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PPRP

MARYLAND SYNOPTIC STREAM CHEMISTRY SURVEY

ESTIMATING THE NUMBER AND DISTRIBUTION OF STREAMS AFFECTED BY OR AT RISK FROM ACIDIFICATION

PREPARED BY

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APRIL, 1988

PREPARED FOR

MARYLAND POWER PLANT RESEARCH PROGRAM

MARYLAND DEPARTMENT OF NATURAL RESOURCES
MARYLAND ENERGY ADMINISTRATION

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F O R E W O R D

This report is submitted to Mr. Michael Bowman, Acid Deposition Administrator, Maryland Department of Natural Resources, Power Plant Research Program, under contract PR87-071-02 with International Science & Technology, Inc. (IS&T). Its purpose is to present estimates of the number and extent of Maryland stream resources that are presently affected by or sensitive to acidification, based on the results of a survey conducted in the spring of 1987. The survey results have been used to design a long-term stream chemistry monitoring program that can be implemented by the State of Maryland. This monitoring program is described in a four-volume companion report:

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The design of the Maryland Synoptic Stream Chemistry Survey was developed in part during a Stream Survey Design Workshop, held November 19 and 20, 1986. Participants in this workshop included scientific and technical advisors to International Science & Technology, Inc. (IS&T) and to the Maryland Power Plant Research Program (PPRP), in addition to representatives of both IS&T and PPRP. Scientific and technical advisors included: Dr. Paul Godfrey, University of Massachusetts; Mr. Jim Gracie, J.W. Gracie and Associates; Dr. George Hornberger, University of Virginia; Dr. Ronald Klauda, Johns Hopkins University; Dr. John Kraeuter, Baltimore Gas and Electric Company; Dr. Jim Lynch, Pennsylvania State University; Dr. Douglas Robson, Cornell University (emeritus); Dr. Cullen Sherwood, James Madison University; and Dr. Kent Thornton, FTN Associates, Inc. Representatives of the State of Maryland attending this workshop were Mr. Michael Bowman, PPRP, and Mr. Paul Slunt, Department of Health and Mental Hygiene (now Department of the Environment). IS&T representatives included: Mr. Michael Bonoff, Mr. Douglas Britt, Dr. Gerald Filbin, Mr. Charles Knapp, Mr. Ky Ostergaard, Mr. Peter Saunders, and Dr. Alan Steiner.

Many people contributed to the implementation of the Survey. The following Project Foresters of the Maryland Forest, Park, and Wildlife Service (MFPWS) assisted in contacting property owners to obtain permission to collect water samples: Mr. Mark Acker, Mr. Joe Barley, Mr. Randy Blass, Mr. David Chessler, Mr. Robert Clark, Mr. Scott Daniels, Ms. Terri Dickerson, Ms. Karen Gailey, Ms. Bonnie Johnson, Mr. John Jordan, Ms. Cynthia Junghans, Mr. Steven Koehrr, Mr. Stark McLaughlin, Mr. Wayne Merkel, Mr. Ernest Metz, Mr. John Michael, Mr. Philip Pannill, Ms. Cynthia Tuck, and Mr. Bernard Zlomek. Mr. James Burtis and Mr. James Roberts of the MFPWS coordinated the activities of the Project Foresters. Water samples were collected by 223 volunteers, who were recruited and organized by Mr. James Gracie, of J.W. Gracie and Associates. The following IS&T staff members participated in the implementation activities: Ms. Barbara Allen, Ms. Bonne Arnold, Mr. Ben Bell, Mr. Alan Biddlecomb, Mr. Michael Bonoff, Ms. Toni Borge, Mr. Jim

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ABSTRACT

The Maryland Synoptic Stream Chemistry Survey was designed to provide statewide estimates of the number and extent of stream resources presently affected by or at risk from acidification. Streams surveyed were selected as a stratified random sample from a statewide list of non-tidal stream reaches. The sample represented water quality conditions in a population of interest comprising the state's headwater (watershed area $\leq$ 100 km^2) stream resources sampled during relatively constant phenological conditions during the spring of 1987. Of the 6875 non-tidal stream reaches in the state, an estimated 5411 stream reaches belong to the population of interest.

Volunteers collected water samples from 559 randomly selected and 71 special interest reaches statewide. Samples were analyzed for acid neutralizing capacity (ANC), pH, conductivity, dissolved organic carbon (DOC), color, and dissolved inorganic carbon (DIC), using analytical methods developed for the EPA National Surface Water Survey. Rigorous quality assurance/quality control procedures were followed throughout site selection, sample collection, and sample analysis.

Population estimates of the number and total length of stream reaches at or below specific levels of ANC or pH were developed using data from 535 randomly sampled stream reaches. (Data from 24 randomly selected streams were eliminated from these analyses on the basis of potential contamination by NPDES permitted discharges or compromised sample quality.) In the Coastal Plain portion of the state, an estimated 1977 stream kilometers had pH values of 6.5 or lower (values that may cause decreased reproductive success in anadromous fish that utilize Coastal Plain streams). In upland portions of the state, 283 stream kilometers had pH values of 6.0 or lower (values that may cause decreased reproductive success of resident native fish populations). Based on a sensitivity criterion of ANC $\leq$200 ueq L^{-1}, approximately one-third (32%) of all stream reaches (nearly 4200 stream kilometers) are potentially sensitive to acidification or already acidified. Sensitive streams are present in all physiographic provinces in Maryland; the highest proportions are found in the South Coastal Plain (74%) and the Appalachian Plateau (52%).

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CHAPTER I

INTRODUCTION

Surface water acidification is a widespread problem affecting lakes and streams in the United States, Canada, and Europe (Likens et al. 1979; Haines 1981). Atmospheric deposition has been implicated as one of the major causes of surface water acidification, especially in regions containing waters that are low in acid neutralizing capacity (Hendrey et al. 1980; Malanchuk et al. 1986). The sensitivity to acidification of any particular stream or lake reflects biogeochemical processes occurring within the surrounding watershed, as well as local hydrology and land use patterns (Schnoor et al. 1986; Sharpe et al. 1987). Typical chemical alterations of acidified surface waters include increased concentrations of hydrogen ions, sulfate, and trace metals (such as aluminum, zinc, manganese, or nickel).

Information that can be used to evaluate the potential impact of acid deposition and surface water acidification on a regional basis is presently being gathered through research programs such as the National Acid Precipitation Assessment Program (NAPAP). Within NAPAP, the National Surface Water Survey (NSWS) provides data that are being used to assess the extent of existing and potential impacts of acid deposition on surface waters. In Maryland, 21 randomly selected and four "special interest" stream reaches were sampled during the NSWS National Stream Survey (NSS) in 1986. Results from the NSS are expected to be available in 1988.

Several recent studies have indicated the need for more comprehensive evaluation of the extent of surface water acidification in Maryland. In 1983, a survey of 23 Coastal Plain streams was conducted to evaluate the potential impact of acid deposition on the water quality of historically important anadromous fish spawning areas. The results of this study showed that each of the sampled streams exhibited pulses of low pH (pH $<$ 6.0) water at least once during periods of heavy rainfall (Janicki and Cummins 1983). In fourteen of the streams, pH values as low as 5.5 were observed; and in six streams, pH values of 4.5 to 4.9 were detected.

Because of the concerns raised by the 1983 survey results, a Coastal Streams Acidification Study was initiated in 1984 (Campbell et al. 1987). Three representative watersheds in the Coastal Plain were chosen to evaluate the potential role of acid deposition on the occurrence of episodic acid conditions. Results of this study and an analysis of atmospheric deposition patterns (Maxwell 1984) indicated that wet deposition rates of acid anions in the area studied are as high as, or higher than, those observed in other regions of the U.S. in which acid deposition has been hypothesized or demonstrated to affect surface water chemistry and aquatic biota. Modelling of the responses in stream water chemistry during storm events suggested that both precipitation chemistry and watershed characteristics influenced the resulting stream pH conditions (Campbell et al. 1987).

A summary and analysis of existing Maryland stream pH and alkalinity data was conducted by Janicki and Greening (1987). Overall, 19 percent of all Maryland streams for which data were available exhibited mean alkalinity values of less than 200 ueq L^{-1}. Minimum alkalinity values of less than 200 ueq L^{-1} were found in 41 percent of the data sets examined. The lower cation exchange and sulfate adsorption capacity of soils in the Coastal Plain and Appalachian Plateau physiographic provinces generally corresponded with lower alkalinity and pH conditions in streams, suggesting that acid deposition may adversely affect the stream chemistry of these two provinces.

Another program concerned with the effects of acidification in Maryland involves a watershed study of the Rhode River, also located within the Coastal Plain Province (Correll et al. 1987). Results from this study showed that the mean acidity of stream water varied over fifteen-fold during the last 13 years; but the relationship of stream acidity to factors such as mean acidity of bulk precipitation, volume of precipitation, or hydrogen ion deposition was not very strong. The timing of soil thaw, leaf emergence, rainfall, cloud cover, and cropland cultivation were suggested as possible significant factors in determining the actual stream pH (Correll et al. 1987).

A hydrogeology and water quality study in Maryland's Catoctin Mountains, located in the Blue Ridge Province, indicates that water from wells, springs, and streams may be affected by acid precipitation (Trombley and Zynjuk 1985). Similarly, results from synoptic surveys of 56 streams that drain the Shenandoah National Park in Virginia indicate that flow-weighted alkalinity concentrations of most streams are below 200 ueq L^{-1} (Lynch and Dise 1985), which is commonly considered the threshold of acid sensitivity. A comparison of actual stream chemistry measurements to analyte values predicted by a model based on carbonic acid weathering reactions suggests that all basins in the Park show signs of acidification by atmospheric deposition (Lynch and Dise 1985).

A widely reported result of acidification is the reduction or elimination of fish populations in acidified surface waters. Low pH and ANC levels, elevated aluminum concentrations, and low calcium levels associated with acidic conditions decrease growth and reproductive potential of adult fish, and can cause high mortality rates in eggs and larvae (Table I-1). A review of available fishery survey records in the Eastern United States (Haines and Baker 1986) indicates that lakes in the Adirondack mountain region and streams in Pennsylvania and Massachusetts show fish population declines that are associated with acidity.

In Maryland, recent interest has focused on the possible effects of stream acidification on anadromous fish populations of the Chesapeake Bay (Hendrey 1987, Correll et al. 1987; Hall 1987; Speir 1987; Klauda et al. 1987). Field and laboratory studies have shown that some important anadromous fish species exhibit increased mortality at pH levels less than 6.5. Other species of fish inhabiting the freshwaters of Maryland have been observed to experience acid-related mortality or population declines in other geographic regions at pH levels between 5.1 and 6.4 (Table I-1).

Results of these studies suggest that stream waters, and their fish resources, in at least three physiographic provinces in Maryland (the Coastal Plain, Appalachian Plateau, and Blue Ridge) may be affected by acid deposition. The need for a standardized statewide survey of water

TABLE I-1. RANGE OF pH VALUES THAT HAVE BEEN ASSOCIATED WITH ADVERSE EFFECTS ON SOME FISH SPECIES FOUND IN MARYLAND. Data sources are numbered in parentheses and listed below.

SPECIES	pH RANGE ASSOCIATED WITH ADVERSE EFFECTS: POPULATION DECLINE OR DISAPPEARANCE	pH RANGE ASSOCIATED WITH ADVERSE EFFECTS: INCREASED MORTALITY IN LABORATORY OR IN-SITU EXPERIMENTS
Brook Trout (*Salvelinus fontinalis*)	5.1-6.0 (1, 2, 10, 11, 40, 44, 45, 47, 48)	3.5 - 6.5 : embryos and fry (3, 4, 5, 6, 10, 12, 30, 31, 32, 42) 3.5 - 6.5 : juveniles and adults (3, 7, 8, 9, 10, 34, 35)
Brown Trout (*Salmo trutta*)	3.9-6.3 (1, 10, 13, 14, 48)	4.0 - 5.2 : embryos and fry (5, 10, 15, 33, 36, 43, 37, 38, 39) 2.6 - 5.0 : juveniles and adults (10, 33, 34, 35)
Smallmouth Bass (*Micropterus dolomieui*)	4.4-6.0 (2, 16, 17, 18, 19, 20)	5.1 - 6.1 : embryos and fry (41) 4.0 - 4.5 : juveniles and adults (21, 22, 23, 24)
Northern Pike (*Esox lucius*)	4.7 - 6.4 (2, 45)	5.0 : embryos and fry (25) : juveniles and adults
Walleye (*Stizostedion v. vitreum*)	5.2 - 6.4 (2, 16, 45)	: embryos and fry : juveniles and adults

TABLE I-1. CONCLUDED

SPECIES	pH RANGE ASSOCIATED WITH ADVERSE EFFECTS: POPULATION DECLINE OR DISAPPEARANCE	pH RANGE ASSOCIATED WITH ADVERSE EFFECTS: INCREASED MORTALITY IN LABORATORY OR IN-SITU EXPERIMENTS
Yellow Perch (*Perca flavescens*)	4.2 - 5.0 (2, 16, 18, 19, 26, 27, 48, 50)	5.0 : embryos and fry (50) : juveniles and adults
Blueback Herring (*Alosa aestivalis*		5.7 - 6.5 : embryos and fry (28,29) : juveniles and adults
American Shad (*Alosa sapidissima*)		5.7 - 6.5 : Embryos and fry (51,52) : juveniles and adults
Striped Bass (*Morone saxatilis*)		5.5 - 6.5 : embryos and fry (49,50) : juveniles and adults

Sources: 1. Grande et al. 1978; 2. Beamish et al. 1975; 3. Menendez 1976; 4. Trojnar 1977; 5. Johansson et al. 1977; 6. Schofield and Trojnar 1980; 7. Robinson et al. 1976; 8. Daye and Garside 1975; 9. Leivestad et al. 1976; 10. Howells 1984; 11. Hall et al. 1980; 12. Kwain and Rose 1985; 13. Jensen and Snekvik 1972; 14. Wright and Snekvik 1978; 15. Carrick 1979; 16. Beamish 1976; 17. Pfeiffer and Festa 1980; 18. Harvey 1980; 19. Rahel and Magnuson 1983; 20. Baynes 1981; 21. Gannon and Werner 1982; 22. Spry et al. 1981; 23. Kwain et al. 1984; 24. Cunningham and Shuter 1986; 25. Johansson and Kihlstrom 1975; 26. Keller et al. 1980; 27. Svardson 1976; 28. Klauda and Palmer 1986; 29. Klauda et al. 1987; 30. Schofield and Trojnar 1980; 31. Baker and Schofield 1982; 32. Driscoll et al. 1980; 33. Brown 1981; 34. Edwards and Hjeldnes 1977; 35. Rosseland and Skogheim 1984; 36. Edwards and Gjedrem 1979; 37. Brown and Lyram 1981; 38. Brown 1982; 39. Brown 1983; 40. Schofield and Driscoll 1987; 41. Kane and Rabeni 1987; 42. Johnson et al. 1987; 43. Sadler and Turnpenny 1986; 44. Frenette and Richard 1986; 45. Wales and Beggs 1986; 46. Haines and Baker 1986; 47. Pauwels and Haines 1986; 48. Smith et al 1986; 49. Mehrle et al. 1984; 50. Correll et al. 1987,; 51. Klauda and Palmer 1987; 52. Klauda and Bender 1987.

quality to evaluate the number and extent of streams that are sensitive to acidification was identified by a working group of Maryland state agencies (Bowman and Wierman 1984). To this end, the following objectives were established for the Maryland Synoptic Stream Chemistry Survey (MSSCS):

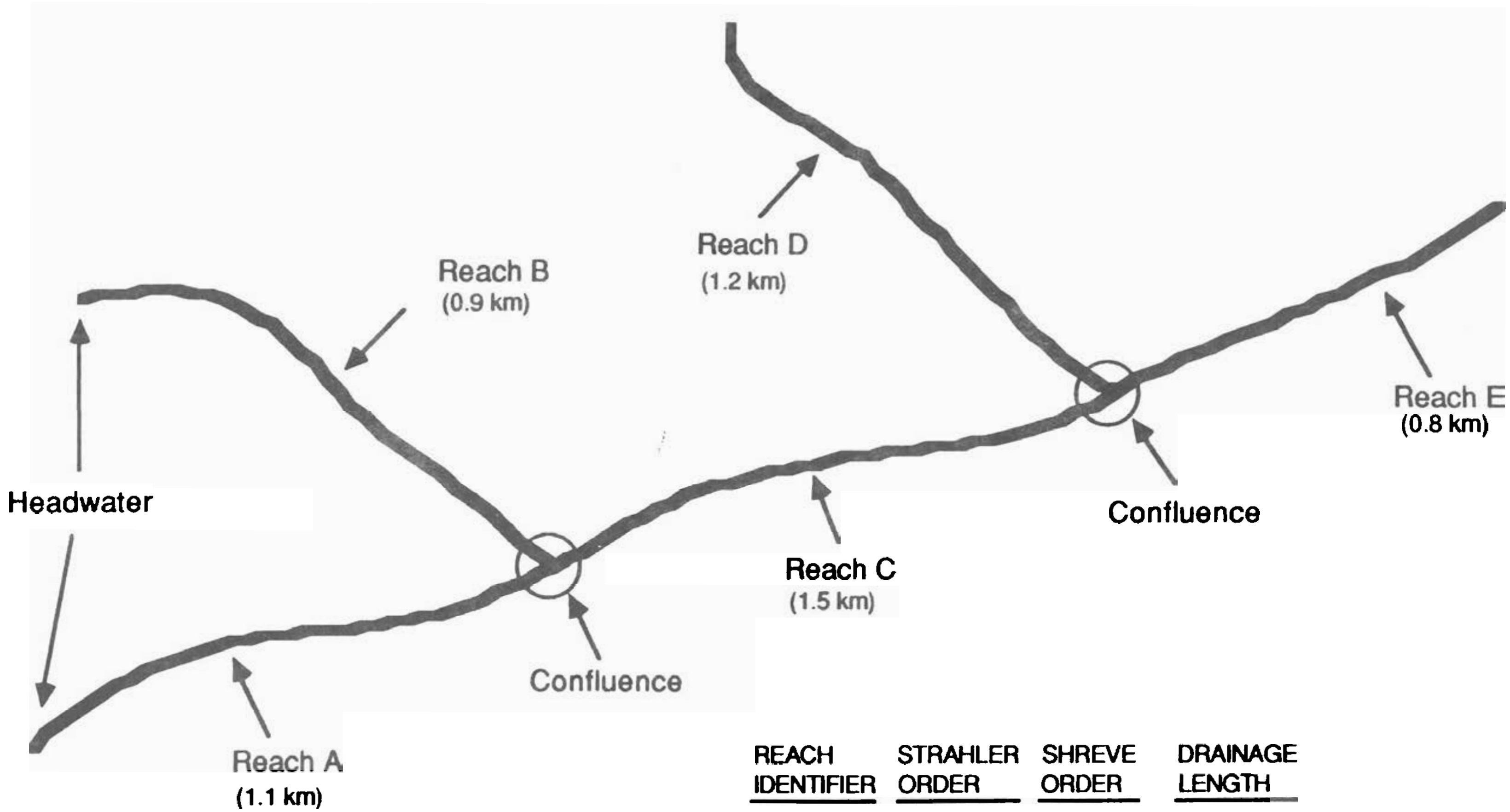
- Design a synoptic stream chemistry survey for Maryland streams that will allow estimation of resources presently affected by, or at risk from acidification;
- Implement the survey design;
- Analyze the data collected to produce statistically valid population estimates of resources at risk; and
- Design a long-term monitoring program (to be implemented by the State), that can detect changes in stream chemistry due to acidic deposition.

