *	-0.028 *	0.000 *	0
1BSTH027.85	0.02	0.00	-0.02 *	3.67 ?	0.00 ?	0.003	0.000	0.000 ?	0 ?
1BSTY001.22	0.11	0.00 ?	-0.01	0.84	0.00 *	0.100 *	0.000	0.007 *	0 *

? indicates .01 <
P < 0.1;
* indicates P < .01

Table A-3. Estimates of Slope (continued.).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
2 James River									
02035000	0.04	0.02	0.02 *		0.00	-0.003	0.000	0.003 *	4
02041650	-0.42 *	-0.25	0.02 ?		0.00	-0.000	0.000	0.000 ?	
2-ALM000.42	0.18 ?	0.00 *	-0.03 *	-1.56 *	-0.19 *	-0.004	0.000	0.000 ?	0
2-APP001.53	0.33 *	0.00 ?	0.00	-1.11	0.32 *	0.001	0.020 *	0.000 ?	0
2-APP012.79	0.14 *	0.00	-0.01 ?	-0.50 ?	0.00 *	0.001	0.000 ?	0.000 *	0
2-APP016.38	0.53 ?	0.00	0.01		-0.25		0.000	-0.001	
2-APP050.23	0.14 ?	0.00	-0.01 ?	-0.43	0.00	0.004 *	0.000 ?	0.000 *	0
2-APP110.93	-0.04	0.00 ?	0.02 *	-0.20	-0.06 ?	0.000	0.000 ?	0.000 ?	0 ?
2-APP118.04	0.14 ?	0.00	0.00	0.20	0.00	0.000	0.000 *	0.000	0
2-BEN001.42	0.00	0.00	0.00	-135.76	-0.50 ?	-0.003 *	0.015 *	0.000	0
2-BLY000.65	1.82 *	-0.50 *	-0.05 *	-35.61 *	-0.82 *	0.014 *	-0.217 *	-0.003 *	-10 *
2-BUF002.10	0.19 *	0.00 ?	0.02 *	-1.86 ?	-0.22 *	-0.000	0.000	0.000	0
2-CHK002.17	0.29 *	0.00	0.00	-1.23	0.21 ?	-0.013 *	0.014 *	0.000 ?	0
2-CHK032.77	0.13 ?	0.00 ?	0.00	0.06	0.00 *	0.000	0.000	0.000 *	0
2-CHK062.57	-0.62 *	0.00	0.00	-0.83 ?	0.00 *	-0.000 ?	0.000	0.000	0
2-CHK076.59	0.02	0.00 *	0.00	2.85 *	-0.06 *	0.072 *	0.000	0.000 *	0 ?
2-CRE002.37	0.31 *	0.00 ?	-0.02 *	-0.08	0.00 ?	-0.000	0.000	0.000 *	0
2-CWP002.58	-0.14	0.00 ?	0.00	0.43	0.00 ?	0.000	0.000 *	0.000	0
2-EBE000.40	-0.04	0.00 ?	-0.03 *	30.16	-0.54 *	-0.001	0.000	0.000	0
2-FAC000.85	0.30 *	0.00	0.00	-1.00 ?	0.00 ?	0.004 *	0.000 *	0.000 ?	0
2-FAC012.96	0.10	0.00 ?	0.02 *	-0.60 ?	-0.05 *	0.000	0.000	0.000	0 ?
2-JKS000.38	0.47 *	0.00 *	0.02 *	12.82 *	0.00 ?	-0.009 *	0.000	-0.007 ?	-20 *
2-JMS021.04	-0.56 *	0.00	-0.03 *	-300.96	0.44 *	-0.025 ?	0.014 *	0.004 *	0
2-JMS055.94	0.48 *	-0.04 ?	0.00	-5.38	1.32 *	-0.017	0.009 ?	0.004 *	0
2-JMS074.44	0.95 *	-0.14 *	0.00	-0.12	-0.36 ?	-0.015 *	-0.038 *	0.000 *	0 ?
2-JMS099.30	0.62 *	0.00 ?	0.01	-0.82	-0.02	-0.012 ?	0.000	-0.013 *	0
2-JMS110.30	0.39 *	0.00	0.00	-0.79	0.00	-0.004 *	0.000 ?	0.000	0
2-JMS117.35	0.24 *	0.00	0.00	0.00	0.00	-0.006 *	0.000	0.000 ?	0 ?
2-JMS157.28	0.13 ?	0.00	0.00	-0.59	0.00 ?	0.000	0.007 *	0.000	0
2-JMS189.31	-0.05	0.00 ?	0.00	-1.39 ?	0.00	-0.001	0.000	0.000	0
2-JMS229.14	0.43 *	0.00 ?	0.01 *	0.70	0.00	-0.001	0.000 ?	0.000	0 ?
2-JMS258.54	0.32 *	0.00 ?	0.01 ?	-0.33	0.00	0.004 *	0.000 *	0.000	0 *
2-JMS275.75	0.54 *	0.00 *	0.01 *	0.00	0.00	0.000	0.000	0.000	0
2-JMS282.28	0.02	0.00	0.01	-0.31	0.00	-0.001	0.000 *	0.000	0

? indicates .01 < P
< 0.1; * indicates P

< .01

Table A-3. Estimates of Slope (continued.).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
2 James River (continued)									
2-LAF000.00	0.41 *	0.00	-0.03 *	47.13	-0.56 *	-0.004 *	0.000	0.000 ?	0
2-MCM005.12	0.02	0.00 *	0.01 *	-0.58	0.00	-0.008 *	0.000	0.000 *	0
2-MRY000.46	-0.06	0.00 *	0.00	-0.23	0.00 ?	0.000	0.000	0.000 ?	0
2-MRY038.10	0.24 *	0.00 *	0.01 ?	-1.49 *	0.00 ?	0.001 ?	0.000	0.000	0
2-NAN002.77	0.09	0.00	-0.03 *	-223.00 ?	-1.00 *	-0.003 *	0.015 *	0.000	0 *
2-NAN019.14	0.54 *	-0.04 *	0.00	-5.00	-0.30 *	-0.005 *	0.000	0.000	0 ?
2-PCT002.46	0.67 *	0.00 ?	0.02 *	-0.05	0.00	-0.003 ?	-0.013 *	0.000	0 ?
2-PGN010.07	-1.00 *	0.00 *	-0.04 *	2.94 ?	0.28 *	0.009 *	0.000 *	0.000 ?	0 *
2-POT000.12	-0.11	0.00 *	0.02 *		0.00	0.000	0.000 ?	0.000	0
2-RVN001.64	0.09	0.00 *	0.02 *	-0.64	0.00	0.000	0.000	0.000	0
2-RVN015.97	0.09	0.00 *	0.03 *	0.91	0.00	0.000	0.000 *	0.000	0
2-RVN033.65	0.15 ?	-0.06 *	0.02 *	-0.36	0.00 ?	0.010 *	-0.010 *	0.000	0
2-SBE001.53	0.06	0.00	-0.02 *	-108.33	-0.50 *	-0.000	0.000	0.000	0
2-SFT004.92	0.18 ?	0.00	0.00	-0.86 *	0.00	0.000 *	0.000 ?	0.000 ?	0
2-SGL001.00	0.74 *	-0.09 *	0.00	0.50	0.00	-0.026 *	-0.005	0.000	0 ?
2-TYE000.30	0.36 *	0.00	0.04 *	-3.27 ?	0.00 ?	0.000	0.000 ?	0.000	0
3 Rappahanock River									
01668000	-0.29 *	0.00	0.01 *	0.00	-0.17	-0.019	0.000	0.001 ?	146
3-CLB000.50	-0.03	0.00	0.02 *	-2.10 *	-0.20 *	0.002	0.085 *	-0.133 *	0
3-GRT001.70	-0.15	0.00	0.00	0.02	0.00 ?	0.026 *	0.013 *	0.000	0 ?
3-HOK000.74	0.09	0.00	0.00	-143.51 ?	0.17	0.000 ?	0.014 *	0.000	5 *
3-LDR000.70	0.11	0.00 ?	0.02 *	-0.57	0.00 *	0.011 ?	0.000	0.000	0 ?
3-RAP006.53	-0.06	0.00 ?	0.00	0.00	0.00	0.000	0.000 ?	0.000	0
3-ROB001.90	0.01	0.00	0.00	1.00	0.00	0.000	0.000 ?	0.000	0
3-RPP017.72	-1.47 *	0.00 *	-0.04 *	-210.79	0.00	0.000	0.022 *	0.001 *	0
3-RPP025.52	-1.16 *	0.00	-0.03 *	-124.81	-0.10	0.000	0.028 *	0.003 *	0
3-RPP080.19	-0.29 ?	0.00 ?	-0.02 ?	3.00	1.11 *	-0.004	0.025 *	0.000 *	0
3-RPP110.57	0.00	-0.10	-0.04 ?		-0.17 ?		-0.017 ?	0.000	
3-RPP147.10	0.03	0.00 ?	0.01 ?	-0.52	0.00	-0.002	0.000	0.000	0
3-THO006.50	-0.01	0.00 *	0.00	-0.20	0.00	-0.003 ?	0.000 ?	0.000	0
3-TOT005.11	-0.09	0.00	0.01 ?	-62.75	0.00	0.000	0.017 *	0.000	0

? indicates .01 < P < 0.1; * indicates P < .01

Table A-3. Estimates of Slope (continued.).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
4A Roanoke River									
02075500	-0.07		0.00			0.000	0.000	-0.006 *	
4ABAN005.58	-0.20 *	0.00	-0.01 *	0.00	0.25 ?	0.003 *	0.005 *	0.000 ?	0
4ABWR019.75	0.20 ?	0.00	0.04 *	-1.00	0.00	0.007 *	0.000 ?	0.000	0
4ABWR032.32	-0.26	0.00 ?	0.03 ?	0.00	0.00	0.013 *	0.013 *	0.000	10 ?
4ADAN015.30	0.17 *	0.00	-0.00 ?	2.00 *	0.14	0.000	0.006 *	0.000 *	0 *
4ADAN055.69	0.82 *	-0.15 *	-0.05 *	-1.00	-1.50 *	0.000	-0.020 *	0.000 ?	0
4ADAN059.80	-0.30 ?	0.00 *	0.00	-0.52	-0.80 *	0.004 ?	0.000	0.000 *	0 *
4ADAN075.22	0.21 *	0.00	0.03 *	0.20	-0.15 ?	0.001	0.000 *	0.000	-6 *
4AHYC002.70	-0.13	0.00	-0.02 *	0.00	0.00	0.001	0.005 *	0.000 *	0
4APGG008.42	-0.21	0.00 *	0.00	0.00	0.00 ?	-0.001	0.000	0.000	0
4ARNF013.66	-0.19	0.00 ?	-0.03 *	-6.28	0.00	-0.005	0.000	0.000 ?	0 *
4AROA018.04	-0.50 *	0.00	-0.02 *	0.33	0.00	0.001 ?	0.000 *	0.000 *	0
4AROA059.12	0.05	0.00	-0.01 *	0.75	0.14	0.002 *	0.000 *	0.000	0
4AROA192.55	0.17	0.00	0.00	0.33	0.00	-0.000	0.000	0.000	0 *
4AROA202.20	0.01	0.00	-0.01 *	0.00	0.00	0.006 *	0.000	0.000	0 *
4AROA227.42	-0.04	0.00	-0.02 *	0.80	0.00	0.002	0.000 ?	0.000	0
4ASRE007.90	0.30 *	0.00	0.03 *	1.00 ?	0.00	-0.001	0.000	-0.001 *	0
4ASRE033.19	0.21 *	0.00 *	0.00	-1.50 *	0.00 *	0.001	0.000 *	0.000	-10 *
4ASRE043.54	-0.11	0.00 ?	0.02 *	-0.60 *	0.00	0.001	0.000	0.000 ?	0
4ATKR000.69	0.39 *	0.00 *	-0.02 *	0.06	0.00 *	0.004 ?	0.000 ?	0.000	-6 ?
5A Chowan River									
5ABLW000.27	-1.80 ?	0.00	-0.05 ?			-0.003	0.017	0.000	
5ABLW009.14	-0.10	0.00 *	0.00	0.23	0.00 *	-0.002	0.000	0.000 *	0 ?
5ABLW022.84	-0.11	0.00 *	-0.01 *	-0.20	-0.12 *	-0.000	0.000 *	0.000	0
5ABLW074.66	-0.28 ?	0.00 ?	-0.01 *	-0.33	0.00 *	-0.004 *	0.000 ?	0.000 *	0
5AMHN052.34	-0.62 *	0.00	-0.02 *	-0.50 ?	0.13 ?	0.001 ?	0.007 *	0.000 *	0
5ANTW000.14	-2.18 *	-0.25 *	-0.08 ?			0.001	0.025 ?	-0.001	
5ANTW003.30	-0.14	0.00 ?	0.00	0.44 ?	0.00 *	0.000	0.000 ?	0.000	0
5ANTW075.48	0.41 *	0.00 *	0.02 *	-0.85	0.00 ?	0.000	0.000	0.000	0 *
5ANTW078.20	0.06	0.00 ?	-0.01 *	-0.40	0.00 ?	0.000	0.000 *	0.000 *	0 *
5ANTW105.67	0.22 ?	0.00	0.01 *	-0.65	0.00	0.000	0.000 ?	0.000	0
5ANTW109.02	0.00	0.00	-0.01 *	0.00	0.00	0.000	0.005 *	0.000 *	0