This report discusses the implementation of the MSSCS and presents the analyses of data collected during the survey. The design of the MSSCS is presented in detail elsewhere by Knapp and Saunders (1987) and will be summarized here.

Throughout this report, the following terms are used to indicate specific characteristics of surface water resources and the MSSCS design:

- A <u>stream reach</u> is a blue-line drainage feature segment on a U.S. Geological Survey (USGS) 1:250,000-scale topographic map. The boundaries of a reach can be its intersection with two other blue lines, with an impoundment, or with the upstream terminus of the line. A graphical representation of a stream reach is presented in Figure I-1.

- The <u>statewide reach list</u> is the equivalent of a census of stream reaches: that is, a complete listing of the members of a population. In the MSSCS, the statewide reach list includes all non-tidal stream reaches in Maryland, excepting mainstem reaches of the Potomac and Susquehanna Rivers.



REACH IDENTIFIER	STRAHLER ORDER	SHREVE ORDER	DRAINAGE LENGTH
A	1	1	1.1 km (A)
B	1	1	0.9 km (B)
C	2	2	3.5 km (A+B+C)
D	1	1	1.2 km (D)
E	2	3	5.5 km (A+B+C+D+E)

FIGURE I-1. STREAM REACH RELATIONSHIPS

- The population of interest is that portion of the statewide reach list that satisfies selection criteria. The population of interest represents well-mixed, flowing waters of the State that have not been affected by identified non-atmospheric sources of acidification. Stream reaches are included in the population of interest if they satisfy all of the following criteria:
  - Acid mine drainage (AMD) does not influence the reach,
  - No major point-source chemical or sewage discharge (i.e., NPDES permitted discharge) is present within the reach,
  - The upstream watershed area is less than or equal to 100 km^2,
  - The length of the reach is greater than 0.3 km, and
  - No impoundment is represented within the reach on the 1:250,000-scale USGS topographic map.

- A stratum is a geographic area of the state having reasonably uniform physiography, geology, and soils, and within which similar stream chemistry is expected. The state is divided into six strata, for purposes of ensuring an equitable distribution of sampling effort among regions where water quality and geographic conditions are known to differ. Stratum boundaries are based upon physiographic province boundaries, modified by geological and soil information (Knapp and Saunders, 1987). The locations of the six strata are shown in Figure I-2.

- Because stratum boundaries are determined from physiographic, geologic, and soil information, they often bisect counties. Counties defined sub-strata within each stratum (county-strata) which were used to achieve an equitable distribution of sampling effort within strata.

- Special interest reaches are those reaches where sampling was requested by state agency personnel or where historical data bases existed.

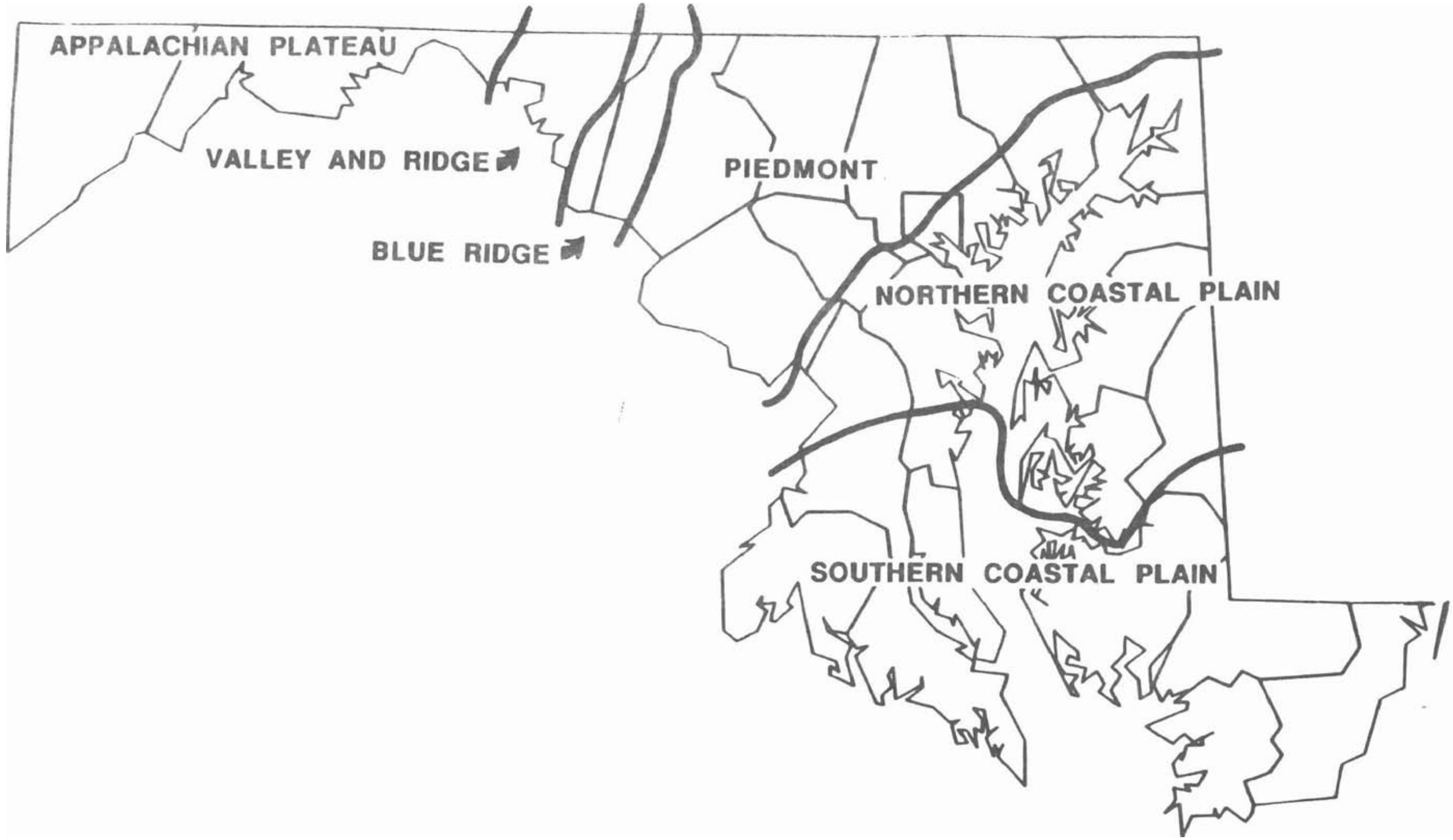


FIGURE I-2. MSSCS SAMPLING STRATA

MSSCS DESIGN SUMMARY

The MSSCS was designed as a probability sample of stream reaches. The objective of this process was to optimize the distribution of a fixed level of sampling effort to produce minimum variance estimates of the population of resources at risk. A stratified random sampling design was developed for the population of non-tidal stream reaches delineated on 1:250,000-scale USGS topographic maps. This population included streams with significant biological resource potential. Because of the project's focus on streams that may have a high probability of being sensitive to acidification, stream reaches with drainage areas greater than 100 km^2, reaches with known sources of industrial pollutants and acid mine drainage, and reaches immediately downstream from large impoundments were excluded from the population of interest.

Six sampling strata, reflecting regional patterns in potential sensitivity of surface waters to acidification, were defined: Appalachian Plateau, Valley and Ridge, Blue Ridge, Piedmont, North Coastal Plain, and South Coastal Plain. The strata were based on the physiographic provinces of Maryland with modification of boundaries to provide for consideration of geology and soils in the stratification scheme.

Representatives of the Maryland Forest, Park, and Wildlife Service assisted in obtaining site access permission for sample collection prior to initiation of water sampling. A central feature of the survey was the use of volunteers in the collection of samples. These volunteers were recruited from conservation organizations and the general public. Sampling was coordinated on Saturdays from regional field headquarters, where samplers assembled to be trained in sample collection protocols, receive stream sampling assignments, and return with collected samples. The field headquarters facilities were staffed at all times when samplers were in the field, for safety reasons and to provide communications.

A single water chemistry sample was collected from each of 559 stream reaches during spring of 1987. The individual samples from each reach represented indices of stream chemistry in all reaches in the region sampled on a specific sampling date, in a manner similar to that described by Messer et. al. (1986). These index values were used to construct population estimates that reflect synoptic stream chemistry during relatively constant spring phenological conditions. No attempt was made either to collect samples during storms or to avoid sampling during storms.

Six water chemistry parameters were measured for all streams sampled: pH, acid neutralizing capacity (ANC), dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), conductivity, and color. In addition, mineral acidity titrations were performed for samples with pH $<$ 4.5, to assess the potential influence of acidic industrial or mine discharges. Quality assurance and quality control (QA/QC) sampling involved collection of field duplicates (10 percent of reaches sampled) to assess sampling system variability; laboratory duplicates (5 percent of field samples) to assess analytical precision; and laboratory audits (5 percent of field samples) to assess analytical accuracy.

Further details of the MSSCS design were presented by Knapp and Saunders (1987).

REPORT ORGANIZATION

Implementation of the MSSCS is summarized in Chapter II of this report. Analysis of the MSSCS data is presented in Chapter III. Chapter IV presents a discussion of the major results of the MSSCS with respect to the results of other state and national studies of resources at risk from acid deposition. Chapter V presents the major conclusions of the survey. Detailed documentation of MSSCS implementation is contained in Appendix A. Appendix B contains a summary and results of the Quality Assurance/Quality Control (QA/QC) program for the MSSCS. Appendix C presents the equations used to produce population estimates, and

Appendix D provides the tabular results of these estimates. Data for randomly selected streams sampled during the MSSCS are presented in Appendix E. Data for special interest streams are presented in Appendix F.

CHAPTER II

IMPLEMENTATION

Implementation of the MSSCS included the following three major activities:

- Development of a data base of Maryland stream reaches containing information necessary to identify each reach uniquely, describe reach characteristics pertinent to the sampling program, and document the results of sample collection and analysis;
- Collection and analysis of samples, including mobilization and training of volunteers who collected the water samples, logistic support for all sampling activities, and laboratory analyses performed on the samples; and
- Providing a comprehensive Quality Assurance/Quality Control (QA/QC) program, designed to assure that all data in the data base are correct, with definable levels of accuracy and precision.

The following paragraphs, along with Appendices A and B, summarize these activities in more detail.

The MSSCS was implemented as a series of activities that began with development of a data base containing location information (map coordinates, stratum, county) for each non-tidal stream reach having its lower confluence in Maryland. Table II-1 lists the number and proportion of stream reaches found in each of the strata and county-strata. Available water chemistry data (primarily Janicki and Greening, 1987) were used with formulae presented by Knapp and Saunders (1987) to allocate the number of reaches to be sampled among the strata. The designated number of reaches in each stratum was apportioned among the counties (including Baltimore City) in the stratum on the basis of the ratio of the number of reaches in the county-stratum to the number of reaches in the entire stratum (Table II-2).

TABLE II-1. DISTRIBUTION OF STREAM REACHES IN MARYLAND

SAMPLING STRATUM	COUNTY	NUMBER OF REACHES	PERCENTAGE IN STATE	PERCENTAGE IN STRATUM
South Coastal Plain	Anne Arundel	44	0.6	3.9
	Calvert	212	3.1	18.6
	Caroline	24	0.4	2.1
	Charles	330	4.8	28.9
	Dorchester	49	0.7	4.3
	Prince Georges	66	1.0	5.8
	Somerset	23	0.3	2.0
	St. Marys	245	3.6	21.5
	Wicomico	86	1.2	7.5
	Worcester	63	0.9	5.5
	Total	1142	16.6	
North Coastal Plain	Anne Arundel	337	4.9	26.3
	Baltimore	69	1.0	5.4
	Baltimore City	17	0.2	1.3
	Caroline	59	0.9	4.6
	Cecil	44	0.6	3.4
	Charles	3	0.0	0.2
	Harford	103	1.5	8.0
	Howard	41	0.6	3.2
	Kent	132	1.9	10.3
	Prince Georges	274	4.0	21.4
	Queen Annes	132	1.9	10.3
	Talbot	71	1.0	5.5
	Total	1282	18.6	

TABLE II-1. CONCLUDED

SAMPLING STRATUM	COUNTY	NUMBER OF REACHES	PERCENTAGE IN STATE	PERCENTAGE IN STRATUM
Piedmont	Baltimore	478	7.0	18.5
	Baltimore City	7	0.1	0.3
	Carroll	437	6.4	16.9
	Cecil	87	1.3	3.4
	Frederick	547	8.0	21.2
	Harford	258	3.8	10.0
	Howard	244	3.6	9.4
	Montgomery	527	7.7	20.4
	Total	2585	37.6	
Blue Ridge	Frederick	171	2.5	87.7
	Washington	24	0.4	12.3
	Total	195	2.8	
Valley & Ridge	Washington	223	3.2	100.0
	Total	223	3.2	
Appalachian Plateau	Allegheny	731	10.6	50.5
	Garrett	568	8.3	39.2
	Washington	149	2.2	10.3
	Total	1448	21.1	
Total		6875		

TABLE II-2. DISTRIBUTION OF RANDOMLY SELECTED AND SAMPLED STREAM REACHES[1]

SAMPLING STRATUM	COUNTY	SELECTED REACHES			SAMPLED REACHES		
		TOTAL	% IN STATE	% IN STRATUM	TOTAL	% IN STATE	% IN STRATUM
South Coastal Plain	Anne Arundel	4	0.6	3.7	5	0.9	5.0
	Calvert	20	3.4	18.5	19	3.4	19.0
	Caroline	2	0.3	1.8	2	0.4	2.0
	Charles	32	5.5	29.6	30	5.4	30.0
	Dorchester	5	0.8	4.6	4	0.7	4.0
	Prince Georges	6	1.0	5.6	5	0.9	5.0
	Somerset	2	0.3	1.8	2	0.4	2.0
	St. Marys	23	3.9	21.3	21	3.8	21.0
	Wicomico	8	1.4	7.4	5	1.1	6.0
	Worchester	6	1.0	5.6	6	1.1	6.0
	Total	108	18.4		99	17.9	
North Coastal Plain	Anne Arundel	27	4.6	27.0	23	4.1	23.2
	Baltimore	5	0.8	5.0	7	1.2	7.1
	Baltimore City	1	0.2	1.0	2	0.4	2.0
	Caroline	5	0.8	5.0	7	1.2	7.1
	Cecil	3	0.5	3.0	4	0.7	4.0
	Charles	0	0.0	0.0	0	0.0	0.0
	Harford	8	1.4	8.0	8	1.4	8.1
	Howard	3	0.5	3.0	3	0.5	3.0
	Kent	10	1.7	10.0	9	1.6	9.1
	Prince Georges	22	3.7	22.0	20	3.6	20.2
	Queen Annes	10	1.7	10.0	10	1.8	10.1
	Talbot	6	1.0	6.0	6	1.1	6.1
	Total	100	17.0		99	17.7	

TABLE II-2. CONCLUDED

		SELECTED REACHES			SAMPLED REACHES		
SAMPLING STATION	COUNTY	TOTAL	% IN STATE	% IN STRATUM	TOTAL	% IN STATE	% IN STRATUM
Piedmont	Baltimore	24	4.1	18.3	22	3.9	17.6
	Baltimore City	1	0.2	0.8	1	0.2	0.8
	Carroll	22	3.8	16.8	20	3.6	16.0
	Cecil	4	0.7	3.0	4	0.7	3.2
	Frederick	28	4.8	21.4	23	4.1	18.4
	Harford	13	2.2	9.9	13	2.3	10.4
	Howard	12	2.0	9.2	13	2.3	10.4
	Montgomery	27	4.6	20.6	29	5.2	23.2
	Total	131	22.4		125	22.3	
Blue Ridge	Frederick	44	7.5	88.0	41	7.3	82.0
	Washington	6	1.0	12.0	9	1.6	18.0
	Total	50	8.5		50	8.9	
Valley & Ridge	Washington	50	8.5	100.0	47	8.4	100.0
	Total	50	8.5		47	8.4	
Appalachian Plateau	Allegheny	74	12.6	50.3	69	12.3	49.6
	Garrett	58	9.9	39.5	57	10.2	41.0
	Washington	15	2.6	10.2	13	2.3	9.4
	Total	147	25.1		139	24.8	
		===			===		
Statewide Total		586			559		

[1]Includes only randomly selected stream reaches.

Reaches were selected randomly without replacement until the target number of reaches for the county-stratum was obtained. This type of sampling is called inverse, or sum-quota, sampling. The sample size in inverse sampling is not fixed in advance, but depends on some attribute of the samples (in this case, satisfying all inclusion criteria). Reaches selected for sampling were mapped and copies of the maps were sent to Project Foresters of the Maryland Forest, Park, and Wildlife Service. Project Foresters then identified and contacted land owners to obtain permission to sample the selected streams.

In addition to the randomly selected streams, 71 special interest streams were sampled (Appendix F). These streams were selected to allow evaluation of the validity of an index sample as a representation of stream chemistry during spring. Twenty-three of these special interest streams were selected to allow comparison of MSSCS data with data collected in the Coastal Plain during the spring of 1983 (Janicki and Cummins, 1983). Forty of the streams were selected to allow comparison of MSSCS data with water quality data collected from USGS monitoring stations around the state. The remaining eight streams were selected in response to specific requests for fisheries management information in Western Maryland.