? indicates .01 < P < 0.1; * indicates P < .01

Table A-3. Estimates of Slope (continued.).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
5B Dismal Swamp River									
5BHPC001.46	0.02	-0.06 *	0.01 ?	-15.35	-0.17	-0.003 *	0.010 ?	0.000 *	0 ?
5BNLR005.56	-0.00	0.00 ?	-0.02 *	79.50 *	0.22	0.000	0.033 *	0.000	0
5BNLR013.61	0.07	0.00	0.00	83.80 *	-0.43 *	-0.003 *	0.017 *	0.000	0
5BNTW011.90	-0.38 ?	0.00 *	0.00	4.33 *	-0.22 *	0.000	0.000	0.000 ?	0
5BWNC001.73	0.75 *	0.00	0.02 *	51.57 *	0.17 ?	0.000 ?	0.012 *	0.000	0
6A Big Sandy									
6AHLY001.67	0.00	-0.55 *	0.03 *	-1.27	-1.00 *	-0.029 *	-0.106 *	-0.073 *	0
6AKOX008.11	0.08	0.00 *	0.03 *	2.67 *	-0.45 *	-0.005 *	0.000	0.000	-143 *
6ALEV130.00	0.39 *	-0.02 *	0.04 *	1.51	-1.38 *	-0.005 ?	0.000	0.000	-100 *
6AMCR007.46	0.01	-0.03 *	0.01 ?	5.22 *	-0.09 *	-0.001	0.000	0.000 ?	-70 *
6ARSS025.40	-0.04	-0.03 *	0.00	3.00 *	0.00 ?	0.000	0.000	0.000 ?	-70 *
6B Clinch-Powell									
6BBER001.14	0.23 ?	-0.18 *	0.04 *	19.57 *	-0.50 *	0.036 *	0.020	-0.014 *	-336 *
6BCLN211.00	-0.21 ?	-0.01 *	-0.03 *	0.51	-0.10 *	-0.001	0.000 *	0.000 ?	-6 *
6BCLN315.11	-0.14	-0.05 *	-0.02 *	0.00	-0.36 *	-0.001	0.000	0.000 *	-62 *
6BGUE006.50	-0.06	-0.03 *	0.01 ?	5.04 *	-0.29 *	0.005	0.000	0.000 ?	-49 *
6BNFC003.80	-0.52 *	0.00 *	-0.02 *	0.97 ?	0.00	0.000	0.000	0.000	0 *
6BPOW143.53	-0.21 *	0.00 *	-0.01 ?	1.50 *	-0.06 *	0.001	0.000 ?	0.000 *	-18 *
6BPOW180.78	0.18 ?	-0.05 *	0.01 ?	4.15 *	-0.25 *	0.010 *	0.000 ?	0.000 ?	-140 *
6BPWL001.49	0.08	-0.04 *	0.01 *	0.71	-0.31 *	0.002	0.000	0.000 ?	-50 *
6BSRA001.11	0.03	-0.04 *	0.01 *	7.11 *	-0.43 *	0.005 ?	0.000	0.000	-75 *
6BSTO004.56	0.20 ?	-0.01 *	0.01	-0.89 ?	0.00 ?	0.000	0.000 ?	0.000 ?	0 *

? indicates .01 < P < 0.1; * indicates P < .01

Table A-3. Estimates of Slope (continued.).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
6C Holston									
6CBEV015.27	0.13 ?	-0.06 *	-0.02 *	0.60 ?	0.00	0.016 *	0.000 ?	0.000	0 *
6CBEV021.07	-0.07	0.00	-0.03 *	1.00 *	0.29 ?	0.011 *	0.005 *	0.000	-43 *
6CBVD000.07	0.26 *	-0.05 *	0.02 *	-1.96 *	0.00 *	0.000	0.000 *	0.000	-45 *
6CLTL000.26	0.38 ?	-0.20 *	-0.02 *	0.14	0.00 ?	0.018 *	0.000	0.000	0 *
6CMFH005.00	-0.41 *	-0.04 *	-0.03 *	0.94 ?	0.00	0.019 *	0.006 *	0.000 ?	0
6CMFH026.00	-0.37 *	-0.12 *	-0.02 *	0.43	-0.05 *	0.006 ?	0.000 *	0.000 *	-25 *
6CNFH008.78	-0.30 *	0.00 *	-0.03 *	-6.18 ?	0.04 ?	-0.003 ?	0.000 *	0.000 ?	-13 *
6CNFH039.18	-0.63 *	-0.02 *	-0.03 *	-3.71 ?	0.00	-0.004 ?	0.000 *	0.000	0
6CNFH059.65	-0.21 ?	0.00 *	-0.03 *	-14.29 *	0.00 *	-0.002	0.000 *	0.000	0 *
6CNFH080.43	0.36 *	-0.01 *	-0.02 *	-16.17 *	0.00 ?	0.000	0.000 *	0.000	-19 *
6CNFH083.32	0.01	-0.06 *	-0.03 *	-1.14	0.00 ?	0.000	0.000 ?	0.000	-21 *
6CNFH085.20	0.01	-0.03 *	0.00	-0.50	0.00 ?	0.001	0.000 *	0.000	0 *
6CNFH097.67	-0.03	-0.05 *	-0.01 ?	0.70	0.00	0.005 ?	0.000 *	0.000	-14 *
6CSFH073.62	-0.19	-0.02 *	-0.01	0.17	0.00	0.007 *	0.000 ?	0.000	-6 ?
6CWLF001.46	0.02	-0.01 *	-0.02 *	0.91 ?	0.00	0.029 *	0.007 *	0.000	-42 *
6CWLF006.55	0.35 *	-0.08 *	-0.02 *	0.38	-0.20 ?	0.015 *	-0.007 *	0.000	-71 *
7 Smll Cstl Bsns, Chspk Bay									
7-BRK004.14	-0.43 *	0.00	0.00	-92.00 ?	-0.33 ?	0.000	0.007 ?	0.000 ?	23 *
7-COC001.61	0.06	-0.09 *	-0.04 *	-75.03	-0.25 *	0.000	0.009 ?	0.000 ?	0
7-HLD002.67	0.79 *	0.00	0.02 *	14.07	0.50 *	0.288 *	-0.033 ?	0.183 *	23 *
7-IND002.26	0.16	0.00	-0.04 *	-20.09	-0.43 *	0.000	0.015 *	0.000 ?	0
7-NEW001.92	-0.12	0.00 *	0.00	-171.56	-0.36	-0.001 ?	0.020 *	0.000	7 ?
7-PAR003.09	2.05 *	-0.40 *	0.02 *	22.14 *	0.00 ?	1.017 *	-0.681 *	0.025	0
7-PRT001.30	0.05	-0.04 *	-0.03 *	-100.91	-1.43 *	0.000 *	0.000	0.000 *	0
7-THA000.76	-0.05	-0.12 *	-0.01 ?	124.48 ?	-0.80 *	-0.002 ?	0.028 *	0.000	0

? indicates .01 < P < 0.1; * indicates P < .01

Table A-3. Estimates of Slope (continued.).

Basin/	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
Station	% Sat	mg/l		mg/l	mg/l	mg/l	mg/l	mg/l	/100 ml
8 York River									
01673000	-0.19 ?	0.25	0.01 *		0.00	0.003	0.000	0.001 *	115
01674500	-0.34 *	0.50	0.00		-0.38	-0.003 ?	0.000	0.001 *	
8-MPN054.17	-0.29 *	0.00	-0.02 *		0.00	-0.085	0.000	0.002 *	0
8-MPN094.79	-0.23 *	0.00	0.00	-0.50	0.00	0.000	0.000 *	0.000 ?	0 ?
8-NAR005.42	-0.06	0.00	-0.02 *	0.00	0.00 ?	0.000	0.000	0.000 ?	0
8-PMK056.87	-0.07	0.00 ?	-0.01 ?	-0.32	0.00	0.009 *	0.000 ?	0.000 ?	0
8-PMK082.34	-0.12	0.00	-0.01 ?	2.50	0.00	0.001	0.000 ?	0.000 *	0
8-YRK011.14	-0.83 *	0.00	-0.04 *	33.70	0.19	0.000	0.023 *	0.004 *	0
9 New River									
9-BST029.71	-0.20 ?	-0.02 *	-0.02 *	-0.08	0.00	0.007 *	0.000 *	0.000	-33 *
9-CST010.45	-0.02	-0.04	0.02 *	-0.40	0.00 ?	0.008 *	0.010 *	0.000	-13 *
9-LVR001.34	-0.23 *	-0.01 *	0.00	-0.33	0.00	0.011 *	0.000 ?	0.000	0
9-NEW030.15	0.23 *	0.00	0.03 *	-0.93 ?	0.00 *	-0.008 *	0.000 *	0.000	0
9-NEW081.72	0.02	0.00	0.03 *	0.88 *	0.00 ?	0.021 *	0.000	0.000	0
9-NEW098.32	-0.09	0.00	0.03 *	0.24	0.00	0.006 *	0.000 *	0.000 ?	0
9-NEW148.23	-0.17 *	0.00 *	0.00	0.00	0.00	0.001	0.000 ?	0.000	0 *
9-NEW187.46	-0.27 *	-0.02 *	-0.01 ?	-0.56 ?	0.00	-0.005 *	0.000 ?	0.000	-2 *
9-PBC002.69	-0.01	0.00 ?	0.00	0.00	0.00	0.001	0.014 *	-0.006 *	-29 *
9-PKC004.65	0.18 ?	-0.11 *	0.02 *	-3.75 ?	-0.22 *	0.000	-0.016 *	0.000 *	0
9-RDC009.00	0.15	-0.03 *	-0.02 *	-0.24	0.00	0.006 ?	0.000	0.000	0 ?
9-STE002.41	0.24 ?	0.00 *	0.00	-1.56	0.00	-0.054 *	-0.006 *	0.000	0
99 USGS - Out of State									
01578310	-0.02		-0.02 *	21.00		0.010	-0.016 *	-0.000	
02080500	-0.30		0.00			0.000	0.000	0.000	
02087570	0.40		0.10 *			0.219 *	-0.050 *	-0.007	
02089500	0.00	0.01	0.02 *			0.016 ?	-0.011 *	-0.005 *	-313 ?

? indicates .01 < P < 0.1; * indicates P < .01

Table A-4. Median Values.

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
1A Potomac									
01646580	102.35		8.00	210	22.50	1.00	0.51	0.07	90
1ABRB002.15	86.60	2.00	7.40	182	11.00	0.71	0.50	0.10	100
1ADIF000.86	94.75	1.00	7.20	97	5.00	0.81	0.30	0.10	150
1AFOU000.19	80.00	5.00	7.30	323	12.50	1.97	6.30	0.10	130
1AGOO002.38	94.40	2.00	7.40	121	8.00	1.30	0.50	0.10	100
1AGOO022.44	95.10	1.00	7.40	96	5.00	0.95	0.30	0.10	100
1AHUT000.01	81.50	8.00	6.90	297	15.00	0.40	10.00	0.10	100
1ALIF000.19	86.80	4.00	7.40	209	25.50	1.32	1.30	0.10	100
1ANEA000.57	103.10	4.00	8.20	208	31.00	0.90	1.00	0.10	100
1APIM000.15	96.60	1.00	7.50	158	5.00	1.46	0.30	0.10	200
1AQUA004.46	94.70	1.00	6.90	64	5.00	0.06	0.20	0.10	100
1ATUS000.37	91.85	3.00	7.60	254	8.00	2.72	1.10	0.10	100
1AUMC004.43	90.90	3.00	7.20	3333	25.00	0.06	0.70	0.10	100
1AWLL001.30	84.10	4.00	7.20	3765	27.00	0.06	1.00	0.20	115
Mean	91.63	3.00	7.40	665	14.68	0.98	1.72	0.11	113
1B Shenandoah									
1BCDR013.29	98.10	1.00	8.00	132	5.00	0.46	0.10	0.10	100
1BHKS000.96	93.50	1.00	7.80	177	5.00	1.27	0.30	0.10	200
1BLEW002.91	92.00	1.00	8.35	381	9.00	1.96	0.40	0.10	500
1BNFS000.57	96.85	1.00	8.40	213	5.00	1.11	0.30	0.10	100
1BNFS010.34	98.10	1.00	8.40	205	5.00	1.32	0.30	0.10	100
1BNFS081.42	105.10	1.00	8.20	176	5.00	2.41	0.30	0.10	100
1BNFS093.53	99.10	1.00	7.80	66	5.00	0.81	0.20	0.10	100
1BNTH014.08	90.25	1.00	8.00	170	8.00	2.55	0.40	0.20	363
1BSHN022.63	99.00	1.80	8.40	205	5.00	1.01	0.40	0.10	100
1BSSF003.56	100.00	1.00	8.50	175	5.00	1.13	0.40	0.10	100
1BSSF054.20	95.10	1.00	8.30	183	6.00	1.60	0.40	0.20	100
1BSTH007.80	96.70	1.00	8.10	144	5.00	1.77	0.50	0.10	200
1BSTH027.85	98.10	1.00	8.10	113	6.00	0.70	0.20	0.10	100
1BSTY001.22	103.80	1.00	8.20	181	5.00	1.52	0.23	0.20	100
Mean	97.55	1.06	8.18	180	5.64	1.40	0.32	0.12	162

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
<u>*2 James River*</u>									
02035000	93.85	1.20	7.25		30.00	0.30	0.38	0.11	85
02041650	98.05	1.00	7.10		6.00	0.13	0.40	0.04	
2-ALM000.42	91.80	2.00	7.00	165	5.50	1.11	0.50	0.10	500
2-APP001.53	91.90	2.00	7.25	112	24.50	0.29	0.60	0.10	100
2-APP012.79	98.40	1.00	7.20	83	6.00	0.16	0.40	0.10	100
2-APP016.38	97.80	1.25	7.15		6.50		0.40	0.05	
2-APP050.23	89.80	1.00	7.10	91	14.00	0.23	0.30	0.10	200
2-APP110.93	90.45	1.00	7.30	84	8.00	0.17	0.20	0.10	200
2-APP118.04	91.80	1.00	7.20	74	6.00	0.17	0.20	0.10	100
2-BEN001.42	80.80	2.00	7.80	14015	27.00	0.11	0.70	0.10	93
2-BLY000.65	62.70	7.90	7.10	349	33.00	0.72	6.70	0.24	550
2-BUF002.10	100.00	1.00	7.30	56	8.00	0.19	0.20	0.10	100
2-CHK002.17	92.45	2.00	7.30	171	22.00	0.36	0.60	0.10	100
2-CHK032.77	79.30	1.50	6.60	90	5.00	0.06	0.50	0.10	100
2-CHK062.57	60.45	2.00	6.50	114	5.00	0.10	0.50	0.10	100
2-CHK076.59	75.00	2.00	6.60	141	7.00	0.95	0.75	0.10	100
2-CRE002.37	102.45	1.00	8.60	225	5.00	0.36	0.10	0.10	100
2-CWP002.58	96.40	1.00	7.80	71	5.00	0.09	0.10	0.10	100
2-EBE000.40	71.50	1.00	7.60	20720	11.00	0.22	0.80	0.10	100
2-FAC000.85	93.48	1.50	7.00	81	5.00	0.23	0.40	0.10	100
2-FAC012.96	88.10	2.00	6.80	84	7.00	0.09	0.40	0.10	100
2-JKS000.38	94.20	2.00	7.95	302	5.00	0.26	0.40	0.40	300
2-JMS021.04	82.72	1.00	7.80	9508	19.50	0.22	0.50	0.08	100
2-JMS055.94	80.93	1.50	7.20	151	37.13	0.88	0.70	0.12	100
2-JMS074.44	94.60	3.00	7.40	132	28.00	0.47	1.00	0.10	100
2-JMS099.30	91.25	1.40	7.40	136	13.00	0.40	0.60	0.15	167
2-JMS110.30	100.70	1.30	7.90	122	7.00	0.28	0.30	0.10	100
2-JMS117.35	98.60	1.00	7.50	116	7.00	0.28	0.30	0.10	100
2-JMS157.28	94.80	1.50	7.60	127	9.00	0.28	0.30	0.11	100
2-JMS189.31	96.30	1.00	7.70	124	6.00	0.30	0.30	0.10	100
2-JMS229.14	96.50	2.00	7.80	150	6.00	0.31	0.30	0.20	100
2-JMS258.54	94.20	2.00	7.70	156	7.00	0.25	0.30	0.10	200
2-JMS275.75	93.25	2.00	8.00	173	7.00	0.19	0.30	0.20	100
2-JMS282.28	95.55	1.00	8.10	170	6.00	0.21	0.28	0.15	100

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
2 James River (continued)									
2-LAF000.00	83.00	1.00	7.80	19266	15.00	0.16	0.60	0.10	32
2-MCM005.12	100.00	1.00	7.30	58	6.00	0.45	0.20	0.10	100
2-MRY000.46	97.35	1.00	8.30	155	5.00	0.35	0.20	0.10	100
2-MRY038.10	98.85	1.00	8.00	78	5.00	0.13	0.10	0.10	100
2-NAN002.77	87.50	2.00	8.00	17973	33.50	0.13	0.60	0.10	30
2-NAN019.14	82.10	3.00	7.20	2045	18.00	0.10	1.20	0.20	1200
2-PCT002.46	92.60	2.00	6.50	75	8.00	0.21	0.50	0.10	100
2-PGN010.07	90.70	1.80	7.80	220	8.00	0.32	0.40	0.10	100
2-POT000.12	92.90	1.00	7.60		5.00	0.11	0.10	0.10	100
2-RVN001.64	94.40	1.00	7.20	72	6.00	0.55	0.30	0.10	100
2-RVN015.97	95.75	1.00	7.30	68	5.00	0.57	0.30	0.10	100
2-RVN033.65	98.80	2.00	7.20	71	6.00	0.56	0.43	0.10	100
2-SBE001.53	70.20	1.00	7.50	20460	9.00	0.27	0.80	0.10	130
2-SFT004.92	94.80	2.00	7.00	71	7.00	0.08	0.40	0.10	100
2-SGL001.00	72.10	3.50	7.00	588	22.00	0.42	1.50	0.20	1280
2-TYE000.30	100.85	1.00	7.30	47	5.00	0.13	0.20	0.10	100
Mean	90.24	1.65	7.41	2377	11.35	0.30	0.57	0.12	174
3 Rappahanock River									
01668000	94.16	2.00	6.95		12.00	0.57	0.35	0.04	
3-CLB000.50	92.20	4.00	7.00	139	8.00	0.87	2.30	1.30	100
3-GRT001.70	91.60	2.00	7.20	112	5.00	1.32	0.40	0.10	100
3-HOK000.74	81.50	2.00	6.95	3048	28.00	0.10	0.60	0.10	110
3-LDR000.70	95.20	1.00	7.10	82	7.00	1.91	0.20	0.10	300
3-RAP006.53	95.80	1.00	7.30	61	5.00	0.60	0.30	0.10	100
3-ROB001.90	95.40	1.00	7.20	57	6.00	0.61	0.20	0.10	350
3-RPP017.72	82.15	1.00	7.98	11665	10.00	0.06	0.51	0.04	3
3-RPP025.52	79.53	1.30	7.73	10435	20.00	0.08	0.58	0.05	100
3-RPP080.19	92.91	2.00	7.00	85	26.00	0.44	0.55	0.10	100
3-RPP110.57	96.50	2.00	7.28		6.00		0.40	0.05	
3-RPP147.10	94.30	1.00	7.20	61	5.00	0.47	0.20	0.10	100
3-THO006.50	98.10	1.00	7.20	58	5.00	0.39	0.20	0.10	100
3-TOT005.11	81.00	2.00	7.00	1179	18.00	0.09	0.50	0.10	100
Mean	90.74	1.66	7.22	2248	11.50	0.58	0.52	0.17	130

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
4A Roanoke River									
02075500	88.45		7.10			0.37	0.50	0.13	
4ABAN005.58	90.20	1.00	7.00	89	18.50	0.18	0.30	0.10	100
4ABWR019.75	90.60	1.00	7.20	68	11.00	0.52	0.30	0.10	200
4ABWR032.32	93.30	1.00	7.20	72	8.00	0.61	0.30	0.10	300
4ADAN015.30	88.50	1.00	7.00	126	24.00	0.37	0.40	0.12	100
4ADAN055.69	95.05	2.00	7.30	146	26.00	0.30	0.30	0.10	275
4ADAN059.80	88.90	1.00	7.00	111	18.00	0.30	0.30	0.10	100
4ADAN075.22	91.45	1.00	7.20	115	18.00	0.30	0.30	0.10	300
4AHYC002.70	86.55	2.00	7.00	105	11.00	0.18	0.40	0.10	100
4APGG008.42	91.50	1.00	7.20	92	10.00	0.24	0.20	0.10	100
4ARNF013.66	93.30	1.00	8.50	247	6.00	0.80	0.20	0.10	300
4AROA018.04	82.00	1.00	7.00	82	5.00	0.21	0.30	0.10	100
4AROA059.12	90.40	1.00	7.30	105	19.00	0.26	0.30	0.10	100
4AROA192.55	98.40	2.00	8.30	207	10.00	0.87	0.50	0.10	100
4AROA202.20	95.70	1.00	8.40	212	5.00	0.46	0.20	0.10	200
4AROA227.42	95.30	1.00	8.30	193	5.00	0.44	0.20	0.10	200
4ASRE007.90	91.90	1.00	7.20	120	7.00	0.30	0.40	0.20	100
4ASRE033.19	92.90	1.00	7.20	63	5.00	0.14	0.20	0.10	300
4ASRE043.54	89.60	1.00	7.10	49	3.00	0.13	0.20	0.10	100
4ATKR000.69	95.45	2.00	8.30	280	6.00	1.10	0.20	0.10	1000
Mean	91.47	1.21	7.44	131	11.34	0.40	0.30	0.11	214
5A Chowan River									
5ABLW000.27	62.92	1.00	6.60			0.20	0.65	0.08	
5ABLW009.14	62.30	1.00	6.60	105	5.00	0.30	0.70	0.10	100
5ABLW022.84	71.90	1.50	6.60	102	5.00	0.18	0.60	0.10	100
5ABLW074.66	62.25	2.00	6.70	102	6.00	0.19	1.00	0.10	100
5AMHN052.34	90.00	1.00	7.00	86	14.00	0.11	0.40	0.10	100
5ANTW000.14	71.27	1.50	6.66			0.14	0.50	0.07	
5ANTW003.30	72.90	1.00	6.70	90	5.00	0.14	0.50	0.10	100
5ANTW075.48	90.55	1.00	7.20	80	5.00	0.13	0.30	0.10	100
5ANTW078.20	90.00	1.00	7.00	79	5.00	0.13	0.30	0.10	100
5ANTW105.67	91.70	1.00	7.20	84	5.00	0.13	0.30	0.10	100
5ANTW109.02	92.00	1.00	7.00	81	5.00	0.14	0.30	0.10	100
Mean	77.98	1.18	6.84	90	6.11	0.16	0.50	0.10	100

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	**DO** % Sat	**BOD** mg/l	**pH**	**TR** mg/l	**NFR** mg/l	**NN** mg/l	**TKN** mg/l	**TP** mg/l	**FC** /100 ml
5B Dismal Swamp River									
5BHPC001.46	89.10	4.00	7.30	1003	37.00	0.08	1.50	0.15	100
5BNLR005.56	84.00	2.00	6.90	690	24.00	0.08	1.10	0.10	100
5BNLR013.61	64.00	2.00	6.80	793	17.00	0.14	1.05	0.15	100
5BNTW011.90	55.00	2.00	6.40	196	6.00	0.08	1.20	0.10	100
5BWNC001.73	77.30	3.00	7.00	667	13.00	0.06	1.10	0.20	100
Mean	73.88	2.60	6.88	670	19.40	0.09	1.19	0.14	100
6A Big Sandy									
6AHLY001.67	84.00	7.90	7.50	386	16.00	0.83	3.40	0.90	400
6AKOX008.11	99.10	1.00	7.80	280	9.50	0.37	0.20	0.10	1400
6ALEV130.00	99.90	1.60	7.90	434	17.00	0.36	0.20	0.10	1150
6AMCR007.46	98.20	1.00	8.00	268	5.00	0.27	0.20	0.10	1850
6ARSS025.40	99.60	1.00	8.00	249	5.00	0.25	0.20	0.10	600
Mean	96.16	2.50	7.84	323	10.50	0.41	0.84	0.26	1080
6B Clinch-Powell									
6BBER001.14	87.65	3.40	7.60	441	10.00	0.89	1.40	0.30	5300
6BCLN211.00	94.10	1.00	8.30	195	6.00	0.59	0.20	0.10	100
6BCLN315.11	86.50	2.00	8.00	194	11.00	0.62	0.30	0.10	800
6BGUE006.50	91.80	1.70	7.70	242	10.00	0.61	0.30	0.10	800
6BNFC003.80	92.40	1.00	7.80	149	6.00	0.44	0.20	0.10	300
6BPOW143.53	93.60	1.00	7.90	220	7.00	0.60	0.20	0.10	230
6BPOW180.78	97.80	1.40	8.10	300	7.00	0.54	0.20	0.10	1950
6BPWL001.49	92.15	1.90	7.60	190	7.00	0.32	0.20	0.10	2800
6BSRA001.11	97.60	1.00	7.90	332	9.00	0.47	0.20	0.10	3800
6BSTO004.56	99.70	1.00	8.00	93	5.00	0.20	0.10	0.10	200
Mean	93.33	1.54	7.89	236	7.80	0.53	0.33	0.12	1628