Collection of samples from selected streams was accomplished with the assistance of volunteers from numerous organizations and the general public, as described in Appendix A. Volunteers were recruited through press releases, direct mailing, and personal solicitation by project staff at meetings of conservation organizations. On nine Saturdays, from March 7, 1987 to May 9, 1987, a total of 223 volunteers assembled at regional base stations, where they were trained in sample collection prior to dispersing to collect samples. A total of 559 randomly selected stream reaches and 71 special interest reaches were sampled (Figure II-1). Samples were returned to the base stations and then to the laboratory on the same day as they were collected. The water quality parameters measured in the laboratory are listed in Table II-3.

FIGURE II-1. GEOGRAPHIC DISTRIBUTION OF REACHES SAMPLED IN THE MSSCS.

TABLE II-3. LABORATORY PARAMETERS MEASURED IN THE MSSCS

Parameter	Units	Detection Limit	Precision Goal (%RSD)*	Accuracy: Maximum Absloute Bias (%)	Maximum Holding Time (Days)	Method	Reference
pH	—	—	0.10 units	±0.1 units	1.5	Potentiometric, unequilibrated	Hillman et.al. 1986
Conductivity	uS cm^{-1}	0.9	10	5	7	Wheatstone Bridge	USEPA 1983. Method 120.1
ANC	ueq L^{-1}	**	10	10	14	Titration (modified Gran Analysis)	Hillman et.al. 1986
DIC	mg L^{-1}	0.05	10	10	1.5	Infrared Spectro-photometer	USEPA 1983. Method 415.2 modified
DOC	mg L^{-1}	0.1	5(5.0) 10(<5.0)	10	14	Infrared Spectro-photometer	USEPA 1983. Method 415.2 modified
True Color	PCU	—	5	—	7	Color comparator	USEPA 1983. Method 110.2 modified
Acidity***	mg L^{-1}	10.0	10	10	14	Potentiometric	USEPA 1983. Method 305.1

* Computed as percent relative standard deviation (coefficient of variation) at 10 times the instrumental detection limit

** Blank titration $\leq$ 10 ueq L^{-1}

*** Performed as qualtiy assurance analysis on samples with pH $\leq$ 4.5

The design of the MSSCS assured that no stratum was sampled in its entirety on any single weekend. This approach, which precluded the possibility that a single precipitation event might unduely influence the stream water chemistry observed in any statum, resulted in a temporal component of variance in the data. The effect of precipitation upon water chemistry is discussed in Chapter III. Table II-4 presents the number of randomly selected reaches from each stratum that were sampled on each weekend of the survey.

During the course of data base development, water sample collection, and water sample analysis, a comprehensive program of QA/QC ensured completeness and accuracy of the results of the MSSCS. Specific quality assurance objectives were established for all areas of the survey. The stream reach list frame was checked for completeness and accuracy by comparison with base maps and transparent drainage feature overlays of the base maps. Watershed areas were measured in duplicate for 10% of all sampled reaches. Duplicate water samples were collected and analyzed for 13.5% of the stream reaches sampled. Laboratory duplicates were analyzed for 60% of all samples. Of all samples analyzed, 6.8% were audit samples. All data were double-key entered into the data base. The results of all QA/QC analyses are presented in Appendix B.

TABLE II-4. NUMBER OF RANDOMLY SELECTED STREAMS SAMPLED IN EACH SAMPLING STRATUM ON EACH SAMPLE COLLECTION DAY

DATE	STRATUM[a]					
	SCP	NCP	P	BR	V&R	AP
March 7	12	5				
March 14	44	8				
March 21	36	12				
March 28	7	38				
April 4		28	38			
April 11		8	58	11		
April 25[b]			29	39	25	
May 2					22	62
May 9						77
	99	99	125	50	47	139

a SCP = South Coastal Plain, NCP = North Coastal Plain, P = Piedmont, BR = Blue Ridge, V&R = Valley & Ridge, AP = Appalachian Plateau

b Includes 5 samples collected May 26, 1987.

CHAPTER III

D A T A   A N A L Y S I S

INTRODUCTION

Analysis of data collected during the MSSCS had three major objectives:

- To describe the stream chemistry and hydrologic parameters of the streams sampled,
- To estimate the number and extent of stream reaches in the population of interest that are acidic or potentially affected by acidification, and
- To classify reaches according to their chemical and hydrological characteristics, and to use those classifications to identify regional or sub-regional patterns in stream chemistry.

The first part of this chapter presents the distributions of individual parameters and relationships between them. These statistics, which describe the distributions of observed data within each of the strata, in themselves do not estimate the statewide distribution of acidic (low pH) and acid-sensitive (low ANC) streams directly, because of differences in the intensity of sampling effort among strata. Population estimation procedures that take into account different sampling intensities among strata are developed and presented following description of the MSSCS data. The representativeness of these estimates was evaluated by comparing the distributions of reach length, number of reaches, and stream order estimated from the streams sampled to the actual distribution of those parameters in the entire population of interest.

Classification analyses were conducted to identify patterns in spatial distribution of acidic and acid sensitive stream reaches. The intent of these analyses was to help identify areas in which to concentrate site-selection activities for the Maryland Long-Term Stream Chemistry Monitoring Program. A secondary objective was to identify different classes of stream chemistry within broad classes of sensitive streams, as defined by ANC values.

In each of the following sections, the methods of analysis and analytical results are presented. The data are discussed in Chapter IV.

DESCRIPTION OF THE MSSCS DATA

Method

Values for five hydrologic variables and six water chemistry parameters were determined for each sampled reach (Table III-1). Statistics describing the distribution of the data for each parameter were computed and summaries prepared. The descriptive statistics indicated that data for most parameters were not normally distributed, thus non-parametric description of the data was preferred. Bivariate relationships between parameters were explored using Spearman's Rank Correlation Test.

Results

Tables III-2 through III-12 present summary statistics on the data distributions for individual geographic and chemistry parameters from randomly selected streams where the data were considered acceptable for use in developing population estimates (see Appendix B). The mean and standard deviation, as well as non-parametric descriptors of the distribution (the minimum, lower quartile, median, upper quartile, and maximum values), are reported.

There were differences among strata in the distributions of all parameters except reach order and color, both of which generally had low values for most reaches. Watershed areas and drainage lengths were somewhat greater in the gently rolling topography of the Piedmont. Smaller drainage areas and shorter drainage lengths were associated with the areas of greatest topographic relief, the Blue Ridge and Appalachian Plateau. Drainage density, an indicator of gross channel sinuosity and drainage network complexity, was relatively lower in the North and South Coastal Plain and Valley and Ridge, and higher in the Piedmont and Appalachian Plateau.

TABLE III-1. PARAMETERS AND MEASUREMENT UNITS FOR REACHES SAMPLED IN THE MSSCS

	PARAMETER	UNITS
HYDROLOGY[1]		
	Watershed Area	km^2
	Drainage Length	km
	Drainage Density (drainage length/ watershed area)	$km\ km^{-2}$
	Strahler Order	Number of upstream confluences of like-order stream reaches
	Shreve Order	Number of headwater reaches
CHEMISTRY		
	pH	Standard pH Units
	ANC	$ueq\ L^{-1}$
	DIC	$mg\ L^{-1}$
	DOC	$mg\ L^{-1}$
	True Color	Pt-Co Units
	Conductivity	$uS\ cm^{-1}$

1 All hydrologic data were determined from USGS 1:250,000-scale topographic maps.

TABLE III-2. DESCRIPTION OF THE DISTRIBUTION OF WATERSHED AREA (km^2) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	9.97	17.31	0.5	1.4	2.9	10.2	97.7
VALLEY AND RIDGE	46	12.06	13.81	1.1	3.3	6.9	15.1	57.4
BLUE RIDGE	47	7.00	7.99	1.4	2.4	4.1	8.2	46.2
PIEDMONT	118	13.54	18.27	1.3	3.0	5.1	17.2	94.9
NORTH COASTAL PLAIN	92	12.40	17.01	0.8	2.6	5.6	11.4	88.9
SOUTH COASTAL PLAIN	98	10.18	12.55	1.1	3.1	5.3	12.5	88.1
ALL STRATA COMBINED	535	11.13	15.84	0.5	2.5	4.8	12.3	97.7

TABLE III-3. DESCRIPTION OF THE DISTRIBUTION OF DRAINAGE LENGTH (km) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	8.04	15.60	0.4	1.2	2.3	7.9	111.0
VALLEY AND RIDGE	46	7.45	8.88	0.8	2.2	4.3	8.3	38.5
BLUE RIDGE	47	5.09	5.77	0.9	1.7	2.9	5.8	29.8
PIEDMONT	118	11.17	15.63	0.7	2.3	4.2	14.0	86.3
NORTH COASTAL PLAIN	92	7.49	9.10	0.5	2.1	3.3	8.4	39.0
SOUTH COASTAL PLAIN	98	6.20	8.33	0.4	2.1	3.3	6.5	59.0
ALL STRATA COMBINED	535	7.99	12.41	0.4	1.9	3.3	8.4	111.0

TABLE III-4. DESCRIPTION OF THE DISTRIBUTION OF STRAHLER ORDER IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	1.53	0.76	1	1	1	2	4
VALLEY AND RIDGE	46	1.43	0.58	1	1	1	2	3
BLUE RIDGE	47	1.36	0.53	1	1	1	2	3
PIEDMONT	118	1.65	0.80	1	1	1	2	4
NORTH COASTAL PLAIN	92	1.37	0.59	1	1	1	2	3
SOUTH COASTAL PLAIN	98	1.33	0.61	1	1	1	2	3
ALL STRATA COMBINED	535	1.47	0.69	1	1	1	2	4

TABLE III-5. DESCRIPTION OF THE DISTRIBUTION OF SHREVE ORDER IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	3.01	5.48	1	1	1	2	42
VALLEY AND RIDGE	46	2.07	2.06	1	1	1	2	11
BLUE RIDGE	47	1.68	1.25	1	1	1	2	7
PIEDMONT	118	3.16	4.06	1	1	1	4	24
NORTH COASTAL PLAIN	92	2.00	2.04	1	1	1	2	11
SOUTH COASTAL PLAIN	98	1.77	1.93	1	1	1	2	10
ALL STRATA COMBINED	535	2.44	3.65	1	1	1	2	42

TABLE III-6. DESCRIPTION OF THE DISTRIBUTION OF DRAINAGE DENSITY (km/km^2) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	0.85	0.35	0.20	0.60	0.76	1.01	2.20
VALLEY AND RIDGE	46	0.69	0.28	0.19	0.53	0.63	0.87	1.52
BLUE RIDGE	47	0.73	0.17	0.43	0.61	0.71	0.85	1.09
PIEDMONT	118	0.82	0.17	0.42	0.72	0.83	0.90	1.35
NORTH COASTAL PLAIN	92	0.68	0.25	0.21	0.49	0.67	0.83	1.50
SOUTH COASTAL PLAIN	98	0.66	0.24	0.11	0.50	0.65	0.82	1.38
ALL STRATA COMBINED	535	0.76	0.27	0.11	0.58	0.73	0.88	2.2

TABLE III-7. DESCRIPTION OF THE DISTRIBUTION OF pH IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	6.90	0.83	4.32	6.69	7.05	7.29	8.49
VALLEY AND RIDGE	46	7.87	0.37	6.77	7.75	7.95	8.06	8.53
BLUE RIDGE	47	7.31	0.56	5.51	7.13	7.34	7.62	8.22
PIEDMONT	118	7.40	0.43	5.58	7.15	7.36	7.60	9.16
NORTH COASTAL PLAIN	92	6.88	0.65	4.32	6.63	6.91	7.26	8.87
SOUTH COASTAL PLAIN	98	6.22	0.78	4.28	5.75	6.44	6.80	7.87
ALL STRATA COMBINED	535	7.00	0.81	4.28	6.68	7.12	7.49	9.16

TABLE III-8. DESCRIPTION OF THE DISTRIBUTION OF ANC (ueq L^{-1}) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	471	909	-65	99	179	310	4731
VALLEY AND RIDGE	45	3496	1908	177	1843	4319	5085	6040
BLUE RIDGE	47	423	271	0	178	437	614	963
PIEDMONT	118	586	362	10	335	469	784	1661
NORTH COASTAL PLAIN	92	506	438	-56	185	396	697	2513
SOUTH COASTAL PLAIN	98	171	218	-64	43	107	200	1228
ALL STRATA COMBINED	534	691	1150	-65	144	307	648	6040

TABLE III-9. DESCRIPTION OF THE DISTRIBUTION OF DIC (mg L^{-1}) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	5.67	10.17	0.30	1.43	2.37	3.79	53.42
VALLEY AND RIDGE	46	43.39	23.63	2.70	21.53	52.67	63.79	73.80
BLUE RIDGE	47	5.29	3.14	0.37	2.28	5.14	7.33	10.73
PIEDMONT	118	7.02	4.16	0.62	4.27	5.79	8.88	20.16
NORTH COASTAL PLAIN	92	6.69	4.90	1.19	3.08	5.36	8.54	32.87
SOUTH COASTAL PLAIN	98	3.40	2.44	0.88	1.85	2.79	3.80	15.23
ALL STRATA COMBINED	535	8.94	14.00	0.30	2.39	4.27	8.28	73.80

TABLE III-10. DESCRIPTION OF THE DISTRIBUTION OF DOC (mg L^{-1}) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	1.27	0.59	0.28	0.81	1.18	1.53	3.92
VALLEY AND RIDGE	46	1.44	2.34	0.23	0.73	0.94	1.38	16.05
BLUE RIDGE	47	1.59	1.24	0.25	0.97	1.23	1.69	8.24
PIEDMONT	118	3.56	3.16	0.70	1.27	2.40	4.93	13.88
NORTH COASTAL PLAIN	92	8.44	5.05	0.72	4.34	7.57	11.03	30.22
SOUTH COASTAL PLAIN	97	5.70	5.09	1.57	2.87	3.92	5.30	31.90
ALL STRATA COMBINED	534	3.86	4.33	0.23	1.13	2.08	4.70	31.90

TABLE III-11. DESCRIPTION OF THE DISTRIBUTION OF COLOR (Pt-Co Units) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	1.21	0.49	0	1	1	1	4
VALLEY AND RIDGE	46	1.73	4.28	0	1	1	1	30
BLUE RIDGE	47	1.11	0.73	0	1	1	1	4
PIEDMONT	118	2.07	1.64	1	1	2	2	10
NORTH COASTAL PLAIN	92	3.26	3.63	0	1	2	4	27
SOUTH COASTAL PLAIN	98	3.47	5.52	0	1	2	3	33
ALL STRATA COMBINED	535	2.20	3.30	0	1	1	2	33

TABLE III-12. DESCRIPTION OF THE DISTRIBUTION OF CONDUCTIVITY (uS cm^{-1}) IN THE MSSCS RANDOM SAMPLE

STRATUM	N	MEAN	STANDARD DEVIATION	MINIMUM	LOWER 25%	MEDIAN	UPPER 25%	MAXIMUM
APPALACHIAN PLATEAU	134	123	127	23	58	78	118	727
VALLEY AND RIDGE	46	479	235	59	248	565	665	860
BLUE RIDGE	47	127	72	21	63	109	177	296
PIEDMONT	118	153	60	19	114	142	188	340
NORTH COASTAL PLAIN	92	206	158	50	128	169	220	1310
SOUTH COASTAL PLAIN	98	118	40	46	78	110	148	208
ALL STRATA COMBINED	535	173	156	19	82	129	189	1310

Sampled streams in the Valley and Ridge stratum, with its predominantly limestone geology, had higher pH, ANC, DIC, and conductivity than streams in all other strata, whereas streams in the South Coastal Plain had the lowest values for these parameters. Streams in the Piedmont and Blue Ridge exhibited similar, moderately high values of pH, but streams in the Piedmont had relatively higher levels of ANC, DIC, and conductivity than were observed in the Blue Ridge. The North Coastal Plain and the Appalachian Plateau had streams with similar, moderate pH values. In the North Coastal Plain, streams had generally higher levels of ANC, DIC, and conductivity. High maximum values of ANC and DIC in streams sampled in the Appalachian Plateau may reflect the presence of isolated areas of limestone geology in that stratum.

The highest levels of DOC typically occurred in the North Coastal Plain. Sampled streams in the South Coastal Plain and Piedmont had moderately low concentrations of DOC. Streams in western Maryland had uniformly low levels of DOC.

Non-parametric correlations between pairs of geographic and chemistry parameters are presented for streams in individual strata in Tables III-13 through III-18. Similar correlations for all reaches sampled throughout the state are presented in Table III-19. Although many of the observed correlations are statistically significant ($p \leq 0.05$), several of these are weak. These weak correlations have little interpretive value and likely occur because the sample size is large. The following observations are somewhat counter to normal expectations:

- ANC or pH were correlated with measures of watershed size (drainage length and watershed area) in only a few cases.

- In all strata except the South Coastal Plain and the Valley and Ridge, DOC was positively correlated with either ANC or pH. Thus, ANC or pH had a weak tendency to increase as DOC increased. Statewide, a statistically significant, but small negative correlation between pH and DOC accounted for about 6% of the variation in these data. No correlation existed between ANC and DOC.