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
6C Holston									
6CBEV015.27	93.40	2.00	8.40	294	17.00	1.40	0.30	0.10	5050
6CBEV021.07	94.03	2.00	8.30	270	18.00	1.32	0.20	0.10	870
6CBVD000.07	91.90	1.00	7.20	50	5.00	0.24	0.10	0.10	200
6CLTL000.26	92.15	2.65	8.30	307	7.00	1.53	0.30	0.10	6000
6CMFH005.00	89.10	1.70	8.10	212	10.00	1.20	0.20	0.10	400
6CMFH026.00	87.50	1.70	7.80	195	8.00	1.10	0.30	0.10	600
6CNFH008.78	92.35	1.00	8.00	247	6.50	0.40	0.20	0.10	300
6CNFH039.18	90.75	1.15	8.20	285	5.00	0.44	0.20	0.10	100
6CNFH059.65	90.85	1.00	8.00	273	5.00	0.50	0.20	0.10	100
6CNFH080.43	94.90	1.15	8.50	480	5.00	0.61	0.30	0.10	300
6CNFH083.32	92.00	1.00	8.30	142	5.00	0.61	0.20	0.10	300
6CNFH085.20	92.00	1.00	8.10	133	5.00	0.61	0.20	0.10	300
6CNFH097.67	97.70	1.30	8.50	143	5.00	0.71	0.20	0.10	300
6CSFH073.62	94.05	1.15	7.95	85	5.00	0.49	0.10	0.10	300
6CWLF001.46	93.70	1.80	8.30	270	16.00	1.90	0.30	0.20	1200
6CWLF006.55	93.90	2.00	8.40	280	12.50	1.84	0.40	0.20	700
Mean	92.52	1.48	8.15	229	8.44	0.93	0.23	0.11	1064
7 Smll Cstl Bsns, Chspk Bay									
7-BRK004.14	66.30	2.00	7.40	2062	18.00	0.06	0.90	0.10	430
7-COC001.61	91.35	3.00	8.45	15980	10.00	0.06	0.80	0.10	40
7-HLD002.67	73.55	4.20	7.00	2396	26.00	2.85	2.60	0.60	430
7-IND002.26	92.00	3.00	8.20	16560	9.00	0.06	0.65	0.10	43
7-NEW001.92	75.85	2.00	7.50	9225	31.50	0.08	0.90	0.10	350
7-PAR003.09	70.63	5.00	7.50	645	7.00	4.20	3.00	1.30	920
7-PRT001.30	82.00	2.00	7.90	32250	27.00	0.06	0.65	0.10	49
7-THA000.76	99.25	6.00	7.90	5393	40.00	0.07	1.40	0.20	540
Mean	81.37	3.40	7.73	10564	21.06	0.93	1.36	0.33	350

Where detection limits were present, medians were determined using detection-limited values.

Table A-4. Median Values (continued).

Basin/ Station	DO % Sat	BOD mg/l	pH	TR mg/l	NFR mg/l	NN mg/l	TKN mg/l	TP mg/l	FC /100 ml
8 York River									
01673000	87.50	1.63	6.82		14.00	0.20	0.40	0.05	162
01674500	85.30	1.00	6.60		6.00	0.14	0.45	0.05	
8-MPN054.17	86.70	1.25	6.60		5.50	0.14	0.45	0.05	100
8-MPN094.79	85.60	1.00	6.80	62	5.00	0.08	0.40	0.10	100
8-NAR005.42	92.85	1.00	6.90	53	5.00	0.15	0.30	0.10	100
8-PMK056.87	84.70	1.00	6.90	91	6.00	0.36	0.40	0.10	100
8-PMK082.34	88.30	1.00	6.90	89	7.00	0.23	0.40	0.10	100
8-YRK011.14	76.35	1.00	7.85	15140	22.00	0.05	0.51	0.07	100
Mean	85.91	1.11	6.92	3087	8.81	0.17	0.41	0.08	109
9 New River									
9-BST029.71	92.60	1.40	8.10	164	11.00	0.85	0.20	0.10	700
9-CST010.45	90.65	3.10	7.30	85	6.00	0.44	0.60	0.30	400
9-LVR001.34	94.10	1.10	7.10	37	6.00	0.42	0.20	0.10	300
9-NEW030.15	92.00	1.00	8.00	99	5.00	0.79	0.20	0.10	100
9-NEW081.72	82.90	1.00	7.50	100	5.00	0.61	0.20	0.10	100
9-NEW098.32	88.70	1.00	7.90	68	5.00	0.39	0.30	0.10	100
9-NEW148.23	92.70	1.00	7.30	57	8.00	0.51	0.20	0.10	200
9-NEW187.46	89.60	1.00	7.20	52	8.00	0.53	0.20	0.10	200
9-PBC002.69	91.85	1.40	7.20	68	9.00	0.61	0.30	0.20	600
9-PKC004.65	89.90	3.00	7.80	208	8.00	0.47	0.50	0.10	100
9-RDC009.00	98.90	1.70	8.30	192	5.00	0.71	0.20	0.10	200
9-STE002.41	91.80	1.00	8.40	335	5.00	1.40	0.30	0.10	100
Mean	91.31	1.48	7.68	122	6.75	0.64	0.28	0.13	258
Statewide									
Mean	89.92	1.70	7.52	1508	10.69	0.56	0.59	0.13	358
99 USGS Out of State									
01578310	96.25		7.50	156		1.10	0.50	0.05	
02080500	96.20		6.90			0.16	0.30	0.02	
02087570	86.10		7.10			1.30	0.60	0.15	
02089500	84.30	2.13	6.60			0.66	0.64	0.18	
Mean	90.71	2.13	7.03	156		0.81	0.51	0.10	

Where detection limits were present, medians were determined using detection-limited values.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year.

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
1A Potomac									
01646580	-0.51 *		-0.10 ?	0.00	-5.93	3.73 *	-1.32 ?	-1.79 *	161.9
1ABRB002.15	-0.43 *	0.00	-0.19 *	1.72 *	0.00	0.00	0.00	0.00	0.0
1ADIF000.86	-0.29 *	0.00	0.14 *	1.55 ?	0.00 ?	2.86 *	0.00 *	0.00	0.0 ?
1AFOU000.19	-0.06	-3.64 *	-0.26 *	0.47 ?	-5.33 *	3.72 *	-4.37 *	-16.67 *	0.0 *
1AGOO002.38	-0.14 ?	0.00 *	-0.14 ?	-2.42 *	0.00 ?	-0.38	0.00	0.00	0.0
1AGOO022.44	-0.11	0.00	0.00	-0.52	0.00 ?	-0.72 ?	0.00 *	0.00	0.0
1AHUT000.01	0.18	-3.75 *	-0.17 *	1.35 *	-4.07 *	-0.45	3.26 *	0.00 *	0.0 *
1ALIF000.19	0.17	-1.88 *	-0.20 ?	-0.64 ?	1.37 *	0.79 *	-2.56 *	0.00 ?	0.0 ?
1ANEA000.57	-0.42	-2.50 *	-0.46 *	1.23	-1.74	3.89 *	0.74 ?	0.00 *	0.0
1APIM000.15	0.05	0.00	0.00	0.63	0.00 *	1.09 *	0.00 ?	0.00	0.0
1AQUA004.46	-0.14 ?	0.00	0.15 *	-1.79 ?	0.00 ?	0.00	0.00	0.00	0.0 ?
1ATUS000.37	-0.01	0.00	-0.16 *	-0.64	-3.13 *	3.09 *	0.00	0.00 ?	0.0 ?
1AUMC004.43	-0.73 *	0.00	-0.17 ?	0.38	-0.67	0.00	5.04 *	0.00	0.0
1AWLL001.30	-0.88 *	0.00	-0.25 *	0.55	0.00	0.00	3.75 *	0.00	0.0 ?
1B Shenandoah									
1BCDR013.29	0.08	0.00 ?	0.00	-1.12	0.00	0.00	0.00	0.00	0.0
1BHKS000.96	0.72 *	0.00 *	0.21 *	-1.31 *	0.00 *	0.66 ?	-4.76 *	0.00 *	0.0 ?
1BLEW002.91	0.51 *	-7.69 *	-0.14 *	-0.09	0.00	-2.95 *	-10.94 *	0.00 *	10.0 *
1BNFS000.57	-0.01	0.00 *	-0.09 ?	-0.35	0.00	2.29 *	0.00	0.00	0.0 ?
1BNFS010.34	-0.22 ?	0.00 *	-0.22 *	-0.15	0.00	2.42 *	0.00 ?	0.00	0.0
1BNFS081.42	0.16	0.00 *	-0.06 ?	0.23	0.00	1.68 *	0.00	0.00	0.0
1BNFS093.53	0.15	0.00	0.43 *	1.45	0.00	0.42	0.00	0.00	0.0
1BNTH014.08	0.24	0.00	0.00	1.07	-1.56 *	2.89 *	0.00	0.00 ?	0.0
1BSHN022.63	-0.18 ?	-1.39 *	-0.13 *	-2.26 *	0.00 ?	1.45 *	-1.39 *	0.00 ?	0.0
1BSSF003.56	-0.30 *	0.00 *	-0.12 ?	-0.29	0.00 ?	0.68 ?	0.00 *	0.00 *	0.0
1BSSF054.20	0.06	0.00 *	-0.13 *	-1.29 ?	0.00 ?	0.85 *	-2.78 *	0.00 *	0.0
1BSTH007.80	0.19 ?	0.00 *	0.00	-2.37 ?	0.00	-2.45 *	-5.56 *	0.00 *	0.0
1BSTH027.85	0.02	0.00	-0.23 *	3.26 ?	0.00 ?	0.40	0.00	0.00 ?	0.0 ?
1BSTY001.22	0.11	0.00 ?	-0.07	0.47	0.00 *	6.59 *	0.00	3.33 *	0.0 *