TABLE III-13. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from randomly sampled reaches in the Appalachian Plateau stratum (N = 134; * = p≤0.05).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.91259*	1.00000									
STRAHLER ORDER	0.77212*	0.82861*	1.00000								
SHREVE ORDER	0.78456*	0.84019*	0.98821*	1.00000							
pH	0.04950	0.10401	0.13604	0.14613	1.00000						
ANC	−0.10496	−0.03332	−0.01121	−0.01229	0.85428*	1.00000					
DIC	−0.20464*	−0.12186	−0.06741	−0.06692	0.78344*	0.95043*	1.00000				
DOC	−0.20732*	−0.18972*	−0.18239*	−0.17499*	0.09149	0.23573*	0.33370*	1.00000			
COLOR	−0.02248	0.04425	−0.05469	−0.03948	0.18703*	0.30112*	0.30525*	0.34714*	1.00000		
COND	−0.01604	0.05933	0.10767	0.10566	0.60903*	0.70959*	0.68058*	0.07918	0.13634	1.00000	
DRAINAGE DENSITY	−0.29496*	0.07651	0.08021	0.09432	0.22680*	0.26606*	0.31657*	0.16897	0.17789*	0.19759*	1.00000

TABLE III-14. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from randomly sampled reaches in the Valley and Ridge stratum (n = 46; * = $p \leq 0.05$).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.89533*	1.00000									
STRAHLER ORDER	0.56622*	0.73470*	1.00000								
SHREVE ORDER	0.61063*	0.77823*	0.97392*	1.00000							
pH	0.36022*	0.26916	0.17765	0.21941	1.00000						
ANC[1]	-0.01331	-0.14432	-0.21881	-0.22487	0.23847	1.00000					
DIC	-0.02923	-0.14985	-0.18574	-0.21345	0.17858	0.95257*	1.00000				
DOC	0.02245	0.08688	0.01131	0.06591	0.10748	-0.51196*	-0.59672*	1.00000			
COLOR	0.12288	0.12137	-0.00952	-0.00073	-0.02320	-0.27943	-0.26298	0.35119*	1.00000		
COND	-0.01363	-0.17206	-0.17840	-0.21838	0.33651*	0.87348*	0.89401*	-0.46988*	-0.29729	1.00000	
DRAINAGE DENSITY	-0.41971*	-0.02116	0.25102	0.26205	-0.21146	-0.29789*	-0.29880*	0.16334	-0.09578	-0.37318*	1.00000

1. n = 45

TABLE III-15. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from randomly sampled reaches in the Blue Ridge stratum ($N = 47$; * = $p \leq 0.05$).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.93031*	1.00000									
STRAHLER ORDER	0.76785*	0.80505*	1.00000								
SHREVE ORDER	0.78788*	0.82131*	0.98082*	1.00000							
pH	0.38221*	0.48369*	0.33835*	0.36630*	1.00000						
ANC	0.22660	0.28916*	0.18218	0.22590	0.81883*	1.00000					
DIC	0.18623	0.25208	0.14014	0.18446	0.78084*	0.98647*	1.00000				
DOC	0.38157*	0.44550*	0.30845*	0.37213*	0.39583*	0.47490*	0.45194*	1.00000			
COLOR	0.37963*	0.42339*	0.35266*	0.42533*	0.38583*	0.40617*	0.42383*	0.57335*	1.00000		
COND	0.27865	0.31345*	0.17784	0.21607	0.77494*	0.94045*	0.93212*	0.49005*	0.43804*	1.0000	
DRAINAGE DENSITY	-0.10225	0.24751	0.17573	0.15601	0.27063	0.18154	0.18340	0.24011	0.12371	0.11251	1.00000

TABLE III-16. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from randomly sampled reaches in the Piedmont stratum (N = 118; * = p≤0.05).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE ENGTH	0.97133*	1.00000									
STRAHLER ORDER	0.85058*	0.87348*	1.00000								
SHREVE ORDER	0.88308*	0.90089*	0.96989*	1.00000							
pH	0.23128*	0.23069*	0.31207*	0.26527*	1.00000						
ANC	0.04554	0.03107	0.16418	0.10250	0.73514*	1.00000					
DIC	0.02398	0.01249	0.11709	0.06225	0.72363*	0.96620*	1.00000				
DOC	0.00678	-0.06817	0.02781	-0.00058	0.02386	0.28923*	0.20870*	1.00000			
COLOR	-0.02574	-0.07094	-0.01055	-0.03500	0.00085	0.24394*	0.17607	0.80552*	1.00000		
COND	-0.06031	-0.07090	0.03061	-0.02433	0.62570*	0.78414*	0.79935*	0.2017*	0.10096	1.00000	
DRAINAGE DENSITY	-0.04613	0.15671	0.20478*	0.17741	0.06922	-0.03585	-0.02617	-0.22296*	-0.16014	-0.04531	1.00000

TABLE III-17. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS.
Data from randomly sampled reaches in the North Coastal Plain stratum (N = 92; * = $p \leq 0.05$).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.93490*	1.00000									
STRAHLER ORDER	0.71371*	0.78108*	1.00000								
SHREVE ORDER	0.71911*	0.78837*	0.98323*	1.00000							
pH	0.09627	0.09318	0.16617	0.19333	1.00000						
ANC	0.05407	0.01935	0.18086	0.19369	0.82475*	1.00000					
DIC	0.01023	-0.03142	0.14431	0.15058	0.65413*	0.93005*	1.00000				
DOC	0.04195	0.04545	0.15928	0.15137	0.28201*	0.49267*	0.52234*	1.00000			
COLOR	0.03811	0.02876	0.05941	0.06168	0.02409	0.21308*	0.21756*	0.54586*	1.00000		
COND	0.07021	0.05206	0.20217	0.19862	0.61012*	0.77087*	0.74079*	0.44938*	0.08093	1.00000	
DRAINAGE DENSITY	-0.19087	0.11555	0.15448	0.18441	0.05572	-0.00076	-0.02483	-0.11284	0.08153	0.01995	1.00000

TABLE III-18. SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from randomly sampled reaches in the South Coastal Plain stratum (N = 98; * = p≤0.05).

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.87081*	1.00000									
STRAHLER ORDER	0.56868*	0.68515*	1.00000								
SHREVE ORDER	0.57676*	0.69210*	0.99524*	1.00000							
PH	-0.00110	0.15571	0.20965*	0.21782*	1.00000						
ANC	0.02990	0.14700	0.14449	0.15139	0.92214*	1.00000					
DIC	0.07190	0.08097	0.09419	0.08475	0.38870*	0.63612*	1.00000				
DOC[1]	0.21122*	0.26305*	0.23458*	0.23876*	-0.02824	0.07085	0.23455*	1.00000			
COLOR	0.29933*	0.15650	0.03688	0.03311	-0.30018*	-0.16495	0.24800*	0.36265*	1.00000		
COND	0.10469	0.13575	0.04227	0.03298	0.31660*	0.47508*	0.58515*	0.19334	0.05944	1.00000	
DRAINAGE DENSITY	-0.26910*	0.17245	0.26261*	0.26678*	0.38997*	0.28679*	-0.01854	0.13375	-0.24082*	0.05376	1.00000

1. n = 97

TABLE III-19. **SPEARMAN'S CORRELATION COEFFICIENTS FOR WATER QUALITY AND WATERSHED CHARACTERISTICS. Data from all randomly sampled reaches in all strata combined (n = 535; * = p≤0.05).**

	WATERSHED AREA	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	pH	ANC	DIC	DOC	COLOR	COND	DRAINAGE DENSITY
WATERSHED AREA	1.00000										
DRAINAGE LENGTH	0.92914*	1.00000									
STRAHLER ORDER	0.71826*	0.79385*	1.00000								
SHREVE ORDER	0.73663*	0.81018*	0.98514*	1.00000							
PH	0.11938*	0.17799*	0.22203*	0.22661*	1.00000						
ANC[1].	0.07057	0.11342*	0.12287*	0.12817*	0.86396*	1.00000					
DIC	0.06437	0.08291	0.06914	0.07114	0.75411*	0.94167*	1.00000				
DOC[1].	0.10122*	0.07249	0.02993	-0.02413	-0.24166*	0.00681	0.10404*	1.00000			
COLOR	0.14063*	0.11314*	0.00022	0.00768	-0.11616*	0.07619	0.15778*	0.66968*	1.00000		
COND	0.14307*	0.14467*	0.09003*	0.08764*	0.58667*	0.76938*	0.81343*	0.16274*	0.15157*	1.00000	
DRAINAGE DENSITY	0.22113*	0.10775*	0.19629*	0.20165*	0.21156*	0.15457*	0.09011*	-0.07142	-0.04497	0.01644	1.00000

1. n = 534

As expected, ANC, pH, DIC, and conductivity were generally well correlated with one another, indicating that most streams sampled had buffering systems dominated by carbonate chemistry. (Figure III-1 depicts the pH-ANC relationship for all reaches sampled.)

Drainage length and watershed area were strongly correlated and the relationship appeared to be linear (Figure III-2). Linear regression of watershed area on drainage length resulted in an r^2 value of 0.95. Drainage length was thus a useful surrogate for watershed area.

DOC and true color were measured in the MSSCS because the presence of high levels of either parameter may indicate the presence of organic acidity is affecting both ANC and pH. However, examination of the relationship between pH and DOC for streams with moderate to low pH (pH $\leq$ 6.5) indicated that few of the sites with low pH also had high values of DOC (Figure III-3).

TEMPORAL VARIATION

Sample collection during the MSSCS was conducted over a series of weekends to accomplish two objectives:

- Maintain relative constancy with respect to the phenology of springtime hydrologic conditions, and
- Avoid the potential for a single precipitation event to unduly influence statewide or stratum-specific population estimates.

Sample collection was accomplished over a varying number of sampling dates in each stratum (Table II-4). The organization of sample collection activities is presented in Appendix A.

In South Coastal Plain streams (Figure III-4), pH apparently increased during the first 3 weeks of sampling. ANC apparently increased during all 4 weeks. In the North Coastal Plain (Figure III-5), both pH and ANC appeared to increase during the final three weeks of sample collection. In both the Piedmont (Figure III-6) and the Blue Ridge

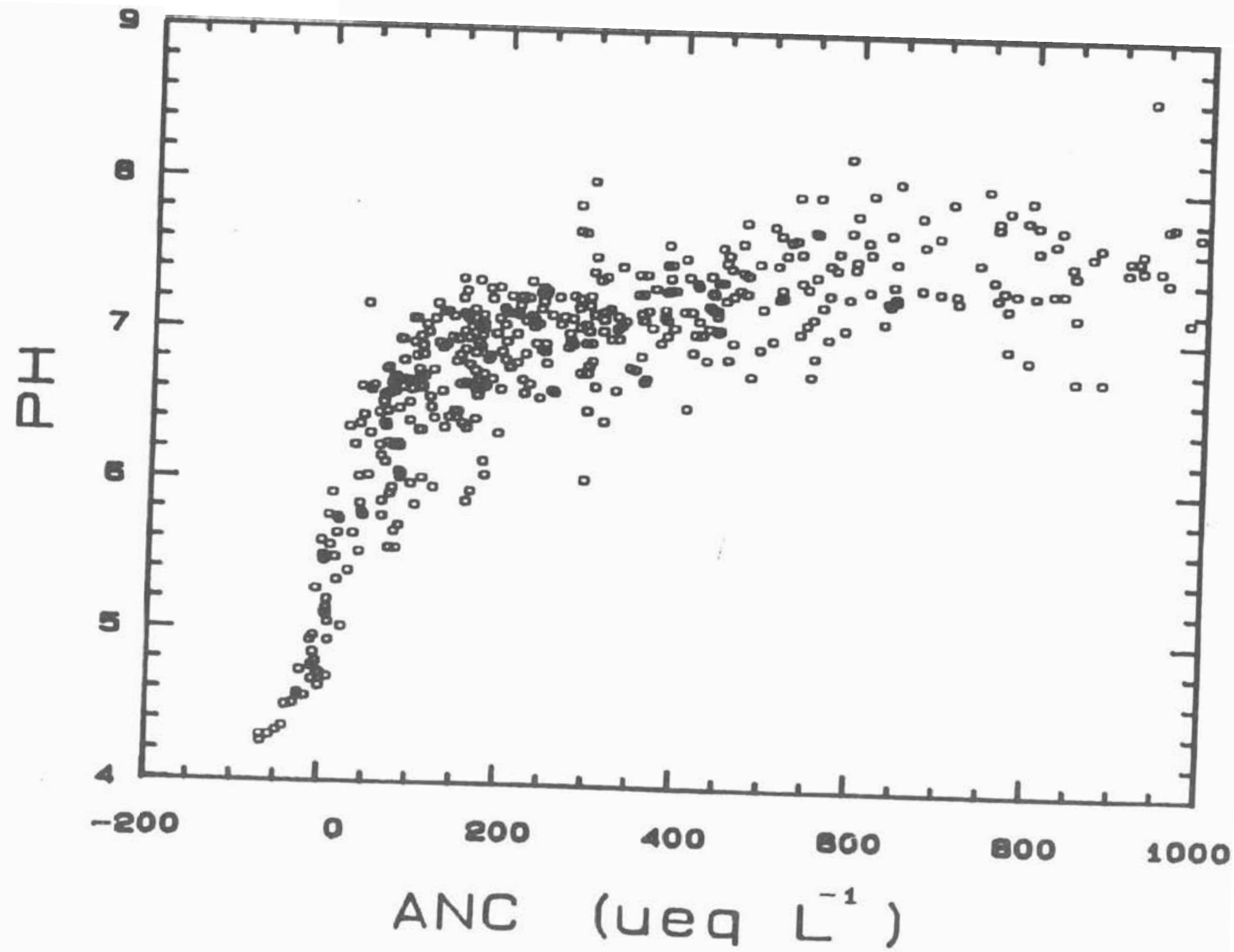


FIGURE III-1. SCATTER PLOT SHOWING THE RELATIONSHIP BETWEEN ANC AND pH IN RANDOMLY SAMPLED MSSCS REACHES.

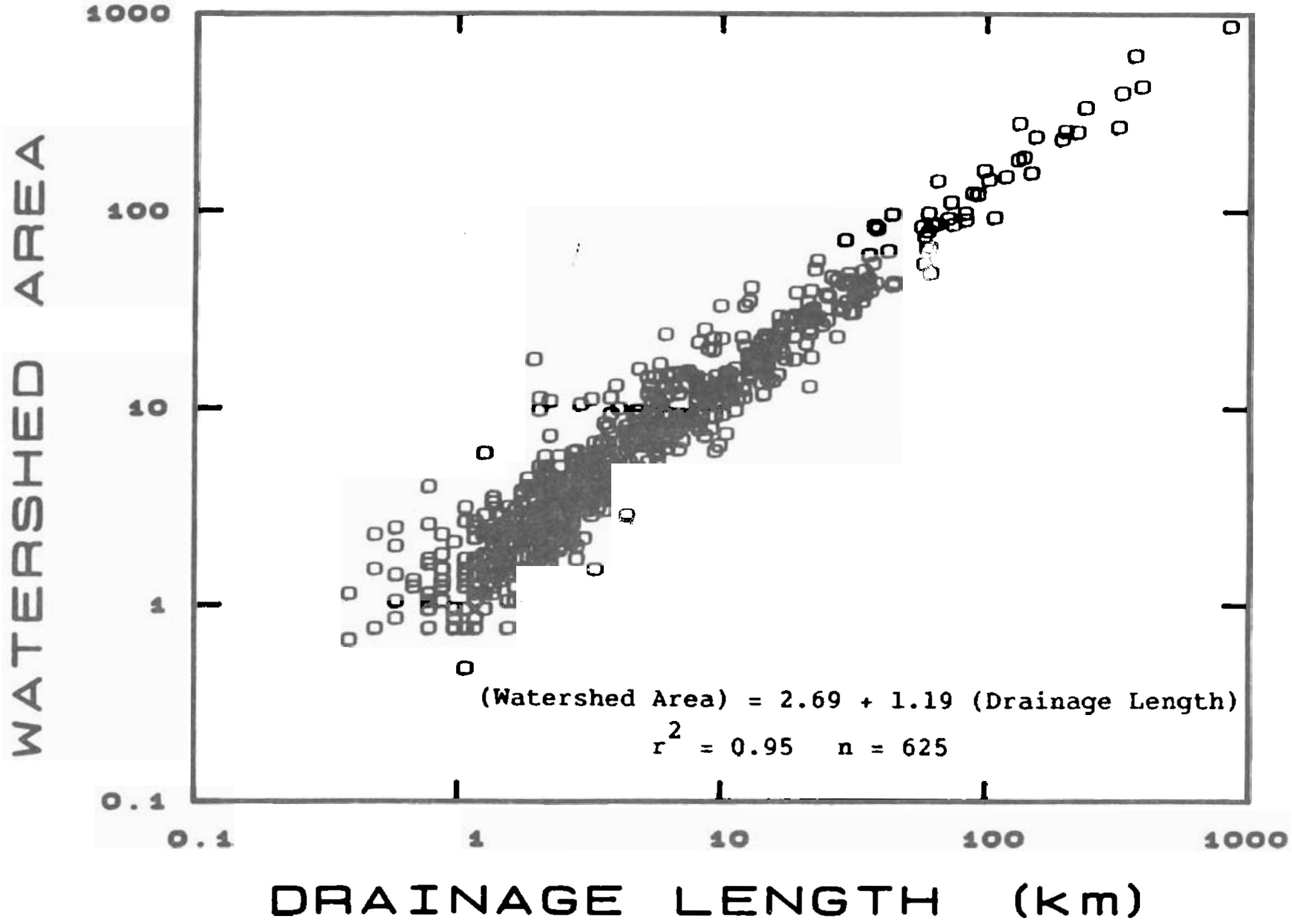


FIGURE III-2. **SCATTER PLOT SHOWING THE LINEAR RELATIONSHIP BETWEEN DRAINAGE LENGTH AND WATERSHED AREA FOR ALL SAMPLED MSSCS REACHES.** (Reaches with watershed areas > 100 km^2 are Special Interest reaches.)

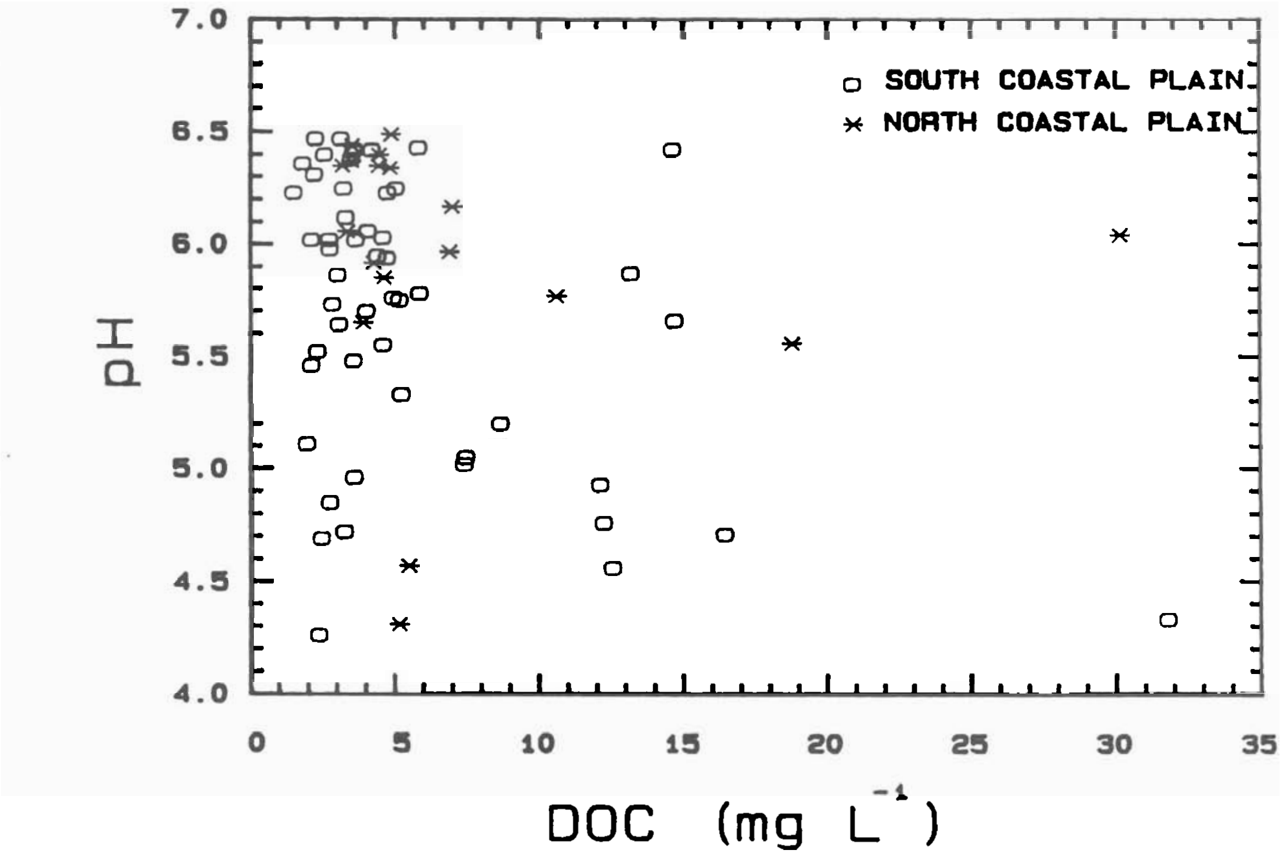


FIGURE III-3. RELATIONSHIP BETWEEN DOC AND pH IN COASTAL PLAIN STREAMS WITH pH ≤ 6.5.

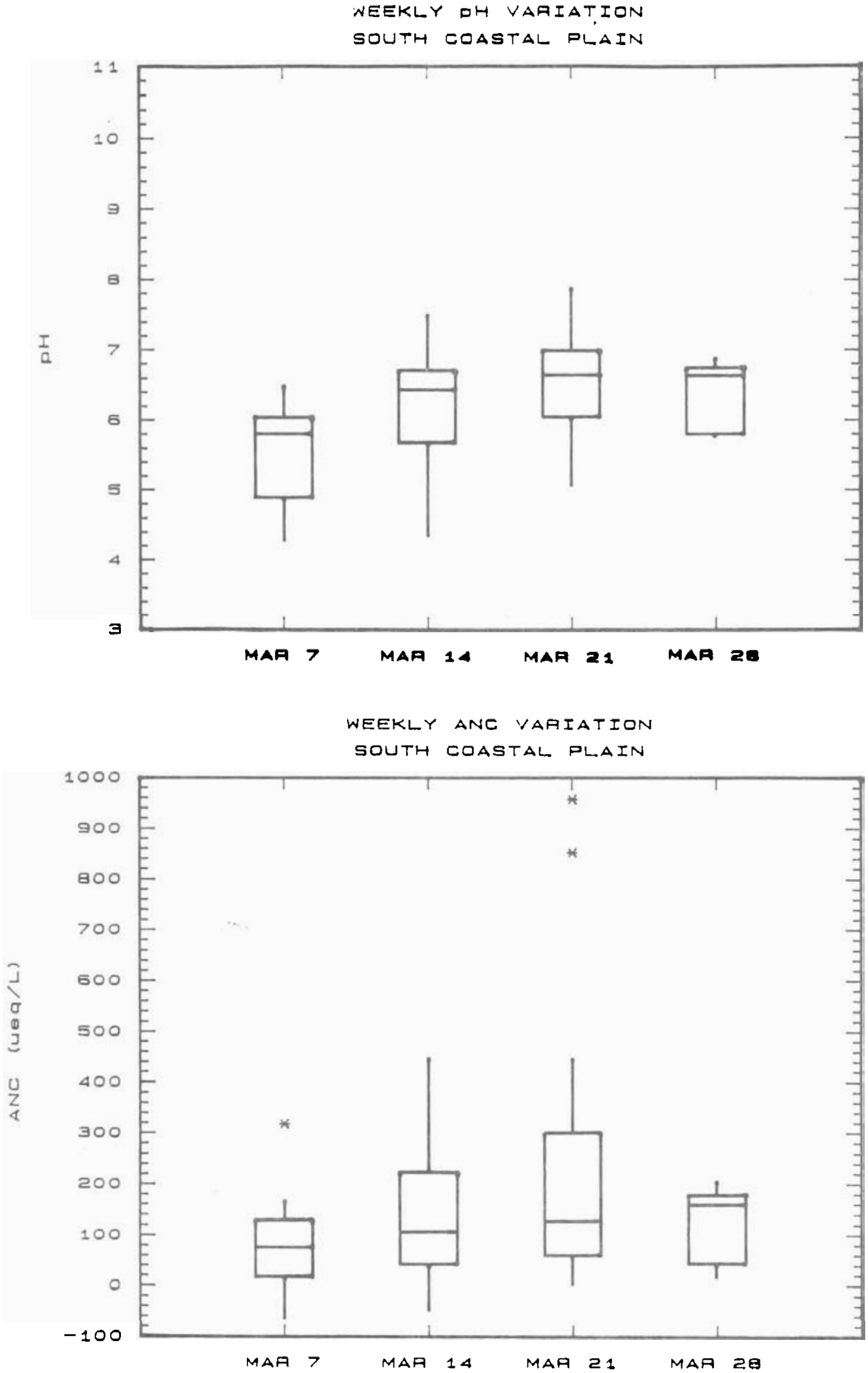
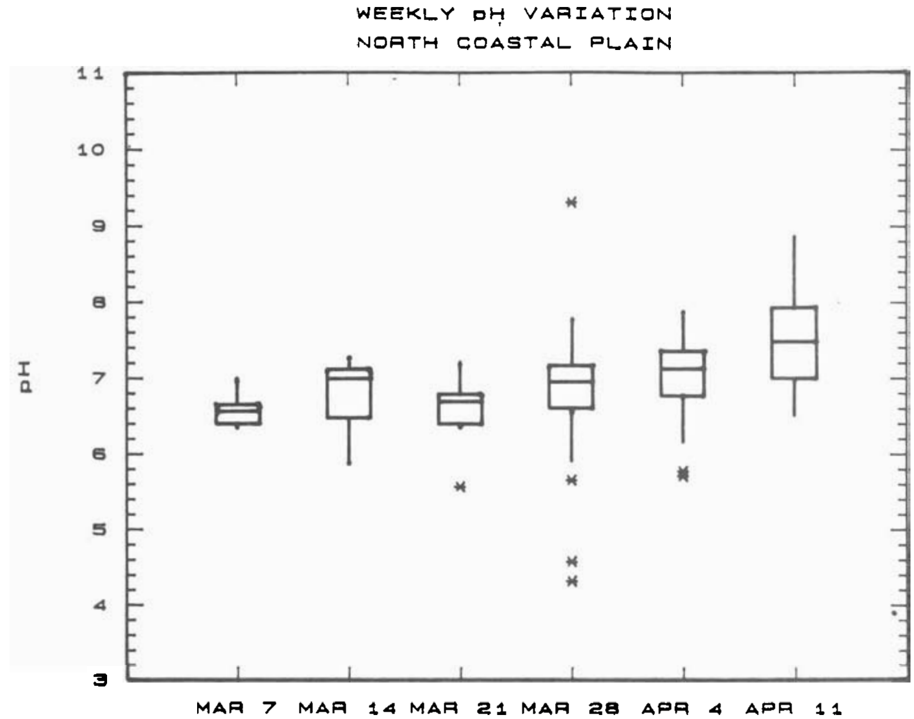


FIGURE III-4. WEEKLY VARIATION IN pH AND ANC OBSERVED IN SOUTH COASTAL PLAIN STREAMS DURING THE MSSCS. The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.



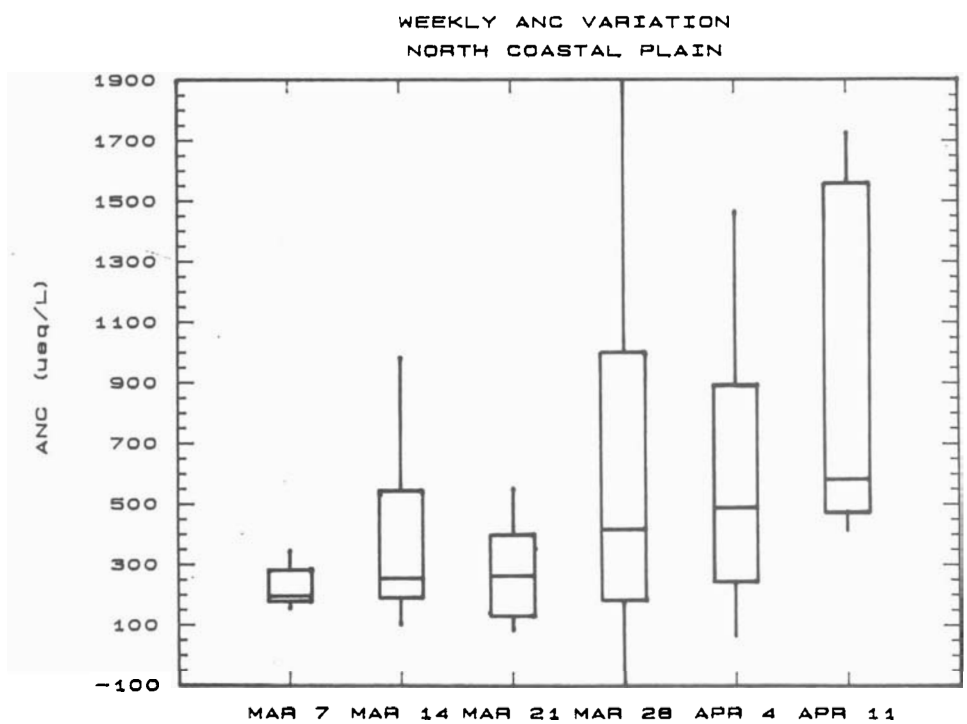


FIGURE III-5. WEEKLY VARIATION IN pH AND ANC OBSERVED IN NORTH COASTAL PLAIN STREAMS DURING THE MSSCS. The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.

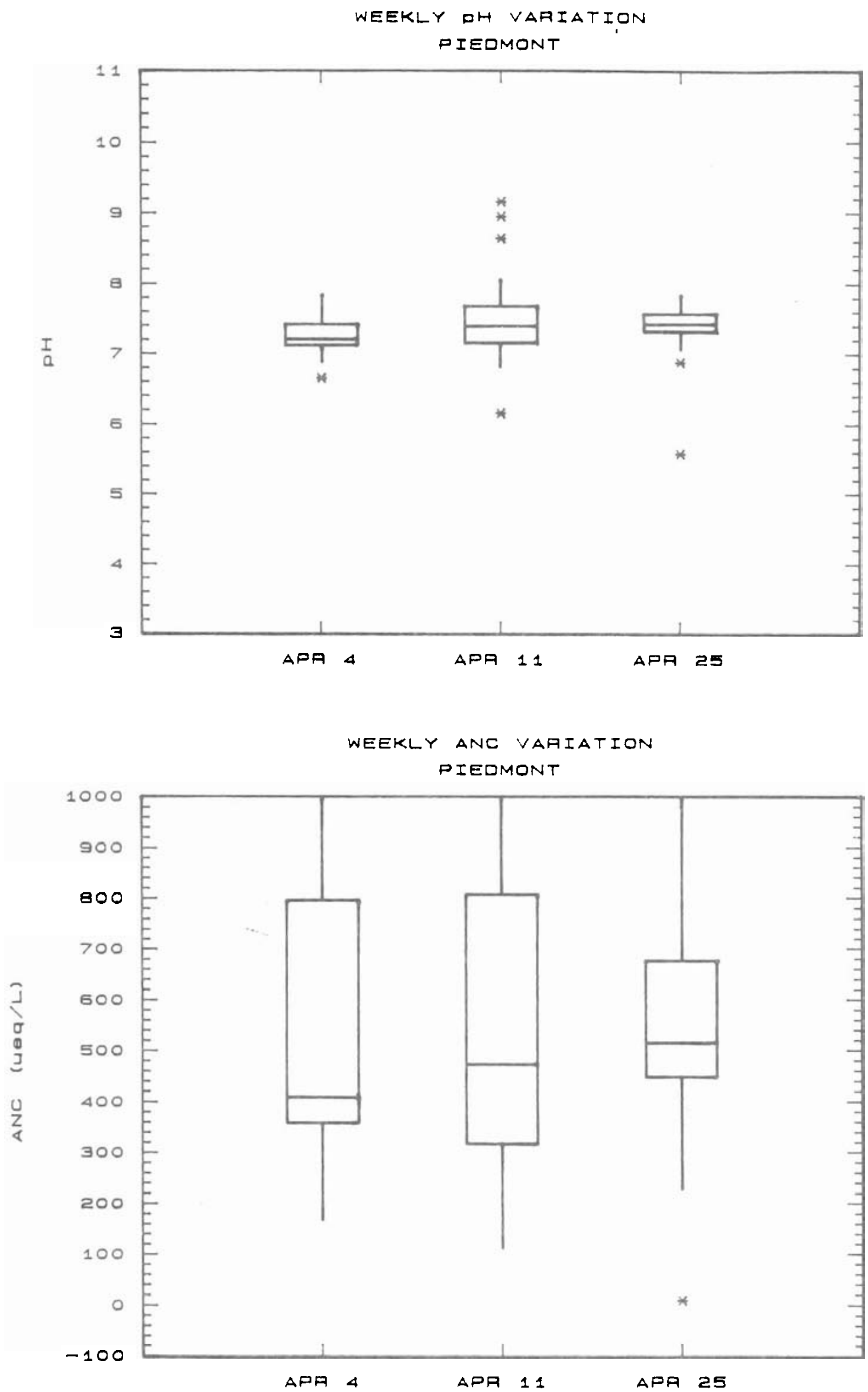


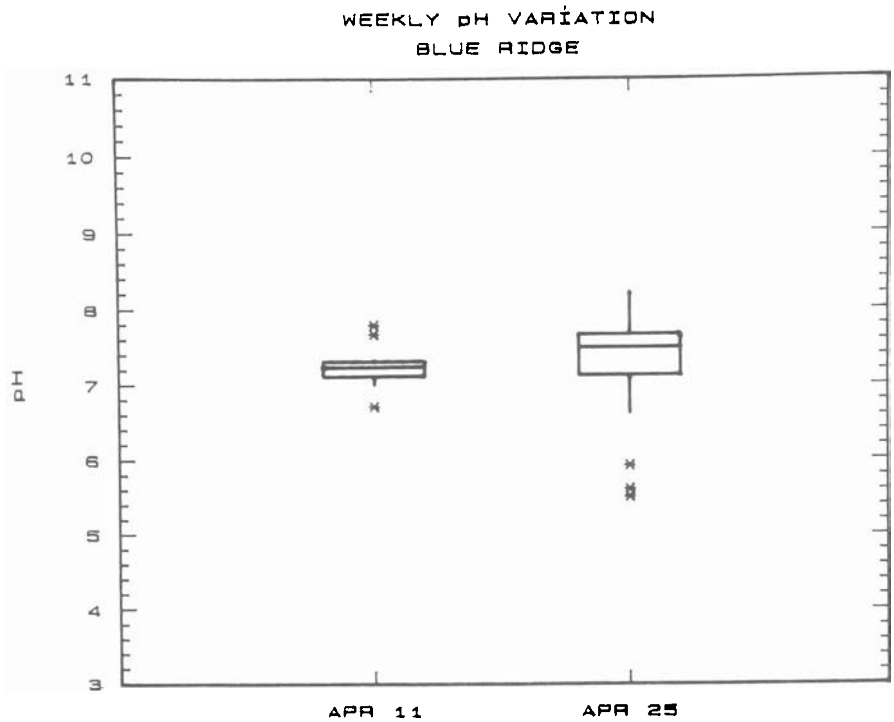
FIGURE III-6. WEEKLY VARIATION IN pH AND ANC OBSERVED IN PIEDMONT STREAMS DURING THE MSSCS. The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.

(Figure III-7), pH and ANC appeared to increase throughout the sampling period. In the Valley and Ridge (Figure III-8) and the Appalachian Plateau strata (Figure III-9), pH did not apparently change, but ANC appeared to decrease from the first to the second week of sampling. Although the reasons for these observed temporal changes in pH and ANC are unknown, they may be due to the seasonal progression of soil and water temperature or other conditions related to the development of spring. Thus, the objective of maintaining phenological constancy during sample collection may not have been achieved.

Precipitation occurred in areas where samples were being collected on four of the nine sample collection dates: March 28, April 4, April 25, and May 2 (Figure III-10 and Figure III-11). With the exception of April 4, precipitation amounts were $\leq$ 0.2 inches at stations in the vicinity of sample collection. On April 4, precipitation from a large frontal system was observed at all of the stations, with the heaviest precipitation occurring in the Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau strata.

Moderate precipitation occurred at Salisbury between the first and second weeks of sample collection in the South Coastal Plain (Figure III-10). Light rain occured at Washington National Airport (DCA) and Baltimore-Washington International Airport (BWI) on March 28, when 7 samples were collected from randomly selected streams in the northwestern portion of the South Coastal Plain (Table II-4). In addition to the South Coastal Plain streams sampled on March 28, 38 randomly selected streams in the northern and western portions of the North Coastal Plain were sampled.

Twenty eight streams in the North Coastal Plain and 38 streams in the Piedmont were sampled on April 4, when 0.5" of rain occured at DCA, and 0.2" occurred at BWI (Figure III-10). Precipitation from this storm continued until April 7.