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
2 James River									
02035000	0.05	1.79	0.23 *		0.00	-0.88	0.00	2.60 *	5.1
02041650	-0.43 *	-25.00	0.28 ?		0.00	-0.30	0.00	1.04 ?	0.0
2-ALM000.42	0.20 ?	0.00 *	-0.43 *	-0.95 *	-3.41 *	-0.35	0.00	0.00 ?	0.0
2-APP001.53	0.36 *	0.00 ?	0.00	-1.00	1.31 *	0.50	3.33 *	0.00 ?	0.0
2-APP012.79	0.14 *	0.00	-0.08 ?	-0.61 ?	0.00 *	0.58	0.00 ?	0.00 *	0.0
2-APP016.38	0.54 ?	0.00	0.17		-3.85		0.00	-2.22	
2-APP050.23	0.16 ?	0.00	-0.11 ?	-0.47	0.00	1.56 *	0.00 ?	0.00 *	0.0
2-APP110.93	-0.04	0.00 ?	0.23 *	-0.24	-0.78 ?	0.00	0.00 ?	0.00 ?	0.0 ?
2-APP118.04	0.15 ?	0.00	0.00	0.27	0.00	0.18	0.00 *	0.00	0.0
2-BEN001.42	0.00	0.00	0.00	-0.97	-1.85 ?	-3.17 *	2.14 *	0.00	0.0
2-BLY000.65	2.90 *	-6.33 *	-0.70 *	-10.20 *	-2.48 *	2.01 *	-3.24 *	-1.04 *	-1.8 *
2-BUF002.10	0.19 *	0.00 ?	0.23 *	-3.35 ?	-2.72 *	-0.24	0.00	0.00	0.0
2-CHK002.17	0.31 *	0.00	0.00	-0.72	0.94 ?	-3.47 *	2.27 *	0.00 ?	0.0
2-CHK032.77	0.16 ?	0.00 ?	0.00	0.07	0.00 *	0.00	0.00	0.00 *	0.0
2-CHK062.57	-1.02 *	0.00	0.00	-0.73 ?	0.00 *	-0.30 ?	0.00	0.00	0.0
2-CHK076.59	0.03	0.00 *	0.00	2.03 *	-0.89 *	7.58 *	0.00	0.00 *	0.0 ?
2-CRE002.37	0.30 *	0.00 ?	-0.21 *	-0.03	0.00 ?	-0.12	0.00	0.00 *	0.0
2-CWP002.58	-0.15	0.00 ?	0.00	0.61	0.00 ?	0.00	0.00 *	0.00	0.0
2-EBE000.40	-0.06	0.00 ?	-0.33 *	0.15	-4.90 *	-0.49	0.00	0.00	0.0
2-FAC000.85	0.32 *	0.00	0.00	-1.23 ?	0.00 ?	1.57 *	0.00 *	0.00 ?	0.0
2-FAC012.96	0.11	0.00 ?	0.34 *	-0.72 ?	-0.75 *	0.00	0.00	0.00	0.0 ?
2-JKS000.38	0.50 *	0.00 *	0.28 *	4.25 *	0.00 ?	-3.37 *	0.00	-1.73 ?	-6.7 *
2-JMS021.04	-0.68 *	0.00	-0.35 *	-3.17	2.24 *	-11.25 ?	2.86 *	5.83 *	0.0
2-JMS055.94	0.60 *	-2.46 ?	0.00	-3.56	3.57 *	-1.94	1.25 ?	3.47 *	0.0
2-JMS074.44	1.01 *	-4.76 *	0.00	-0.09	-1.29 ?	-3.19 *	-3.75 *	0.00 *	0.0 ?
2-JMS099.30	0.68 *	0.00 ?	0.08	-0.60	-0.19	-3.05 ?	0.00	-8.97 *	0.0
2-JMS110.30	0.39 *	0.00	0.00	-0.65	0.00	-1.45 *	0.00 ?	0.00	0.0
2-JMS117.35	0.25 *	0.00	0.00	0.00	0.00	-2.11 *	0.00	0.00 ?	0.0 ?
2-JMS157.28	0.14 ?	0.00	0.00	-0.46	0.00 ?	0.00	2.22 *	0.00	0.0
2-JMS189.31	-0.05	0.00 ?	0.00	-1.12 ?	0.00	-0.33	0.00	0.00	0.0
2-JMS229.14	0.45 *	0.00 ?	0.17 *	0.46	0.00	-0.18	0.00 ?	0.00	0.0 ?
2-JMS258.54	0.34 *	0.00 ?	0.08 ?	-0.21	0.00	1.50 *	0.00 *	0.00	0.0 *
2-JMS275.75	0.58 *	0.00 *	0.14 *	0.00	0.00	0.00	0.00	0.00	0.0
2-JMS282.28	0.02	0.00	0.07	-0.18	0.00	-0.43	0.00 *	0.00	0.0

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
2 James River (continued)									
2-LAF000.00	0.50 *	0.00	-0.32 *	0.24	-3.76 *	-2.55 *	0.00	0.00 ?	0.0
2-MCM005.12	0.02	0.00 *	0.20 *	-1.00	0.00	-1.67 *	0.00	0.00 *	0.0
2-MRY000.46	-0.07	0.00 *	0.00	-0.15	0.00 ?	0.00	0.00	0.00 ?	0.0
2-MRY038.10	0.24 *	0.00 *	0.13 ?	-1.90 *	0.00 ?	0.80 ?	0.00	0.00	0.0
2-NAN002.77	0.10	0.00	-0.42 *	-1.24 ?	-2.99 *	-2.78 *	2.56 *	0.00	0.0 *
2-NAN019.14	0.65 *	-1.19 *	0.00	-0.24	-1.67 *	-5.00 *	0.00	0.00	0.0 ?
2-PCT002.46	0.72 *	0.00 ?	0.38 *	-0.07	0.00	-1.53 ?	-2.50 *	0.00	0.0 ?
2-PGN010.07	-1.10 *	0.00 *	-0.46 *	1.34 ?	3.49 *	2.81 *	0.00 *	0.00 ?	0.0 *
2-POT000.12	-0.12	0.00 *	0.24 *		0.00	0.00	0.00 ?	0.00	0.0
2-RVN001.64	0.10	0.00 *	0.28 *	-0.88	0.00	0.00	0.00	0.00	0.0
2-RVN015.97	0.09	0.00 *	0.34 *	1.34	0.00	0.00	0.00 *	0.00	0.0
2-RVN033.65	0.15 ?	-3.13 *	0.21 *	-0.51	0.00 ?	1.70 *	-2.35 *	0.00	0.0
2-SBE001.53	0.08	0.00	-0.28 *	-0.53	-5.56 *	0.00	0.00	0.00	0.0
2-SFT004.92	0.19 ?	0.00	0.00	-1.21 *	0.00	0.00 *	0.00 ?	0.00 ?	0.0
2-SGL001.00	1.02 *	-2.49 *	0.00	0.09	0.00	-6.07 *	-0.35	0.00	0.0 ?
2-TYE000.30	0.35 *	0.00	0.50 *	-7.04 ?	0.00 ?	0.00	0.00 ?	0.00	0.0
3 Rappahanock River									
01668000	-0.31 *	0.00	0.19 *		-1.39	-3.37	0.00	3.00 ?	
3-CLB000.50	-0.03	0.00	0.30 *	-1.51 *	-2.50 *	0.26	3.68 *	-10.26 *	0.0
3-GRT001.70	-0.17	0.00	0.00	0.02	0.00 ?	2.00 *	3.13 *	0.00	0.0 ?
3-HOK000.74	0.11	0.00	0.00	-4.71 ?	0.60	0.00 ?	2.38 *	0.00	4.5 *
3-LDR000.70	0.11	0.00 ?	0.23 *	-0.70	0.00 *	0.58 ?	0.00	0.00	0.0 ?
3-RAP006.53	-0.06	0.00 ?	0.00	0.00	0.00	0.00	0.00 ?	0.00	0.0
3-ROB001.90	0.01	0.00	0.00	1.75	0.00	0.00	0.00 ?	0.00	0.0
3-RPP017.72	-1.79 *	0.00 *	-0.45 *	-1.81	0.00	0.00	4.34 *	3.33 *	0.0
3-RPP025.52	-1.46 *	0.00	-0.36 *	-1.20	-0.52	0.00	4.93 *	5.26 *	0.0
3-RPP080.19	-0.31 ?	0.00 ?	-0.26 ?	3.53	4.27 *	-0.80	4.55 *	0.00 *	0.0
3-RPP110.57	0.00	-5.00	-0.55 ?		-2.78 ?		-4.17 ?	0.00	
3-RPP147.10	0.03	0.00 ?	0.08 ?	-0.86	0.00	-0.45	0.00	0.00	0.0
3-THO006.50	-0.01	0.00 *	0.00	-0.34	0.00	-0.65 ?	0.00 ?	0.00	0.0
3-TOT005.11	-0.11	0.00	0.10 ?	-5.32	0.00	0.00	3.33 *	0.00	0.0

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
4A Roanoke River									
02075500	-0.08		0.00			0.00	0.00	-4.51 *	0.0
4ABAN005.58	-0.22 *	0.00	-0.14 *	0.00	1.35 ?	1.67 *	1.52 *	0.00 ?	0.0
4ABWR019.75	0.22 ?	0.00	0.56 *	-1.48	0.00	1.40 *	0.00 ?	0.00	0.0
4ABWR032.32	-0.27	0.00 ?	0.40 ?	0.00	0.00	2.18 *	4.17 *	0.00	3.3 ?
4ADAN015.30	0.20 *	0.00	-0.03 ?	1.59 *	0.57	0.11	1.39 *	0.00 *	0.0 *
4ADAN055.69	0.86 *	-7.69 *	-0.75 *	-0.68	-5.77 *	0.00	-6.67 *	0.00 ?	0.0
4ADAN059.80	-0.34 ?	0.00 *	0.00	-0.47	-4.44 *	1.43 ?	0.00	0.00 *	0.0 *
4ADAN075.22	0.23 *	0.00	0.42 *	0.17	-0.84 ?	0.45	0.00 *	0.00	-2.2 *
4AHYC002.70	-0.15	0.00	-0.31 *	0.00	0.00	0.46	1.28 *	0.00 *	0.0
4APGG008.42	-0.22	0.00 *	0.00	0.00	0.00 ?	-0.35	0.00	0.00	0.0
4ARNF013.66	-0.20	0.00 ?	-0.39 *	-2.54	0.00	-0.63	0.00	0.00 ?	0.0 *
4AROA018.04	-0.61 *	0.00	-0.29 *	0.41	0.00	0.51 ?	0.00 *	0.00 *	0.0
4AROA059.12	0.06	0.00	-0.11 *	0.71	0.75	0.84 *	0.00 *	0.00	0.0
4AROA192.55	0.17	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.0 *
4AROA202.20	0.02	0.00	-0.16 *	0.00	0.00	1.34 *	0.00	0.00	0.0 *
4AROA227.42	-0.05	0.00	-0.24 *	0.41	0.00	0.37	0.00 ?	0.00	0.0
4ASRE007.90	0.32 *	0.00	0.46 *	0.83 ?	0.00	-0.42	0.00	-0.44 *	0.0
4ASRE033.19	0.23 *	0.00 *	0.00	-2.38 *	0.00 *	0.62	0.00 *	0.00	-3.3 *
4ASRE043.54	-0.12	0.00 ?	0.24 *	-1.22 *	0.00	0.77	0.00	0.00 ?	0.0
4ATKR000.69	0.41 *	0.00 *	-0.20 *	0.02	0.00 *	0.37 ?	0.00 ?	0.00	-0.6 ?
5A Chowan River									
5ABLW000.27	-2.86 ?	0.00	-0.76 ?			-1.25	2.56	0.00	
5ABLW009.14	-0.16	0.00 *	0.00	0.22	0.00 *	-0.50	0.00	0.00 *	0.0 ?
5ABLW022.84	-0.16	0.00 *	-0.21 *	-0.20	-2.38 *	-0.21	0.00 *	0.00	0.0
5ABLW074.66	-0.45 ?	0.00 ?	-0.19 *	-0.32	0.00 *	-2.26 *	0.00 ?	0.00 *	0.0
5AMHN052.34	-0.69 *	0.00	-0.32 *	-0.58 ?	0.89 ?	1.00 ?	1.67 *	0.00 *	0.0
5ANTW000.14	-3.05 *	-16.67 *	-1.17 ?			0.46	5.00 ?	-1.49	
5ANTW003.30	-0.19	0.00 ?	0.00	0.49 ?	0.00 *	0.00	0.00 ?	0.00	0.0
5ANTW075.48	0.45 *	0.00 *	0.23 *	-1.06	0.00 ?	0.00	0.00	0.00	0.0 *
5ANTW078.20	0.07	0.00 ?	-0.18 *	-0.51	0.00 ?	0.00	0.00 *	0.00 *	0.0 *
5ANTW105.67	0.24 ?	0.00	0.20 *	-0.77	0.00	0.00	0.00 ?	0.00	0.0
5ANTW109.02	0.00	0.00	-0.11 *	0.00	0.00	0.00	1.75 *	0.00 *	0.0

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
5B Dismal Swamp River									
5BHPC001.46	0.02	-1.58 *	0.17 ?	-1.53	-0.45	-3.33 *	0.67 ?	0.00 *	0.0 ?
5BNLR005.56	0.00	0.00 ?	-0.23 *	11.52 *	0.93	0.00	3.03 *	0.00	0.0
5BNLR013.61	0.10	0.00	0.00	10.57 *	-2.52 *	-2.34 *	1.59 *	0.00	0.0
5BNTW011.90	-0.68 ?	0.00 *	0.00	2.21 *	-3.70 *	0.00	0.00	0.00 ?	0.0
5BWNC001.73	0.97 *	0.00	0.24 *	7.74 *	1.28 ?	0.00 ?	1.07 *	0.00	0.0
6A Big Sandy									
6AHLY001.67	0.00	-7.01 *	0.42 *	-0.33	-6.25 *	-3.52 *	-3.13 *	-8.13 *	0.0
6AKOX008.11	0.08	0.00 *	0.32 *	0.95 *	-4.74 *	-1.37 *	0.00	0.00	-10.2 *
6ALEV130.00	0.39 *	-1.53 *	0.45 *	0.35	-8.09 *	-1.32 ?	0.00	0.00	-8.7 *
6AMCR007.46	0.01	-2.50 *	0.15 ?	1.95 *	-1.82 *	-0.46	0.00	0.00 ?	-3.8 *
6ARSS025.40	-0.04	-2.89 *	0.00	1.21 *	0.00 ?	0.00	0.00	0.00 ?	-11.7 *
6B Clinch-Powell									
6BBER001.14	0.26 ?	-5.23 *	0.54 *	4.44 *	-5.00 *	4.07 *	1.43	-4.79 *	-6.3 *
6BCLN211.00	-0.22 ?	-0.91 *	-0.30 *	0.26	-1.67 *	-0.18	0.00 *	0.00 ?	-6.3 *
6BCLN315.11	-0.16	-2.57 *	-0.29 *	0.00	-3.28 *	-0.09	0.00	0.00 *	-7.7 *
6BGUE006.50	-0.07	-1.96 *	0.14 ?	2.08 *	-2.86 *	0.82	0.00	0.00 ?	-6.1 *
6BNFC003.80	-0.56 *	0.00 *	-0.26 *	0.65 ?	0.00	0.00	0.00	0.00	0.0 *
6BPOW143.53	-0.22 *	0.00 *	-0.11 ?	0.68 *	-0.79 *	0.17	0.00 ?	0.00 *	-7.7 *
6BPOW180.78	0.18 ?	-3.25 *	0.12 ?	1.38 *	-3.57 *	1.85 *	0.00 ?	0.00 ?	-7.2 *
6BPWL001.49	0.08	-2.11 *	0.18 *	0.38	-4.46 *	0.53	0.00	0.00 ?	-1.8 *
6BSRA001.11	0.03	-4.29 *	0.18 *	2.15 *	-4.76 *	1.16 ?	0.00	0.00	-2.0 *
6BSTO004.56	0.20 ?	-1.43 *	0.09	-0.96 ?	0.00 ?	0.00	0.00 ?	0.00 ?	0.0 *

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
6C Holston									
6CBEV015.27	0.14 ?	-3.13 *	-0.27 *	0.20 ?	0.00	1.13 *	0.00 ?	0.00	0.0 *
6CBEV021.07	-0.07	0.00	-0.40 *	0.37 *	1.63 ?	0.85 *	2.33 *	0.00	-4.9 *
6CBVD000.07	0.28 *	-5.00 *	0.28 *	-3.96 *	0.00 *	0.00	0.00 *	0.00	-22.5 *
6CLTL000.26	0.41 ?	-7.55 *	-0.27 *	0.05	0.00 ?	1.14 *	0.00	0.00	0.0 *
6CMFH005.00	-0.46 *	-2.35 *	-0.31 *	0.44 ?	0.00	1.60 *	3.13 *	0.00 ?	0.0
6CMFH026.00	-0.43 *	-6.86 *	-0.20 *	0.22	-0.66 *	0.59 ?	0.00 *	0.00 *	-4.2 *
6CNFH008.78	-0.32 *	0.00 *	-0.31 *	-2.50 ?	0.62 ?	-0.84 ?	0.00 *	0.00 ?	-4.4 *
6CNFH039.18	-0.69 *	-1.74 *	-0.30 *	-1.30 ?	0.00	-0.86 ?	0.00 *	0.00	0.0
6CNFH059.65	-0.23 ?	0.00 *	-0.33 *	-5.24 *	0.00 *	-0.45	0.00 *	0.00	0.0 *
6CNFH080.43	0.38 *	-0.50 *	-0.24 *	-3.37 *	0.00 ?	0.00	0.00 *	0.00	-6.3 *
6CNFH083.32	0.01	-5.71 *	-0.40 *	-0.80	0.00 ?	0.00	0.00 ?	0.00	-7.1 *
6CNFH085.20	0.01	-2.50 *	0.00	-0.38	0.00 ?	0.13	0.00 *	0.00	0.0 *
6CNFH097.67	-0.03	-3.85 *	-0.17 ?	0.49	0.00	0.68 ?	0.00 *	0.00	-4.8 *
6CSFH073.62	-0.20	-1.74 *	-0.08	0.20	0.00	1.37 *	0.00 ?	0.00	-2.0 ?
6CWLF001.46	0.03	-0.79 *	-0.28 *	0.34 ?	0.00	1.51 *	2.22 *	0.00	-3.5 *
6CWLF006.55	0.37 *	-4.17 *	-0.18 *	0.13	-1.60 ?	0.80 *	-1.73 *	0.00	-10.1 *
7 Smll Cstl Bsns, Chspk Bay									
7-BRK004.14	-0.65 *	0.00	0.00	-4.46 ?	-1.85 ?	0.00	0.74 ?	0.00 ?	5.3 *
7-COC001.61	0.06	-3.03 *	-0.44 *	-0.47	-2.50 *	0.00	1.14 ?	0.00 ?	0.0
7-HLD002.67	1.07 *	0.00	0.24 *	0.59	1.92 *	10.12 *	-1.28 ?	30.56 *	5.5 *
7-IND002.26	0.18	0.00	-0.47 *	-0.12	-4.76 *	0.00	2.37 *	0.00 ?	0.0
7-NEW001.92	-0.16	0.00 *	0.00	-1.86	-1.15	-0.74 ?	2.22 *	0.00	2.0 ?
7-PAR003.09	2.90 *	-8.00 *	0.28 *	3.43 *	0.00 ?	24.21 *	-22.69 *	1.92	0.0
7-PRT001.30	0.06	-1.96 *	-0.32 *	-0.31	-5.31 *	0.00 *	0.00	0.00 *	0.0
7-THA000.76	-0.05	-1.96 *	-0.12 ?	2.31 ?	-2.00 *	-2.12 ?	1.98 *	0.00	0.0

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-5. Estimates of Slope, Expressed as Percent of Median per Year (continued).

Basin/ Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
8 York River									
01673000	-0.21 ?	15.38	0.13 *		0.00	1.33	0.00	2.50 *	71.0
01674500	-0.40 *	50.00	0.00		-6.25	-2.38 ?	0.00	1.67 *	
8-MPN054.17	-0.34 *	0.00	-0.38 *		0.00	-60.71	0.00	3.33 *	0.0
8-MPN094.79	-0.26 *	0.00	0.00	-0.81	0.00	0.00	0.00 *	0.00 ?	0.0 ?
8-NAR005.42	-0.07	0.00	-0.26 *	0.00	0.00 ?	0.00	0.00	0.00 ?	0.0
8-PMK056.87	-0.08	0.00 ?	-0.10 ?	-0.35	0.00	2.48 *	0.00 ?	0.00 ?	0.0
8-PMK082.34	-0.14	0.00	-0.16 ?	2.81	0.00	0.31	0.00 ?	0.00 *	0.0
8-YRK011.14	-1.09 *	0.00	-0.46 *	0.22	0.88	0.00	4.56 *	6.41 *	0.0
9 New River									
9-BST029.71	-0.22 ?	-1.59 *	-0.21 *	-0.05	0.00	0.83 *	0.00 *	0.00	-4.8 *
9-CST010.45	-0.02	-1.23	0.23 *	-0.47	0.00 ?	1.83 *	1.67 *	0.00	-3.2 *
9-LVR001.34	-0.25 *	-1.30 *	0.00	-0.91	0.00	2.63 *	0.00 ?	0.00	0.0
9-NEW030.15	0.25 *	0.00	0.31 *	-0.95 ?	0.00 *	-1.07 *	0.00 *	0.00	0.0
9-NEW081.72	0.02	0.00	0.44 *	0.88 *	0.00 ?	3.40 *	0.00	0.00	0.0
9-NEW098.32	-0.10	0.00	0.38 *	0.35	0.00	1.49 *	0.00 *	0.00 ?	0.0
9-NEW148.23	-0.18 *	0.00 *	0.00	0.00	0.00	0.29	0.00 ?	0.00	0.0 *
9-NEW187.46	-0.31 *	-2.31 *	-0.10 ?	-1.08 ?	0.00	-0.89 *	0.00 ?	0.00	-1.1 *
9-PBC002.69	-0.02	0.00 ?	0.00	0.00	0.00	0.21	4.76 *	-3.00 *	-4.8 *
9-PKC004.65	0.20 ?	-3.70 *	0.25 *	-1.81 ?	-2.78 *	0.00	-3.16 *	0.00 *	0.0
9-RDC009.00	0.15	-1.47 *	-0.20 *	-0.13	0.00	0.91 ?	0.00	0.00	0.0 ?
9-STE002.41	0.26 ?	0.00 *	0.00	-0.46	0.00	-3.86 *	-2.08 *	0.00	0.0
99 USGS - Out of State									
01578310	-0.02		-0.31 *	13.46		0.90	-3.12 *	-0.74	
02080500	-0.31		0.00			0.00	0.00	0.00	
02087570	0.46		1.41 *			16.86 *	-8.33 *	-4.72	
02089500	0.00	0.26	0.30 *			2.47 ?	-1.75 *	-2.82 *	-70.2 ?

Values calculated from Tables A-3 and A-4. ? indicates .01 < P < 0.1; * indicates P < .01.

Table A-6. Data Starting and Ending Dates (Years).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
1A Potomac																		
01646580	73	96	78	78	73	96	79	81	74	77	74	92	73	96	73	96	74	76
1ABRB002.15	73	97	75	97	73	97	76	97	76	97	73	97	73	97	79	97	73	97
1ADIF000.86	72	97	79	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
1AFOU000.19	74	97	74	97	74	97	74	97	74	97	74	97	74	97	79	97	74	97
1AGOO002.38	74	97	75	97	74	97	75	97	75	97	74	97	74	97	79	97	74	97
1AGOO022.44	74	97	75	97	74	97	79	97	76	97	74	97	74	97	79	97	74	97
1AHUT000.01	74	97	74	97	74	97	75	97	75	97	74	97	74	97	79	97	74	97
1ALIF000.19	74	97	74	97	74	97	75	97	75	97	74	97	74	97	79	97	74	97
1ANEA000.57	72	97	74	97	72	97	75	97	75	97	72	97	72	97	79	97	72	97
1APIM000.15	72	97	79	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
1AQUA004.46	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
1ATUS000.37	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
1AUMC004.43	73	97	78	97	73	97	79	97	79	97	73	97	73	97	79	97	73	97
1AWLL001.30	73	97	75	97	73	97	75	97	75	97	73	97	73	97	79	97	73	97
1B Shenandoah																		
1BCDR013.29	74	97	76	97	74	97	74	92	74	97	74	97	74	97	79	97	74	97
1BHKS000.96	68	97	68	97	68	97	68	92	68	97	70	97	70	97	79	97	72	97
1BLEW002.91	68	97	68	97	68	97	68	92	68	97	68	97	68	97	79	97	72	97
1BNFS000.57	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
1BNFS010.34	68	97	68	97	68	97	68	92	68	97	70	97	70	97	79	97	72	97
1BNFS081.42	68	97	68	97	68	97	68	92	68	97	70	97	70	97	79	97	72	97
1BNFS093.53	74	97	79	97	74	97	79	92	79	97	74	97	74	97	79	97	74	97
1BNTH014.08	78	97	79	97	78	97	79	92	79	97	78	97	78	97	79	97	78	95
1BSHN022.63	68	97	68	97	68	97	68	92	68	97	70	97	70	97	79	97	72	97
1BSSF003.56	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
1BSSF054.20	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
1BSTH007.80	67	97	70	97	67	97	70	92	70	97	70	97	70	97	79	97	72	97
1BSTH027.85	74	97	79	97	74	97	79	92	79	97	74	97	74	97	79	97	74	97
1BSTY001.22	73	97	75	97	73	97	73	92	73	97	73	97	73	97	79	97	73	97

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
2 James River																		
02035000	70	94	69	91	67	94			88	94	74	92	74	94	74	94	72	77
02041650	77	94	89	92	77	94			89	94	77	92	78	94	77	94		
2-ALM000.42	69	97	69	97	69	97	69	97	69	97	72	97	72	97	79	97	72	94
2-APP001.53	68	97	68	97	68	97	68	94	69	97	70	94	70	94	79	94	72	94
2-APP012.79	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94
2-APP016.38	89	97	89	90	89	97			89	95			89	95	89	95		
2-APP050.23	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	94
2-APP110.93	68	90	68	90	68	90	68	90	68	90	70	90	70	90	79	92	72	90
2-APP118.04	73	97	79	97	73	97	79	97	79	97	73	97	73	97	79	97	73	94
2-BEN001.42	74	97	74	97	74	97	75	97	75	97	74	97	74	97	81	97	74	93
2-BLY000.65	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94
2-BUF002.10	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
2-CHK002.17	67	97	68	97	67	97	68	97	69	97	68	97	68	97	79	97	72	94
2-CHK032.77	67	97	67	97	67	97	68	97	69	97	68	97	68	97	79	97	72	94
2-CHK062.57	68	94	67	94	67	94	68	94	69	94	68	94	68	94	79	94	72	94
2-CHK076.59	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	94
2-CRE002.37	73	97	75	97	73	97	73	92	73	97	73	97	73	97	79	97	73	97
2-CWP002.58	70	97	70	88	70	97	70	85	70	88	70	88	70	88	79	88	72	97
2-EBE000.40	68	97	68	97	68	97	68	97	69	97	70	97	70	97	83	97	72	94
2-FAC000.85	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94
2-FAC012.96	68	90	68	90	68	90	68	90	69	90	70	90	70	90	79	90	72	90
2-JKS000.38	74	97	75	97	74	97	79	97	75	97	74	97	74	97	79	97	74	97
2-JMS021.04	68	97	69	97	68	97	69	97	69	97	70	79	70	93	84	93	72	85
2-JMS055.94	68	97	69	97	68	97	69	74	69	97	69	83	69	93	83	93	72	87
2-JMS074.44	70	97	70	97	70	97	71	97	71	97	70	97	70	97	80	97	72	94
2-JMS099.30	68	97	69	97	68	97	69	95	69	97	69	95	69	95	80	95	72	93
2-JMS110.30	68	97	68	97	68	97	68	95	68	97	70	95	70	95	79	95	72	94
2-JMS117.35	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	95
2-JMS157.28	68	97	68	97	68	97	68	94	69	97	70	94	70	95	79	95	72	94
2-JMS189.31	68	97	68	97	68	97	68	92	68	97	70	97	70	97	79	97	72	97
2-JMS229.14	67	97	68	97	68	97	68	97	68	97	68	97	68	97	79	97	72	97
2-JMS258.54	68	97	68	97	68	97	68	97	69	97	68	97	68	97	78	97	72	97
2-JMS275.75	68	97	68	97	68	97	68	97	69	97	68	97	68	97	79	97	72	97
2-JMS282.28	69	97	69	97	69	97	69	97	69	97	70	97	70	97	79	97	72	97