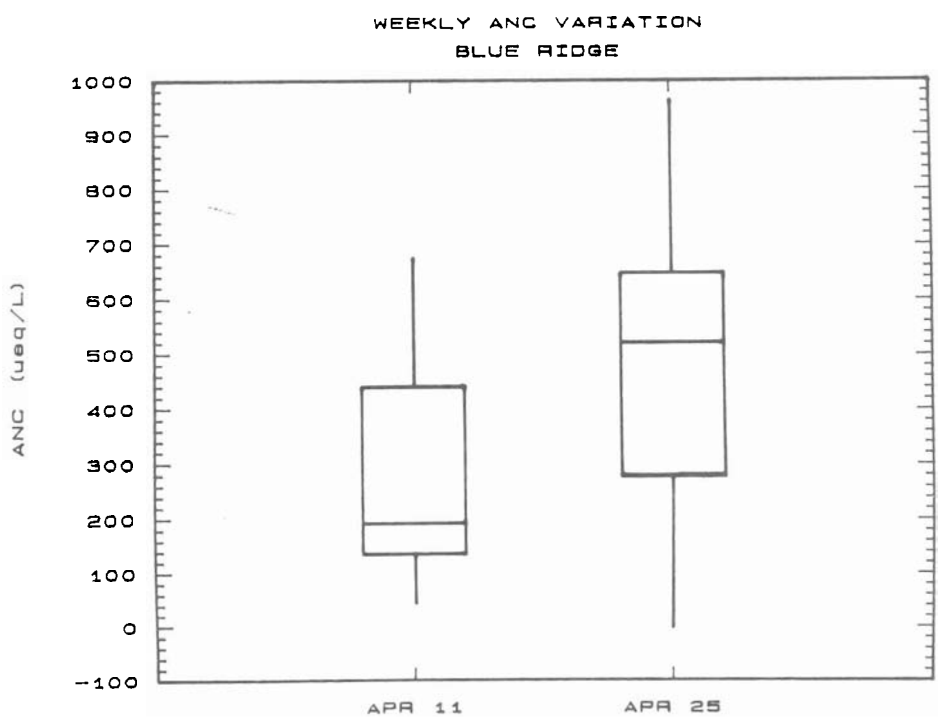


FIGURE III-7. **WEEKLY VARIATION IN pH AND ANC OBSERVED IN BLUE RIDGE STREAMS DURING THE MSSCS.** The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.

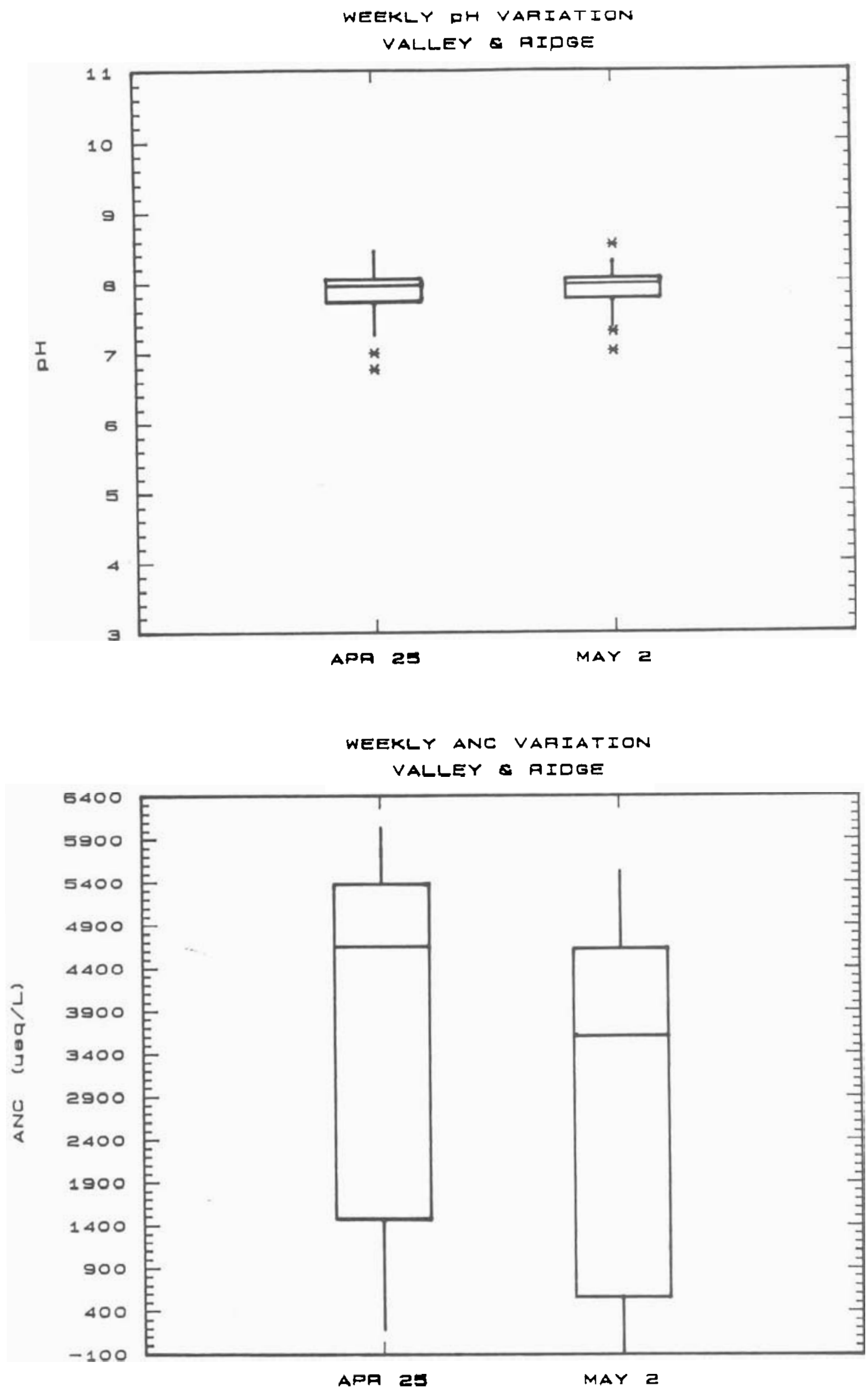
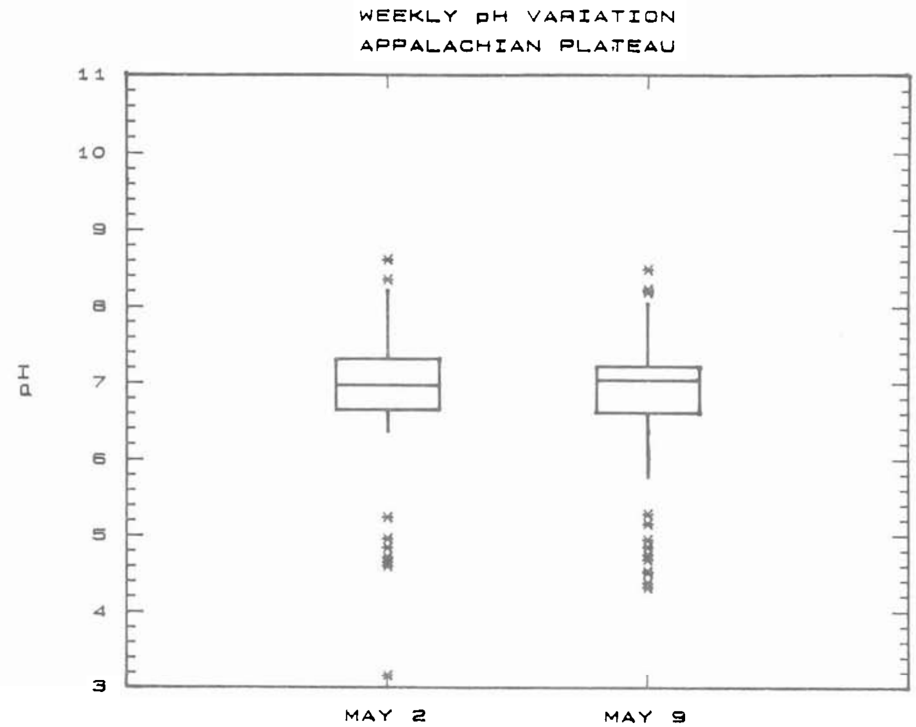


FIGURE III-8. WEEKLY VARIATION IN pH AND ANC OBSERVED IN VALLEY AND RIDGE STREAMS DURING THE MSSCS. The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.



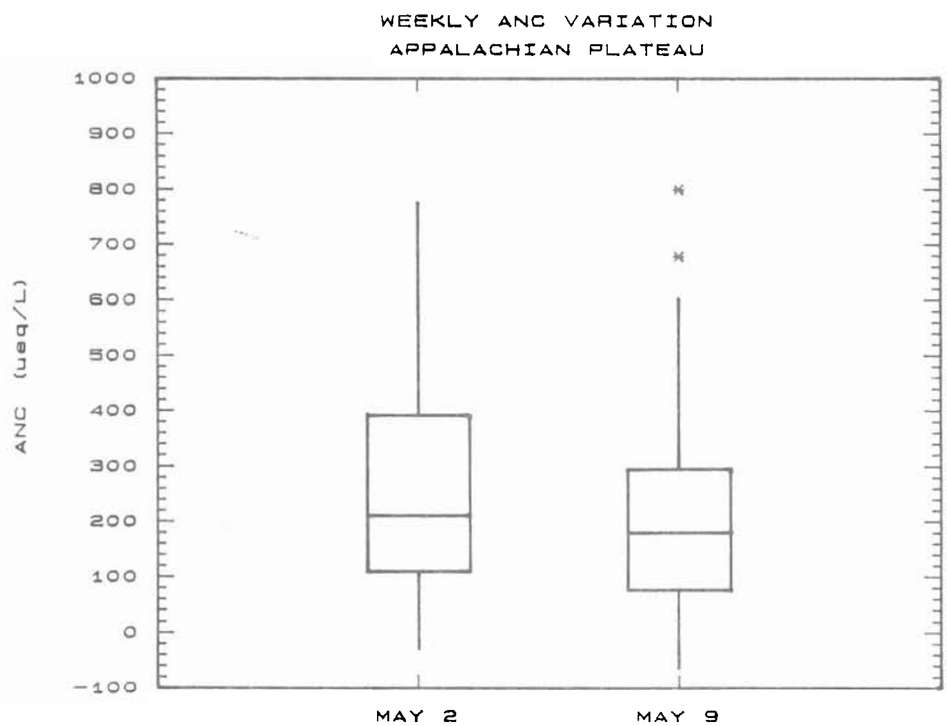


FIGURE III-9. WEEKLY VARIATION IN pH AND ANC OBSERVED IN APPALACHIAN PLATEAU STREAMS DURING THE MSSCS. The horizontal lines inside the boxes, the boxes, and the vertical lines outside the boxes represent the median, upper and lower quartiles, and 1.5 times the interquartile range respectively. Asterisks (*) represent single values beyond 1.5 times the interquartile range.

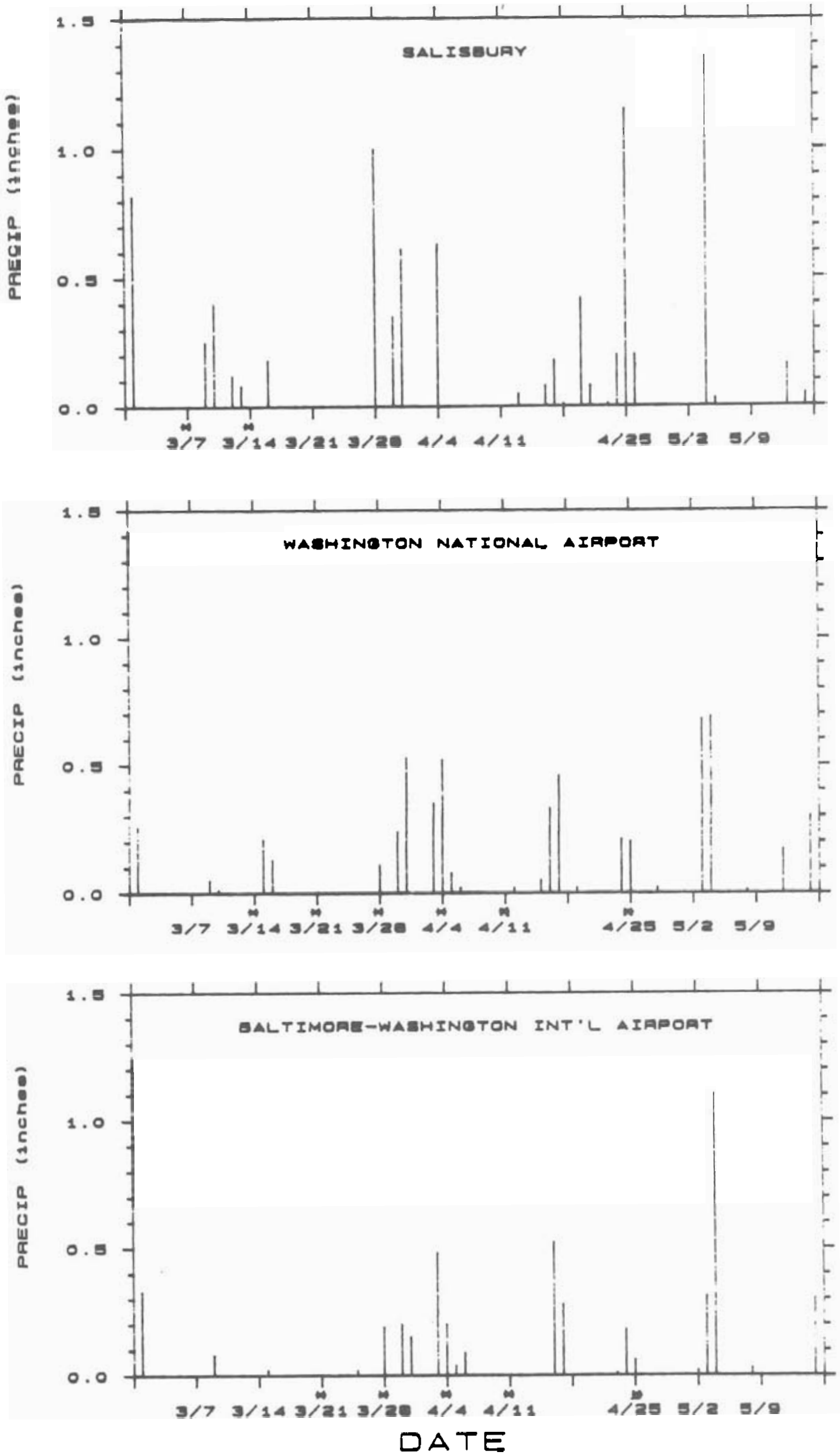


FIGURE III-10. PRECIPITATION AT WEATHER STATIONS IN THE MARYLAND COASTAL PLAIN DURING THE MSSCS. X-axis entries indicate all sample collection dates. Asterisks (*) indicate dates when sampling was conducted in the vicinity of the indicated precipitation station.

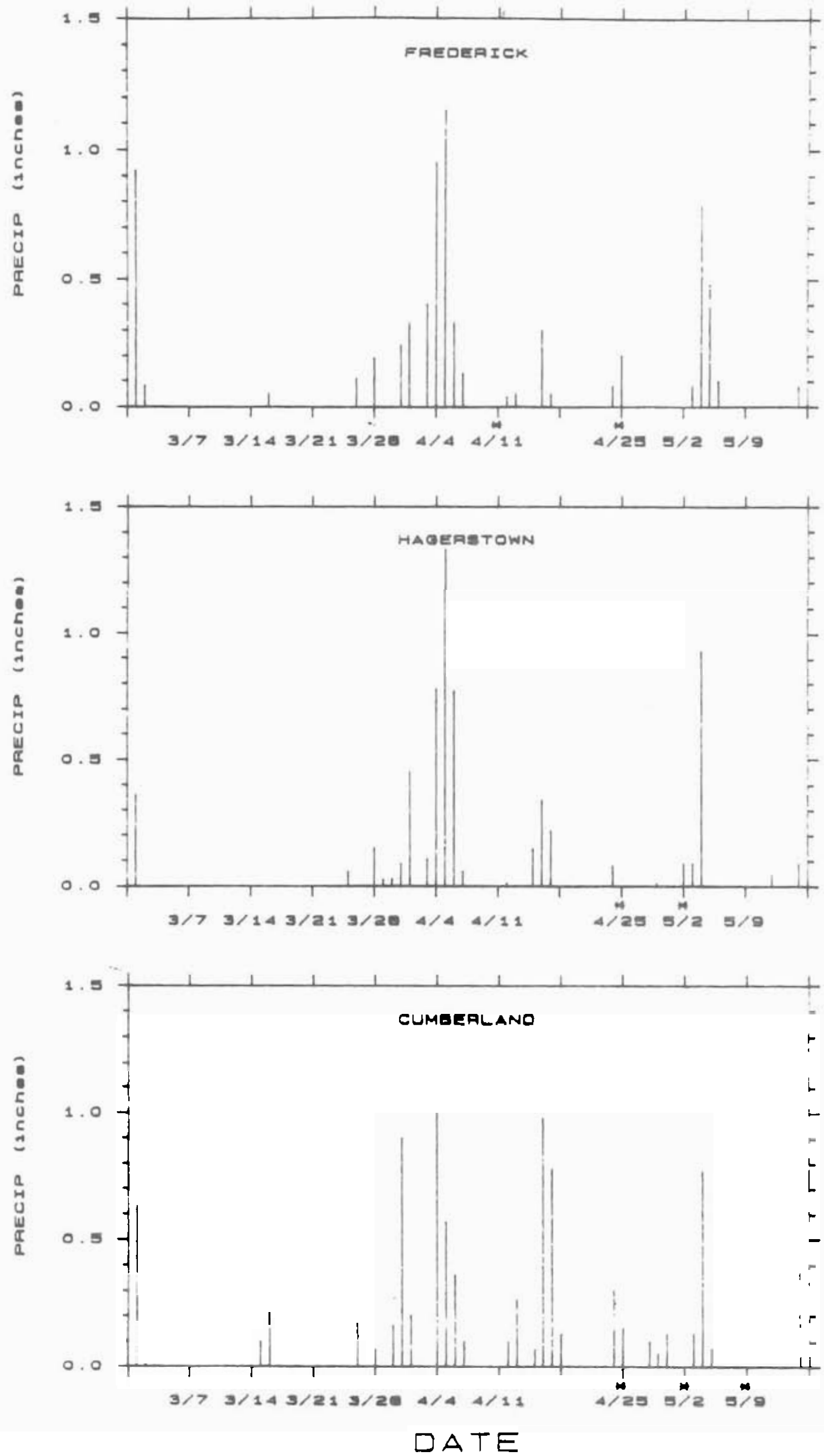


FIGURE III-11. PRECIPITATION AT WEATHER STATIONS IN THE UPLAND AREAS OF MARYLAND DURING THE MSSCS. X-axis entries indicate all sample collection dates. Asterisks (*) indicate dates when sampling was conducted in the vicinity of the indicated precipitation station.