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	**DO**		**BOD**		**PH**		**TR**		**NFR**		**NN**		**TKN**		**TP**		**FC**	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
2 James River (continued).																		
2-LAF000.00	72	97	72	97	72	97	79	97	79	97	72	97	72	97	83	97	72	94
2-MCM005.12	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
2-MRY000.46	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
2-MRY038.10	68	97	68	97	68	97	68	92	69	97	70	97	70	97	79	97	72	97
2-NAN002.77	68	97	68	97	68	97	68	97	69	97	70	97	70	97	82	97	72	92
2-NAN019.14	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	95
2-PCT002.46	68	90	68	90	68	90	68	90	69	90	70	90	70	90	79	90	72	90
2-PGN010.07	73	97	74	97	73	97	79	97	79	97	73	97	73	97	79	97	73	97
2-POT000.12	70	97	70	88	70	97			70	88	70	88	70	88	79	88	72	97
2-RVN001.64	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
2-RVN015.97	74	97	76	97	74	97	74	92	74	97	74	97	74	97	79	97	74	97
2-RVN033.65	68	97	68	97	68	97	68	92	69	97	68	97	68	97	79	97	72	97
2-SBE001.53	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	94
2-SFT004.92	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94
2-SGL001.00	68	97	68	97	68	97	68	97	69	97	68	97	68	97	79	97	72	95
2-TYE000.30	70	97	70	97	70	97	70	92	70	97	70	97	70	97	79	97	72	97
3 Rappahanock River																		
01668000	77	94	88	90	67	94			88	94	77	92	78	94	77	94		
3-CLB000.50	68	97	68	97	68	97	68	97	69	97	70	97	70	97	78	97	72	97
3-GRT001.70	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
3-HOK000.74	68	97	69	97	68	97	69	96	69	97	70	97	70	97	79	97	72	93
3-LDR000.70	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
3-RAP006.53	74	97	76	97	74	97	79	97	76	97	74	97	74	97	79	97	74	97
3-ROB001.90	73	97	76	97	73	97	79	97	76	97	73	97	73	97	79	97	73	97
3-RPP017.72	68	97	69	97	68	97	69	97	69	97	70	84	70	93	79	93	72	93
3-RPP025.52	68	97	69	97	68	97	69	97	69	97	70	79	70	93	84	93	72	88
3-RPP080.19	79	97	79	97	79	97	79	93	79	97	79	93	79	93	79	93	79	93
3-RPP110.57	86	97	88	94	86	97			88	97			86	95	86	95		
3-RPP147.10	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
3-THO006.50	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
3-TOT005.11	71	97	72	97	71	97	79	97	79	97	71	97	71	97	79	97	72	94

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
4A Roanoke River																		
02075500	79	92			68	92					79	92	79	92	79	92		
4ABAN005.58	72	97	79	97	72	97	73	97	73	97	72	97	72	97	79	97	72	94
4ABWR019.75	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
4ABWR032.32	79	95	79	88	79	95	79	95	79	95	79	95	79	95	79	95	79	95
4ADAN015.30	67	97	70	97	67	97	70	97	70	97	70	97	70	97	79	97	72	94
4ADAN055.69	67	88	69	88	67	88	69	79	69	88	70	88	70	88	79	88	72	88
4ADAN059.80	68	88	68	88	67	88	68	87	69	88	68	88	70	88	79	88	72	88
4ADAN075.22	68	97	68	97	68	97	68	97	69	97	68	97	68	97	79	97	72	97
4AHYC002.70	74	97	79	97	74	97	79	97	79	97	74	97	74	97	79	97	74	94
4APGG008.42	70	88	70	88	70	88	70	85	70	88	70	88	70	88	79	88	72	89
4ARNF013.66	70	88	70	88	70	88	70	79	70	88	70	88	70	88	79	88	72	88
4AROA018.04	71	97	71	97	71	97	79	97	79	97	71	97	71	97	79	97	72	96
4AROA059.12	68	97	68	97	68	97	68	97	68	97	68	97	70	97	79	97	72	94
4AROA192.55	71	97	71	97	71	97	72	97	72	97	71	97	71	97	79	97	72	97
4AROA202.20	67	97	70	97	67	97	70	97	70	97	70	97	70	97	79	97	72	97
4AROA227.42	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
4ASRE007.90	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
4ASRE033.19	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
4ASRE043.54	67	97	67	97	67	97	70	97	70	97	70	97	70	97	88	97	72	97
4ATKR000.69	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
5A Chowan																		
5ABLW000.27	79	86	83	86	79	86					79	86	79	86	79	86		
5ABLW009.14	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
5ABLW022.84	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	97
5ABLW074.66	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	94
5AMHN052.34	68	97	68	97	68	97	68	97	68	97	70	97	70	97	79	97	72	94
5ANTW000.14	79	86	83	86	79	86					79	86	79	86	79	86		
5ANTW003.30	67	97	67	97	67	97	67	97	67	97	70	97	70	97	79	97	72	97
5ANTW075.48	68	90	68	90	68	90	68	90	69	90	70	90	70	90	79	90	72	90
5ANTW078.20	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94
5ANTW105.67	68	90	68	90	68	90	68	90	69	90	70	90	70	90	79	90	72	90
5ANTW109.02	68	97	68	97	68	97	68	97	69	97	70	97	70	97	79	97	72	94

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
5B Dismal Swamp																		
5BHPC001.46	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
5BNLR005.56	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
5BNLR013.61	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
5BNTW011.90	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
5BWNC001.73	72	97	72	97	72	97	79	97	79	97	72	97	72	97	79	97	72	97
6A Big Sandy																		
6AHLY001.67	70	91	70	91	70	91	70	91	70	91	70	91	70	91	79	91	72	91
6AKOX008.11	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6ALEV130.00	67	91	68	91	67	91	67	91	67	91	68	91	68	91	79	91	72	91
6AMCR007.46	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6ARSS025.40	70	96	70	96	70	96	70	96	70	96	70	96	70	96	79	96	72	95
6B Clinch-Powell																		
6BBER001.14	73	95	75	95	73	95	73	95	73	95	73	95	73	95	79	95	73	94
6BCLN211.00	68	95	68	95	68	95	68	95	68	95	68	95	68	95	78	95	72	94
6BCLN315.11	67	97	70	97	67	97	67	97	67	97	70	97	70	97	79	97	72	97
6BGUE006.50	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6BNFC003.80	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6BPOW143.53	70	95	70	95	70	95	70	95	70	95	70	95	70	95	79	95	72	94
6BPOW180.78	68	97	68	97	68	97	68	97	68	97	68	97	68	97	79	97	72	97
6BPWL001.49	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6BSRA001.11	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6BSTO004.56	73	97	82	97	73	97	73	97	73	97	73	97	73	97	79	97	73	97

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
6C Holston																		
6CBEV015.27	67	97	68	97	67	97	67	97	67	97	69	97	69	97	79	97	72	97
6CBEV021.07	72	97	75	97	72	97	73	97	73	97	73	97	73	97	79	97	72	97
6CBVD000.07	69	97	69	97	69	97	69	97	69	97	69	97	69	97	79	97	72	97
6CLTL000.26	69	91	69	91	69	91	69	91	69	91	69	91	69	91	79	91	72	91
6CMFH005.00	68	91	68	91	68	91	68	91	68	91	68	91	68	91	79	91	72	91
6CMFH026.00	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6CNFH008.78	68	97	68	97	68	97	68	97	68	97	68	97	69	97	79	97	72	97
6CNFH039.18	70	91	70	91	70	91	70	91	70	91	70	91	70	91	79	91	72	91
6CNFH059.65	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6CNFH080.43	67	97	67	96	67	97	67	97	67	97	68	96	69	96	78	96	72	97
6CNFH083.32	68	91	68	91	68	91	68	91	68	91	69	91	69	91	80	91	72	91
6CNFH085.20	67	91	68	91	67	91	67	91	67	91	69	91	69	91	79	91	72	91
6CNFH097.67	73	91	79	91	73	91	79	91	79	91	73	91	73	91	78	91	73	91
6CSFH073.62	68	91	68	91	68	91	68	91	68	91	68	91	68	91	78	91	72	91
6CWLF001.46	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
6CWLF006.55	70	91	70	91	70	91	70	91	70	91	70	91	70	91	79	91	72	91
7 Smll Cstl Bsns, Chspk Bay																		
7-BRK004.14	72	97	72	97	72	97	79	97	77	97	72	97	72	97	79	97	72	93
7-COC001.61	68	97	69	97	68	97	69	97	69	97	70	97	70	97	79	97	72	93
7-HLD002.67	73	97	73	97	73	97	74	97	74	97	73	97	73	97	79	97	73	93
7-IND002.26	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	94
7-NEW001.92	72	97	72	97	72	97	79	97	74	97	72	97	72	97	79	97	72	93
7-PAR003.09	73	97	73	97	73	97	74	97	74	97	73	97	73	97	79	97	73	97
7-PRT001.30	68	97	70	97	68	97	70	97	70	97	70	97	70	97	80	97	72	93
7-THA000.76	68	97	69	97	68	97	69	97	69	97	69	97	69	97	79	97	72	93

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-6. Data Starting and Ending Dates (Continued).

Basin/	DO		BOD		PH		TR		NFR		NN		TKN		TP		FC	
Station	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
8 York River																		
01673000	69	94	89	90	67	94			69	94	74	92	69	94	69	94	74	76
01674500	79	94	89	90	68	94			89	94	79	92	79	94	79	94		
8-MPN054.17	72	97	89	97	72	97			88	97	72	74	72	95	86	95	72	74
8-MPN094.79	74	97	79	97	74	97	79	97	79	97	74	97	74	97	79	97	74	97
8-NAR005.42	72	97	74	97	72	97	73	97	73	97	72	97	72	97	79	97	72	94
8-PMK056.87	68	96	70	93	68	96	70	93	70	93	70	93	70	93	79	93	72	93
8-PMK082.34	79	97	79	97	79	97	79	93	79	97	79	93	79	95	79	95	79	93
8-YRK011.14	68	97	69	97	68	97	69	97	69	97	70	79	70	93	84	93	72	79
9 New River																		
9-BST029.71	67	91	68	91	67	91	67	91	67	91	68	91	68	91	78	91	72	91
9-CST010.45	70	91	70	91	70	91	70	91	70	91	70	91	70	91	79	91	72	91
9-LVR001.34	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
9-NEW030.15	67	97	68	97	67	97	67	97	67	97	69	97	69	97	79	97	72	97
9-NEW081.72	67	97	68	97	67	97	67	97	67	97	68	97	68	97	79	97	72	97
9-NEW098.32	72	97	79	97	72	97	73	97	73	97	73	97	73	97	79	97	72	97
9-NEW148.23	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
9-NEW187.46	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
9-PBC002.69	73	97	75	97	73	97	76	97	76	97	73	97	73	97	79	97	73	97
9-PKC004.65	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
9-RDC009.00	70	97	70	97	70	97	70	97	70	97	70	97	70	97	79	97	72	97
9-STE002.41	70	97	70	88	70	97	70	88	70	88	70	88	70	88	79	88	72	97
99 USGS - Out of State																		
01578310	78	96			78	96	79	81			78	92	78	96	78	96		
02080500	76	95			76	95					76	92	76	95	76	95		
02087570	88	96			88	96					88	92	88	95	88	95		
02089500	73	96	73	96	73	96					73	96	73	96	73	96	73	76

Some data sets are not continuous. 1997 observations typically extend through 4th or 5th month.

Table A-7. Numbers of Monthly Observations.