Moderate precipitation occurred in the upland areas (Figure III-11) on April 16 and 17. No samples were collected on April 18, the Saturday of a holiday weekend. Light precipitation occurred on April 25, when 29 streams in the Piedmont, 39 in the Blue Ridge, and 25 in the Valley and Ridge were sampled.

Very light precipitation occurred at one station (Hagerstown) in western Maryland on May 2, when 22 streams in the Valley and Ridge and 62 streams in the Appalachian Plateau were sampled. Moderately heavy precipitation occurred throughout western Maryland on May 4.

Based on this information, the MSSCS data must be considered to represent synoptic stream water chemistry during a variety of conditions that can be expected to occur during spring in Maryland. These data should neither be considered as "worst-case" nor "best-case" results.

Comparison of the dates of precipitation at stations near sample collection activities (Figures III-10 and III-11) with the week-to-week changes in pH and ANC in each stratum (Figures III-4 through III-9) does not indicate an effect of precipitation on distribution of these water quality parameters.

POPULATION ESTIMATES OF ACIDIC AND ACID SENSITIVE STREAMS

Development of population estimates of resources affected by, or at risk from, acidification was the primary objective of the MSSCS. The population estimates also serve to help determine the degree to which the estimated population of interest represents the total population of Maryland stream reaches. In the following sections, population estimates are developed to provide a tool for estimating the resources at risk and for placing those resources in perspective of the total population of non-tidal stream reaches in the state.

Methods

Population Estimators

The proportion of stream reaches with a pH or ANC value less than a specified level was estimated using equations presented below. The variance associated with these estimates was estimated using equations presented in Appendix C. The number of stream reaches in the population of interest had to be estimated because the total number of reaches that satisfied all inclusion criteria (i.e., the population of interest) was not enumerated as part of the sampling design. Rather, only those streams selected at random for field sampling were examined for this purpose. Unbiased estimators for population totals (Pathak, 1976, Kremers and Robson, 1987) are presented below.

For each county-stratum, the number of stream reaches in the population of interest was estimated as:

$$\hat{X}_h = \frac{N_h}{n_h} \sum_{i=1}^{n_h} x_{i,h}$$

where $\hat{X}_h$ = the estimated number of stream reaches in the population of interest in county-stratum h

N_h = the number of stream reaches in the list of streams in county-stratum h

n_h = the number of stream reaches selected at random from the list of streams in county-stratum h

$x_{i,h} = \begin{cases} \text{"1" if reach i in stratum h satisfied all inclusion criteria} \\ \text{"0" otherwise.} \end{cases}$

Stream reaches were selected at random from the reach list until the sum of the x's was equal to the specified number of reaches to be sampled. The number of stream reaches in the population of interest that had pH values less than or equal to a specified level (g) was estimated as:

$$\hat{Y}_h(g) = \frac{N_h}{n_h}\sum_{i=1}^{n_h} y_{i,h}(g)$$

where $\hat{Y}_h(g)$ = the estimated number of stream reaches in the population of interest in stratum h that had pH less than or equal to g

$$y_{i,h}(g) = \begin{cases} \text{"1" if reach i in stratum h satisfied all inclusion criteria and had pH less than or equal to g} \\ \text{"0" otherwise.} \end{cases}$$

These estimates by county-strata were summed as follows to produce estimates for each stratum:

$$\hat{X}_r = \sum_{h \in R} \hat{X}_h$$

$$\hat{Y}_r(g) = \sum_{h \in R} \hat{Y}_h(g)$$

where R = the set of all county-strata within stratum r

$\hat{X}_r$ = the estimated number of stream reaches in the population of interest in stratum r

$\hat{Y}_h(g)$ = the estimated number of stream reaches in the population of interest in stratum r that had pH less than or equal to g.

Similarly, the statewide estimates were computed by summing over all county-strata:

$$\hat{X}_s = \sum_{\text{all } h} \hat{X}_h$$

$$\hat{Y}_s(g) = \sum_{\text{all } h} \hat{Y}_h(g)$$

where $\hat{X}_s$ = the estimated number of stream reaches in the population of interest in the state

$\hat{Y}_s(g)$ = the estimated number of stream reaches in the population of interest in the state that had pH less than or equal to g.

Estimates of the proportion of stream reaches with pH values less than or equal to a specified level (g) were computed for each county-stratum, stratum, and for the state as follows:

$$\hat{P}_h(g) = \frac{\hat{Y}_h(g)}{\hat{X}_h}$$

$$\hat{P}_r(g) = \frac{\hat{Y}_r(g)}{\hat{X}_r}$$

$$\hat{P}_s(g) = \frac{\hat{Y}_s(g)}{\hat{X}_s}$$

where $\hat{P}_h(g)$ = the estimated proportion of stream reaches in the population of interest in county-stratum h with pH less than or equal to g

$\hat{P}_r(g)$ = the estimated proportion of stream reaches in the population of interest in stratum r with pH less than or equal to g

$\hat{P}_s(g)$ = the estimated proportion of stream reaches in the population of interest in the state with pH less than or equal to g.

Confidence limits (95%) for these estimates of the proportions were approximated using the following formulae:

$$\text{UPPER CONFIDENCE LIMIT} = \hat{p} + 2\sqrt{\text{var}(\hat{p})}$$

$$\text{LOWER CONFIDENCE LIMIT} = \hat{p} - 2\sqrt{\text{var}(\hat{p})}$$

where $\text{var}(\hat{p})$ = the estimated variance of the estimated proportion.

A similar approach was used to estimate reach length distribution and confidence limits. The variance of each estimate of proportion was computed using the formulae presented in Appendix C.

These formulae produce slight underestimates of the true variance. The magnitude of underestimation for each county-stratum is equal to the measurement error (i.e., the variance among field duplicates and among laboratory duplicates) divided by the number of stream reaches in the list frame for the county-stratum. Consequently, variance estimates for county-strata with few reaches will be biased downward more than for county-strata with many reaches. The magnitude of measurement errors is discussed in Appendix B.

Representativeness of the Estimates

The distribution of stream sizes included in the population of interest was compared to the statewide distribution of stream sizes by estimating the numbers of stream reaches in different drainage length and reach order classes in the population of interest and comparing the resulting frequency distribution to the known distribution of those characteristics for the entire stream reach population.

Results

Estimates of Number and Extent of Acidic and Acid Sensitive Streams

The results of the population estimation process are presented as cumulative frequency curves. Detailed tables containing the information from which these curves were developed are presented in Appendix D. Figure III-12 illustrates how to interpret these curves:

1. The parameter value of interest (in this example a pH of 6.3) is selected and a line is extended from that point on the x-axis (abscissa) perpendicularly to its intersection with the frequency curve.

2. From the intersection point on the frequency curve, a line is extended parallel to the x-axis until it intersects the y-axis (ordinate). The value at that point on the y-axis is the estimated number (or length, or percentage, as appropriate) of stream reaches having a pH less than or equal to 6.3.

3. The upper and lower confidence limits are determined in an analogous manner, using the lower dashed line to determine the lower confidence limit, and the upper dashed line to determine the upper confidence limit.

Statewide, the estimated population of interest comprises 5411 reaches with a total length of 12,499 km. Reasonably precise population estimates of the number and percentage of stream reaches and the number and percentage of stream kilometers were obtained, as indicated by the 95 percent confidence intervals (Figures III-13 through III-16). The majority of stream reaches and kilometers were estimated to have pH values greater than 7.0.

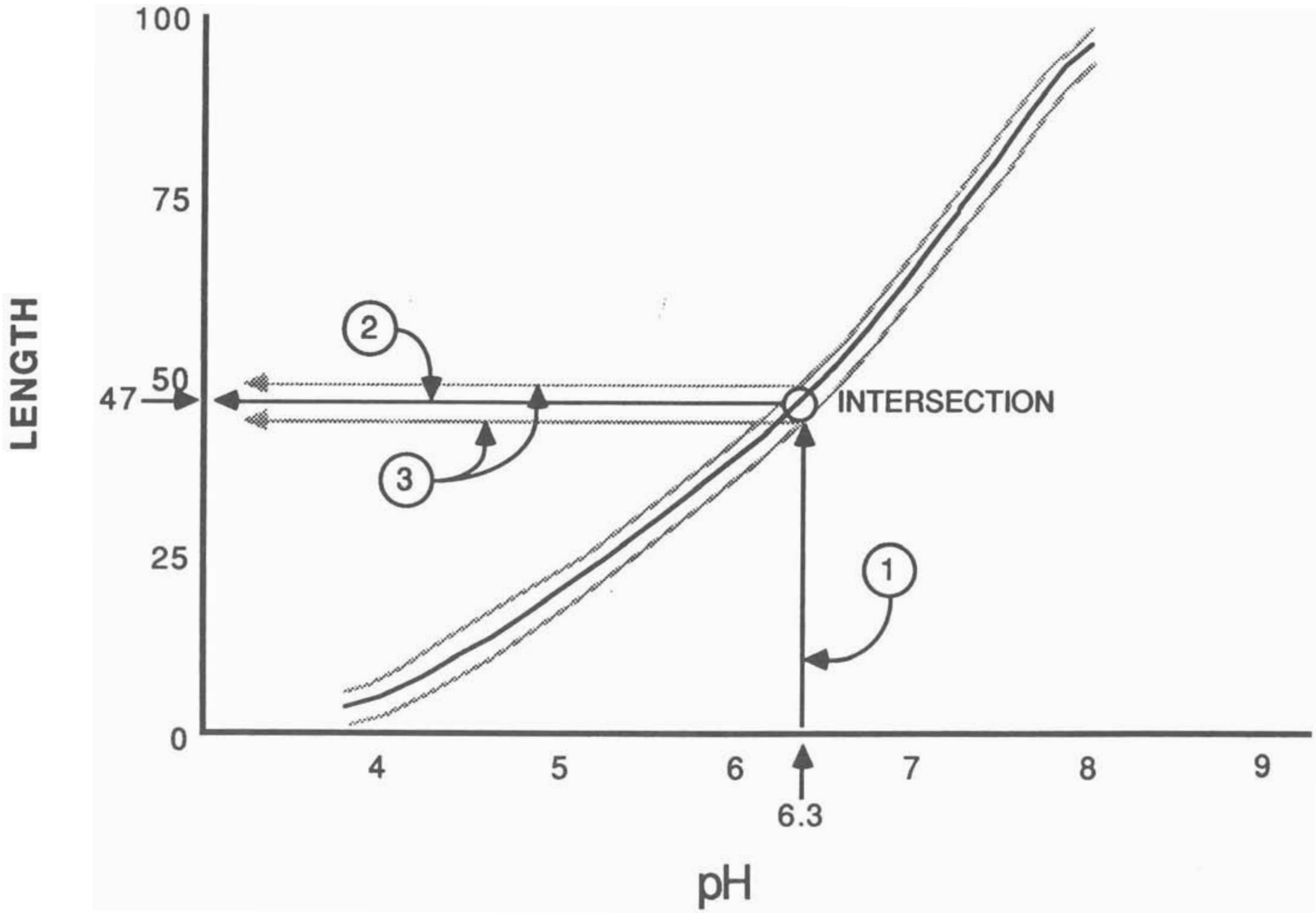


FIGURE III-12. EXAMPLE OF THE INTERPRETATION OF CUMULATIVE FREQUENCY DISTRIBUTION CURVES. (See text for explanation.)

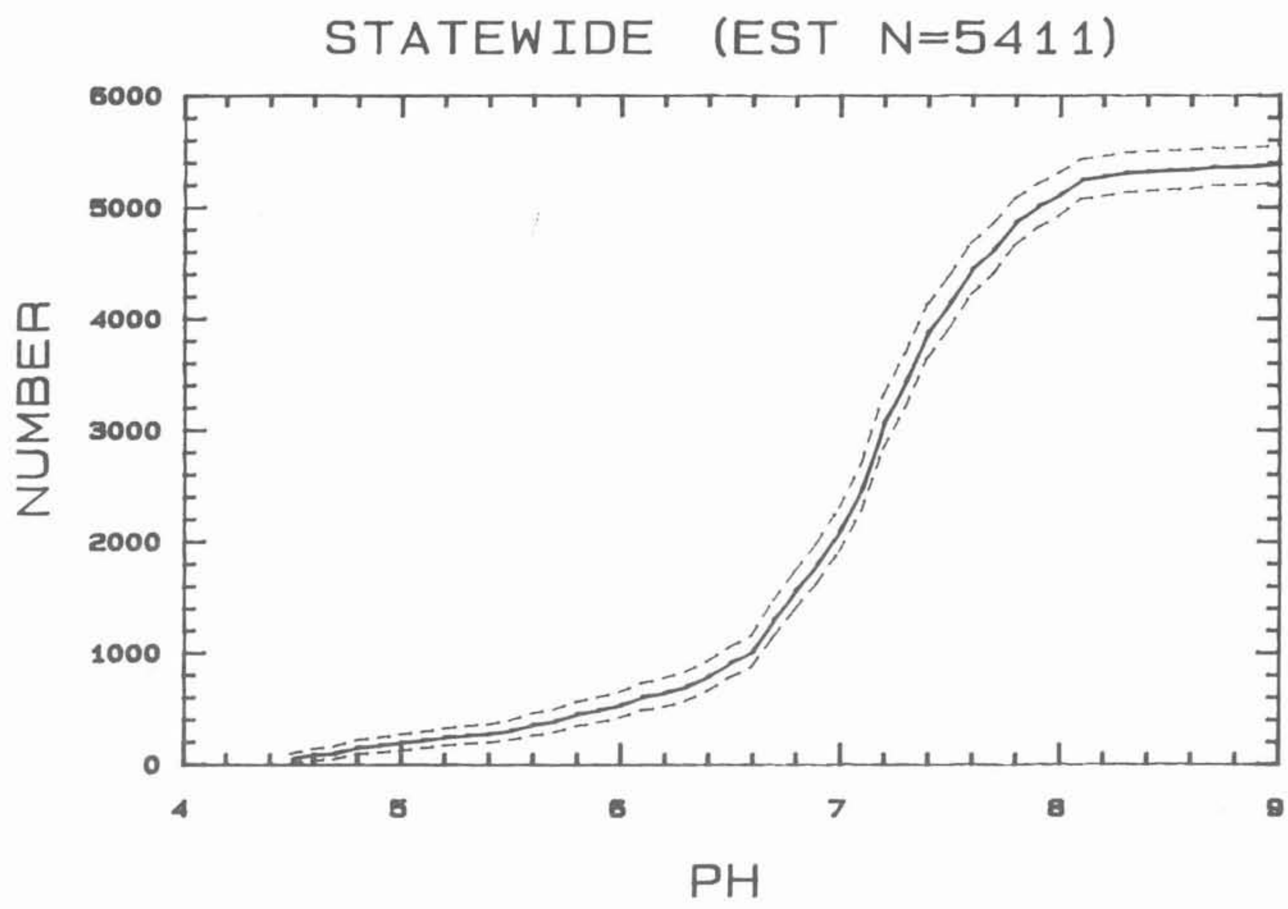


FIGURE III-13. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR PH VS. THE ESTIMATED NUMBER OF REACHES IN THE STATEWIDE POPULATION OF INTEREST. The estimate is represented by the solid line (____). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

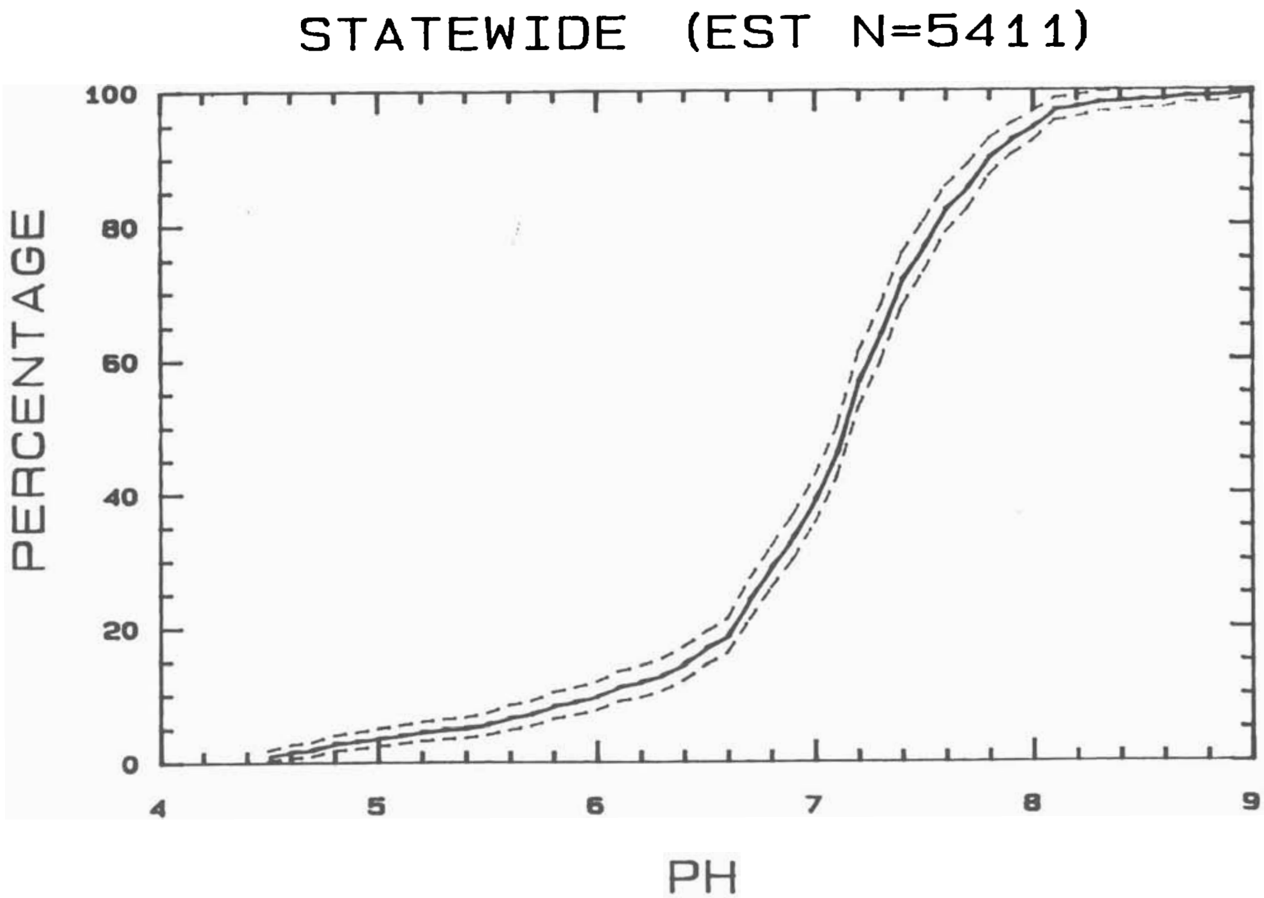


FIGURE III-14. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR PH VS. THE ESTIMATED PERCENTAGE OF REACHES IN THE STATEWIDE POPULATION OF INTEREST. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