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
1A Potomac									
01646580	134	4	190	13	8	100	187	190	21
1ABRB002.15	237	182	239	80	185	234	234	167	215
1ADIF000.86	242	180	243	89	180	251	250	178	216
1AFOU000.19	229	225	223	139	235	234	232	190	203
1AGOO002.38	237	238	235	105	239	241	241	192	201
1AGOO022.44	227	194	221	93	192	229	230	183	189
1AHUT000.01	233	223	227	109	235	238	239	192	204
1ALIF000.19	239	241	233	105	234	240	243	195	209
1ANEA000.57	187	177	185	91	173	198	198	159	166
1APIM000.15	221	181	219	90	181	231	231	182	195
1AQUA004.46	249	175	235	91	174	251	250	175	225
1ATUS000.37	238	190	232	62	189	232	231	139	180
1AUMC004.43	227	158	220	76	161	226	214	143	196
1AWLL001.30	221	199	217	80	199	223	212	139	192
1B Shenandoah									
1BCDR013.29	225	184	221	71	218	219	215	180	211
1BHKS000.96	270	224	268	119	262	236	236	174	233
1BLEW002.91	266	175	266	40	176	237	235	166	223
1BNFS000.57	270	189	264	44	190	242	240	179	240
1BNFS010.34	266	182	268	43	176	233	230	168	226
1BNFS081.42	276	191	278	46	188	246	246	181	237
1BNFS093.53	227	178	225	37	179	220	222	179	208
1BNTH014.08	188	181	187	48	185	190	188	181	150
1BSHN022.63	261	211	260	47	183	251	251	169	229
1BSSF003.56	265	191	259	39	183	239	236	178	237
1BSSF054.20	261	184	262	39	181	242	241	175	238
1BSTH007.80	265	178	266	40	182	235	235	175	228
1BSTH027.85	221	182	221	38	184	220	218	178	203
1BSTY001.22	231	176	235	94	228	232	230	175	220

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
2 James River									
02035000	198	95	244		67	78	165	168	47
02041650	132	17	132		56	41	129	131	
2-ALM000.42	225	163	216	132	224	222	220	158	215
2-APP001.53	271	227	271	66	235	198	212	167	201
2-APP012.79	294	237	290	108	238	260	259	195	233
2-APP016.38	76	15	77		67		66	66	
2-APP050.23	277	199	280	109	198	243	240	186	205
2-APP110.93	214	159	215	34	155	180	179	121	179
2-APP118.04	219	165	221	70	165	218	217	169	184
2-BEN001.42	246	230	243	124	187	243	188	142	187
2-BLY000.65	255	225	278	188	288	283	286	196	228
2-BUF002.10	260	181	260	40	176	232	230	166	226
2-CHK002.17	266	184	265	118	192	237	235	177	194
2-CHK032.77	283	189	293	165	254	281	278	177	224
2-CHK062.57	232	147	236	137	225	224	222	123	195
2-CHK076.59	279	198	279	188	272	273	272	186	217
2-CRE002.37	230	194	224	33	169	221	221	164	210
2-CWP002.58	222	105	222	9	103	162	160	95	196
2-EBE000.40	226	177	223	64	168	216	159	116	175
2-FAC000.85	244	143	248	54	145	205	202	129	200
2-FAC012.96	217	122	219	24	120	178	176	108	184
2-JKS000.38	253	240	250	102	239	250	248	197	245
2-JMS021.04	184	36	184	14	139	56	127	88	42
2-JMS055.94	168	52	168	7	114	30	125	98	41
2-JMS074.44	207	185	206	103	200	204	204	179	163
2-JMS099.30	193	77	193	38	139	64	157	115	71
2-JMS110.30	306	217	310	72	247	247	265	170	221
2-JMS117.35	296	240	294	109	240	274	274	183	231
2-JMS157.28	297	203	299	61	206	211	238	174	215
2-JMS189.31	267	182	268	45	176	228	227	163	219
2-JMS229.14	296	217	298	167	263	266	264	196	266
2-JMS258.54	306	214	308	168	268	266	268	204	268
2-JMS275.75	258	211	256	123	220	223	221	196	222
2-JMS282.28	294	207	293	159	260	262	258	197	265

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
2 James River (continued).									
2-LAF000.00	219	168	212	63	168	218	156	122	182
2-MCM005.12	261	212	266	39	179	265	260	170	226
2-MRY000.46	264	212	264	89	225	241	238	174	233
2-MRY038.10	268	184	266	97	233	237	236	173	231
2-NAN002.77	231	150	222	94	148	212	153	99	193
2-NAN019.14	275	208	270	140	193	251	228	168	227
2-PCT002.46	211	157	216	29	157	178	176	106	181
2-PGN010.07	221	194	217	125	191	217	210	182	217
2-POT000.12	218	102	219		103	163	160	96	203
2-RVN001.64	264	204	267	39	177	265	263	172	226
2-RVN015.97	216	175	217	37	177	216	214	169	197
2-RVN033.65	268	216	272	44	183	262	262	170	222
2-SBE001.53	212	176	210	64	168	211	152	123	176
2-SFT004.92	249	153	244	54	150	214	213	140	209
2-SGL001.00	279	215	274	205	268	256	245	178	226
2-TYE000.30	258	179	256	40	176	233	232	168	227
3 Rappahanock River									
01668000	144	25	208		66	37	143	144	
3-CLB000.50	240	189	238	65	193	233	231	136	194
3-GRT001.70	211	142	212	84	172	176	176	128	157
3-HOK000.74	252	228	244	112	219	241	228	176	175
3-LDR000.70	230	183	223	54	179	204	202	135	182
3-RAP006.53	227	195	225	95	195	232	229	182	201
3-ROB001.90	241	187	235	90	188	241	239	174	207
3-RPP017.72	224	140	220	16	179	74	110	94	155
3-RPP025.52	174	25	168	10	95	26	107	91	29
3-RPP080.19	178	160	180	37	172	107	141	142	132
3-RPP110.57	117	28	116		98		99	99	
3-RPP147.10	293	197	289	101	197	258	254	184	221
3-THO006.50	263	216	265	87	211	229	226	155	205
3-TOT005.11	227	171	219	101	168	221	212	158	194

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
4A Roanoke River									
02075500	78		83			27	80	80	
4ABAN005.58	260	194	259	141	240	243	241	189	214
4ABWR019.75	284	194	286	103	199	270	267	192	262
4ABWR032.32	134	102	134	39	132	128	126	126	124
4ADAN015.30	282	228	282	108	227	262	259	191	220
4ADAN055.69	196	153	194	96	187	184	180	98	172
4ADAN059.80	210	158	211	82	170	172	167	93	174
4ADAN075.22	302	205	300	168	261	277	274	201	272
4AHYC002.70	232	195	230	99	193	224	220	188	190
4APGG008.42	197	108	199	10	103	170	169	97	180
4ARNF013.66	203	107	207	9	111	180	176	103	184
4AROA018.04	226	203	229	97	196	214	212	188	179
4AROA059.12	288	206	289	106	204	275	271	192	216
4AROA192.55	222	201	224	101	198	222	220	194	214
4AROA202.20	301	202	303	104	204	272	274	198	278
4AROA227.42	304	204	305	115	208	279	277	199	277
4ASRE007.90	301	201	300	101	203	272	271	198	275
4ASRE033.19	274	214	270	141	235	243	239	167	247
4ASRE043.54	202	104	201	166	169	175	175	98	177
4ATKR000.69	284	217	285	89	222	247	242	167	261
5A Chowan									
5ABLW000.27	66	34	63			72	73	73	
5ABLW009.14	240	205	237	111	196	211	211	185	213
5ABLW022.84	273	205	272	103	188	244	243	177	241
5ABLW074.66	288	245	287	110	236	260	255	195	225
5AMHN052.34	293	244	293	115	238	260	263	199	231
5ANTW000.14	67	35	64			73	73	74	
5ANTW003.30	238	193	233	163	191	205	205	181	206
5ANTW075.48	206	131	206	29	124	179	177	113	183
5ANTW078.20	290	212	290	112	206	262	260	196	230
5ANTW105.67	197	126	200	25	121	170	168	108	168
5ANTW109.02	278	206	282	106	203	250	248	188	215

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
5B Dismal Swamp									
5BHPC001.46	261	202	257	133	201	267	262	196	262
5BNLR005.56	212	180	208	79	173	209	207	170	212
5BNLR013.61	235	214	230	100	193	232	228	191	232
5BNTW011.90	256	217	252	106	195	253	248	187	252
5BWNC001.73	256	204	252	100	190	251	247	185	252
6A Big Sandy									
6AHLY001.67	187	155	189	173	172	180	179	124	175
6AKOX008.11	233	120	235	195	196	199	199	140	200
6ALEV130.00	221	135	224	183	181	188	188	128	190
6AMCR007.46	235	150	235	202	202	206	206	141	200
6ARSS025.40	260	173	255	200	198	231	230	162	223
6B Clinch-Powell									
6BBER001.14	198	171	201	197	195	200	201	140	189
6BCLN211.00	260	182	258	227	225	230	229	164	216
6BCLN315.11	231	179	230	199	197	206	205	140	198
6BGUE006.50	235	183	235	203	203	210	208	146	205
6BNFC003.80	216	150	217	185	186	183	182	145	187
6BPOW143.53	238	143	238	213	207	223	221	156	206
6BPOW180.78	236	158	239	209	204	216	212	147	196
6BPWL001.49	233	181	233	202	200	213	211	145	199
6BSRA001.11	231	121	233	204	201	210	212	146	201
6BSTO004.56	210	120	210	209	208	208	209	144	197

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
6C Holston									
6CBEV015.27	248	191	251	214	212	222	220	149	202
6CBEV021.07	212	185	210	207	207	219	216	147	194
6CBVD000.07	239	129	243	246	242	226	224	149	207
6CLTL000.26	220	178	220	154	153	204	202	130	175
6CMFH005.00	218	138	219	216	214	195	194	129	185
6CMFH026.00	233	131	236	235	234	217	218	150	199
6CNFH008.78	282	178	286	107	122	255	252	183	233
6CNFH039.18	218	128	221	140	138	186	185	119	193
6CNFH059.65	272	157	273	102	104	248	246	178	231
6CNFH080.43	240	186	243	163	169	221	217	152	199
6CNFH083.32	210	105	212	116	117	201	197	114	187
6CNFH085.20	212	106	220	122	124	202	199	118	191
6CNFH097.67	185	126	188	129	130	194	193	133	178
6CSFH073.62	162	134	164	136	138	159	158	134	149
6CWLF001.46	241	123	244	174	172	222	220	150	206
6CWLF006.55	218	176	220	156	154	205	204	131	193
7 Smll Cstl Bsns, Chspk Bay									
7-BRK004.14	234	203	222	129	194	229	181	149	172
7-COC001.61	194	175	197	64	172	188	136	105	169
7-HLD002.67	232	226	221	117	182	229	215	168	185
7-IND002.26	215	163	215	66	168	216	161	125	187
7-NEW001.92	242	207	233	130	196	239	195	154	180
7-PAR003.09	238	220	227	123	193	232	199	158	233
7-PRT001.30	241	199	228	112	188	215	144	124	173
7-THA000.76	278	204	272	105	200	266	243	172	193

Table A-7. Numbers of Monthly Observations (continued).

Basin/Station	DO	BOD	pH	TR	NFR	NN	TKN	TP	FC
8 York River									
01673000	155	14	236		61	67	167	170	13
01674500	135	13	138		59	29	133	132	
8-MPN054.17	142	50	143		103	20	120	101	19
8-MPN094.79	210	163	208	82	161	211	208	163	175
8-NAR005.42	254	196	257	128	190	248	249	187	208
8-PMK056.87	228	148	230	98	187	223	220	142	206
8-PMK082.34	198	180	198	50	196	146	170	169	142
8-YRK011.14	184	33	179	10	121	37	112	92	39
9 New River									
9-BST029.71	226	137	226	221	217	228	225	133	187
9-CST010.45	212	161	213	148	150	223	222	122	189
9-LVR001.34	211	148	213	146	145	206	205	144	183
9-NEW030.15	284	181	283	84	183	261	259	170	248
9-NEW081.72	305	217	303	111	208	291	287	192	260
9-NEW098.32	219	191	218	99	193	209	208	185	212
9-NEW148.23	266	178	265	199	198	274	273	179	222
9-NEW187.46	271	181	270	199	201	278	275	175	228
9-PBC002.69	202	177	203	164	164	210	208	144	191
9-PKC004.65	232	171	232	98	190	220	216	158	209
9-RDC009.00	214	148	215	150	149	210	209	143	181
9-STE002.41	227	105	229	9	104	193	190	97	207
99 USGS - Out of State									
01578310	170		175	21		78	174	174	
02080500	87		90			45	87	89	
02087570	67		70			45	67	66	
02089500	132	14	141			61	128	132	21