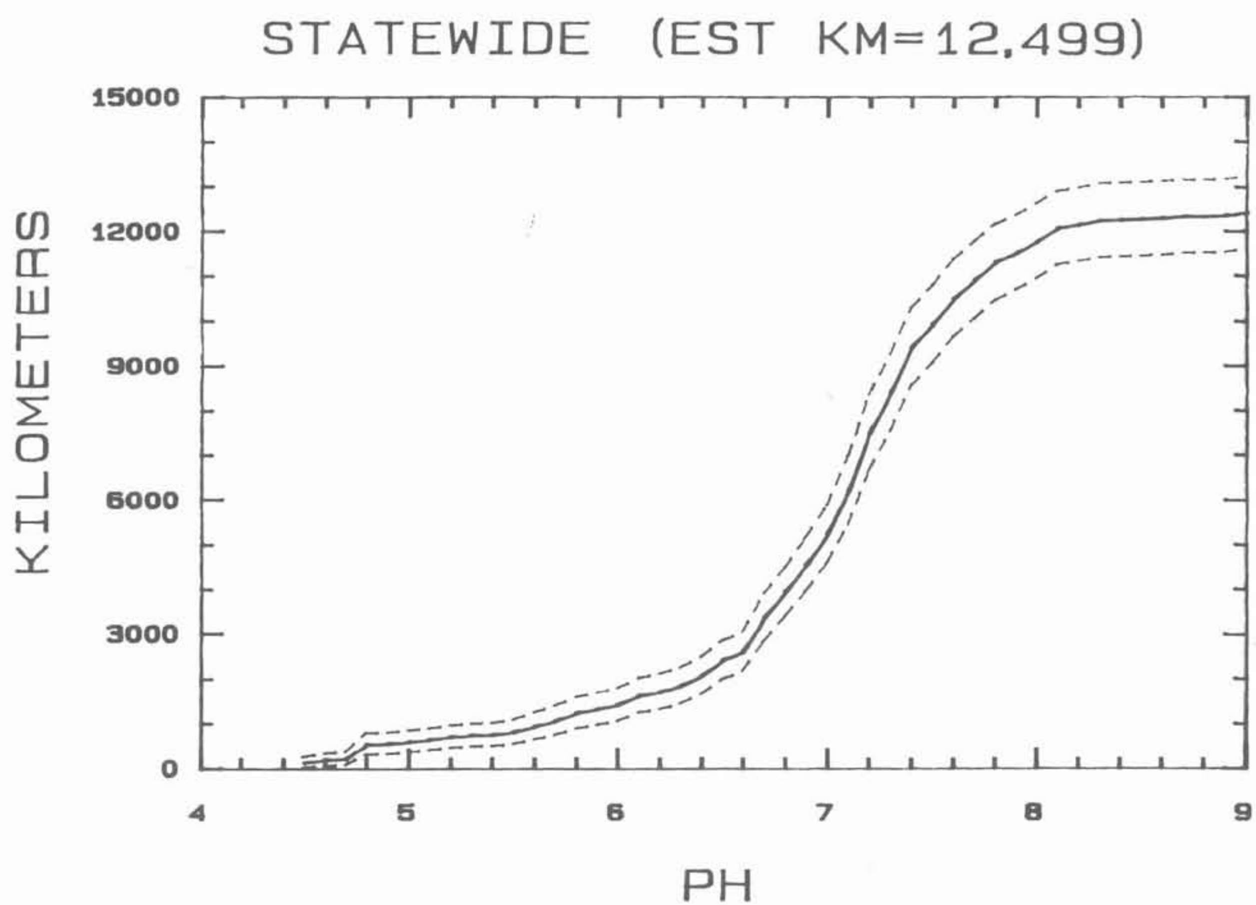


FIGURE III-15. **CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR PH VS. THE ESTIMATED TOTAL LENGTH OF REACHES IN THE STATEWIDE POPULATION OF INTEREST.** The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

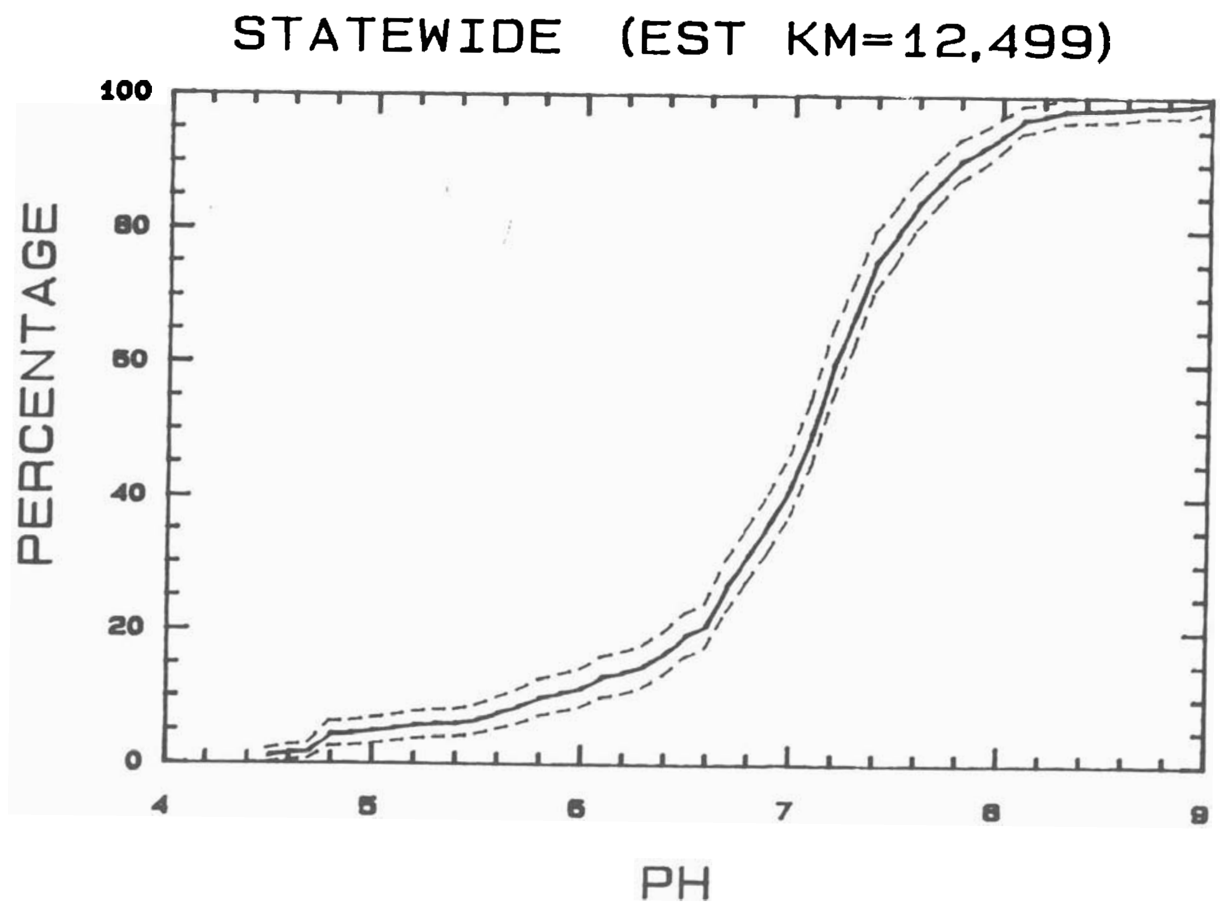


FIGURE III-16. **CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR PH VS. THE ESTIMATED PERCENTAGE OF TOTAL REACH LENGTH IN THE STATEWIDE POPULATION OF INTEREST.** The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

Comparison of stratum-specific population estimates for pH (Figures III-17 through III-20) reveals that the South Coastal Plain had significantly larger numbers and higher proportions of reaches and stream kilometers with low pH than did any other stratum. Of an estimated 932 stream reaches (2644 km) in the South Coastal Plain, an estimated 101 (10.8%) had pH values $\leq$ 5.0, and 318 (34.1%) had pH values $\leq$ 6.0. This corresponds to estimates of 374 and 902 km of streams at or below pH 5.0 and 6.0, respectively.

The Appalachian Plateau had the second highest proportion of low-pH stream reaches. In this stratum, the population of interest was estimated to comprise 1153 reaches (1917 km). Six percent (74 reaches, comprising 186 km) were estimated to have pH values $\leq$ 5.0; and 8.6 percent (99 reaches, comprising 223 km) were estimated to have pH values $\leq$ 6.0.

The North Coastal Plain and the Blue Ridge had similar proportions of stream reaches with low pH values. In the North Coastal Plain, few reaches with pH $\leq$ 5.0 were estimated to occur (22 reaches, comprising 48 km or 2.9 % of all reaches). No reaches with pH $\leq$ 5.0 were estimated to occur in the Blue Ridge. The estimated number of reaches with pH values $\leq$ 6.0 was 11 (6.8 percent, comprising 14 km) in the Blue Ridge, and 84 (9.2 percent, comprising 235 km) in the North Coastal Plain.

As expected, few low-pH reaches were estimated to occur in the Piedmont; no reaches are expected to have pH values $\leq$ 5.0, and only an estimated 20 reaches (1.0 percent, comprising 46 km) are expected to have pH values $\leq$ 6.0. In the Valley and Ridge stratum, no low-pH reaches are likely to be found.

Reasonably precise estimates of the statewide distribution of numbers and percentage of stream reaches and number and percentages of stream kilometers also were obtained for ANC (Figures III-21 through III-24). Over 1700 reaches (32%) and over 4100 kilometers throughout the State were estimated to have ANC values $\leq$ 200 ueq L^{-1}.

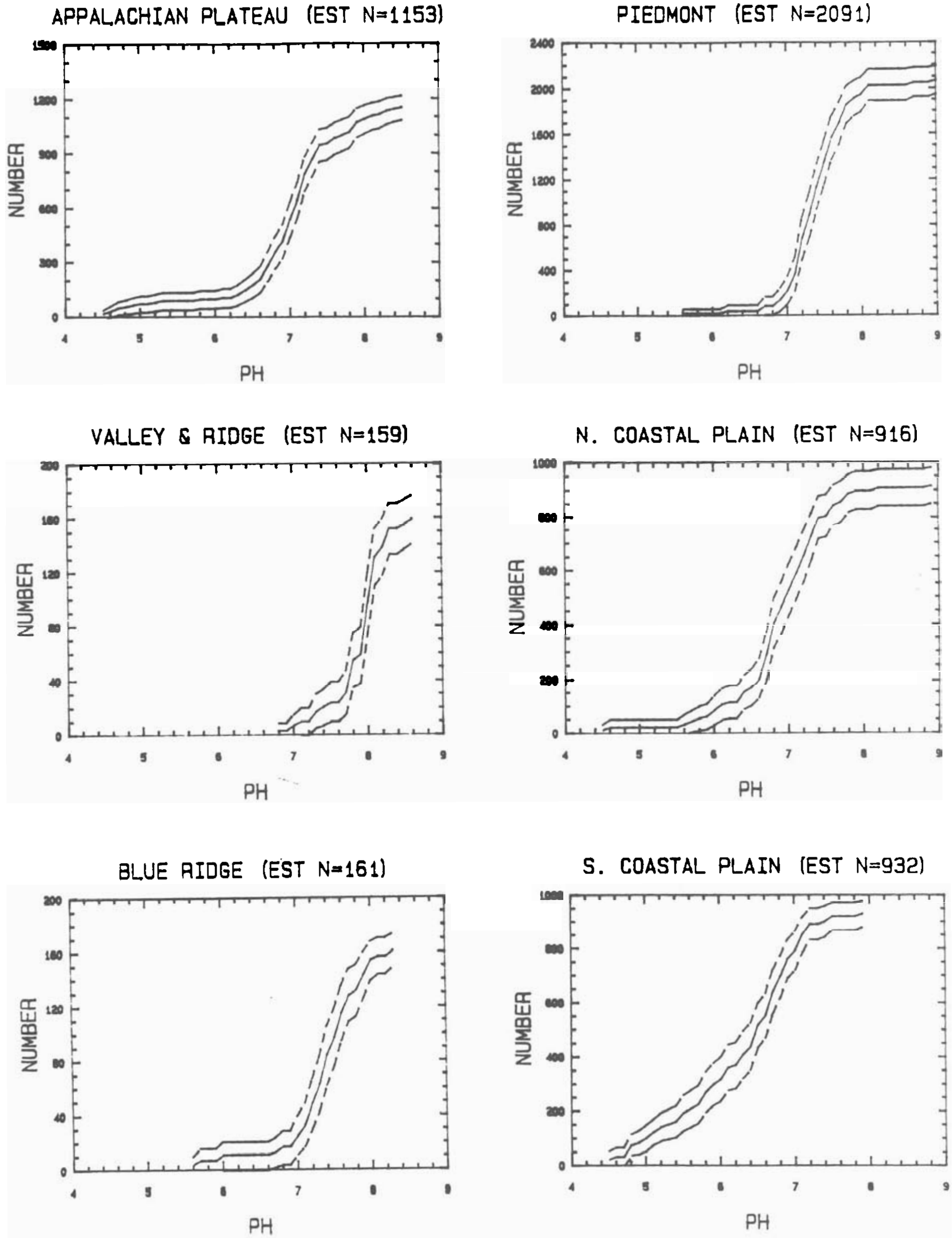


FIGURE III-17. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR PH VS. THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

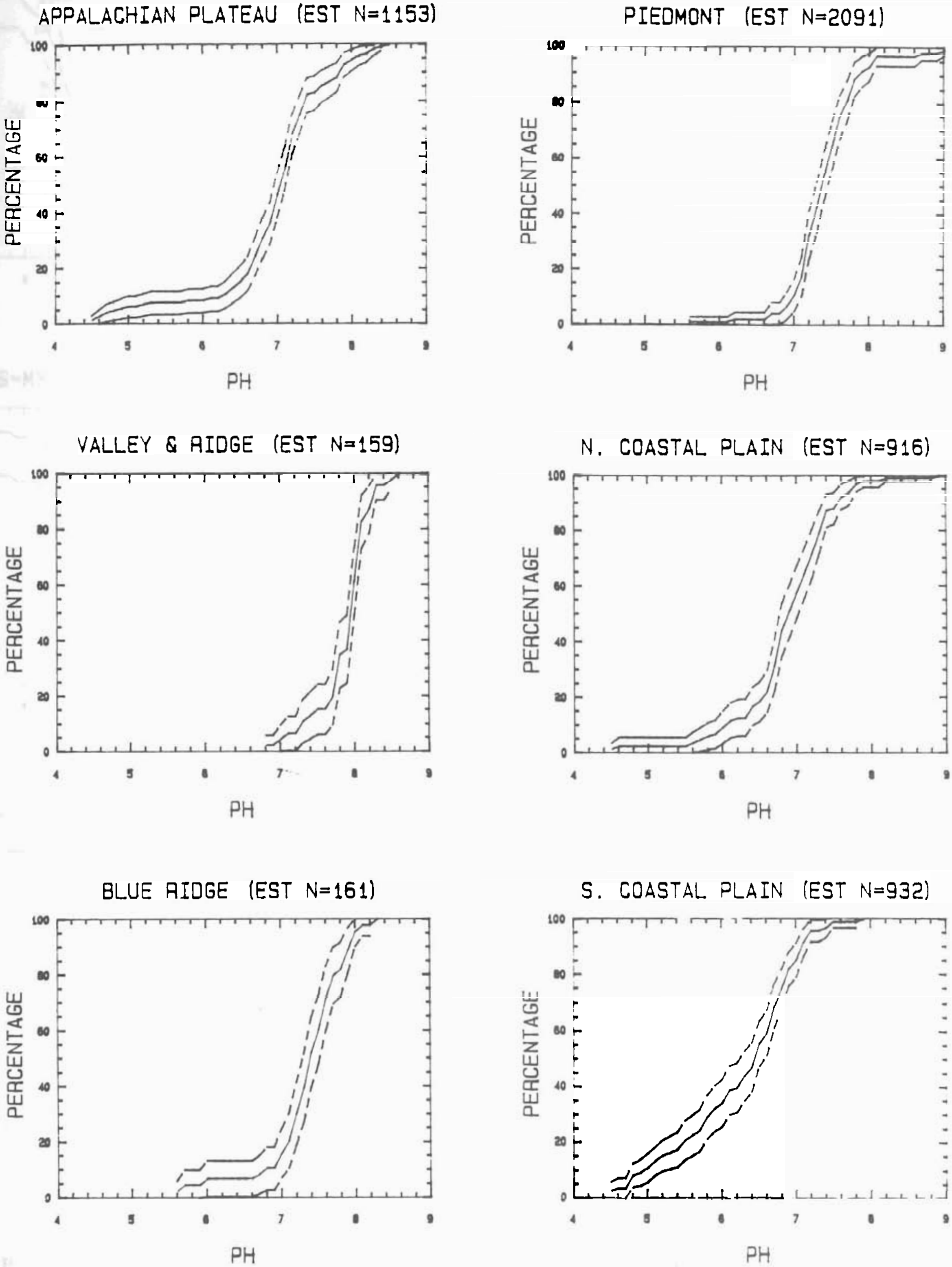


FIGURE III-18. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR PH VS. THE ESTIMATED PERCENTAGE OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

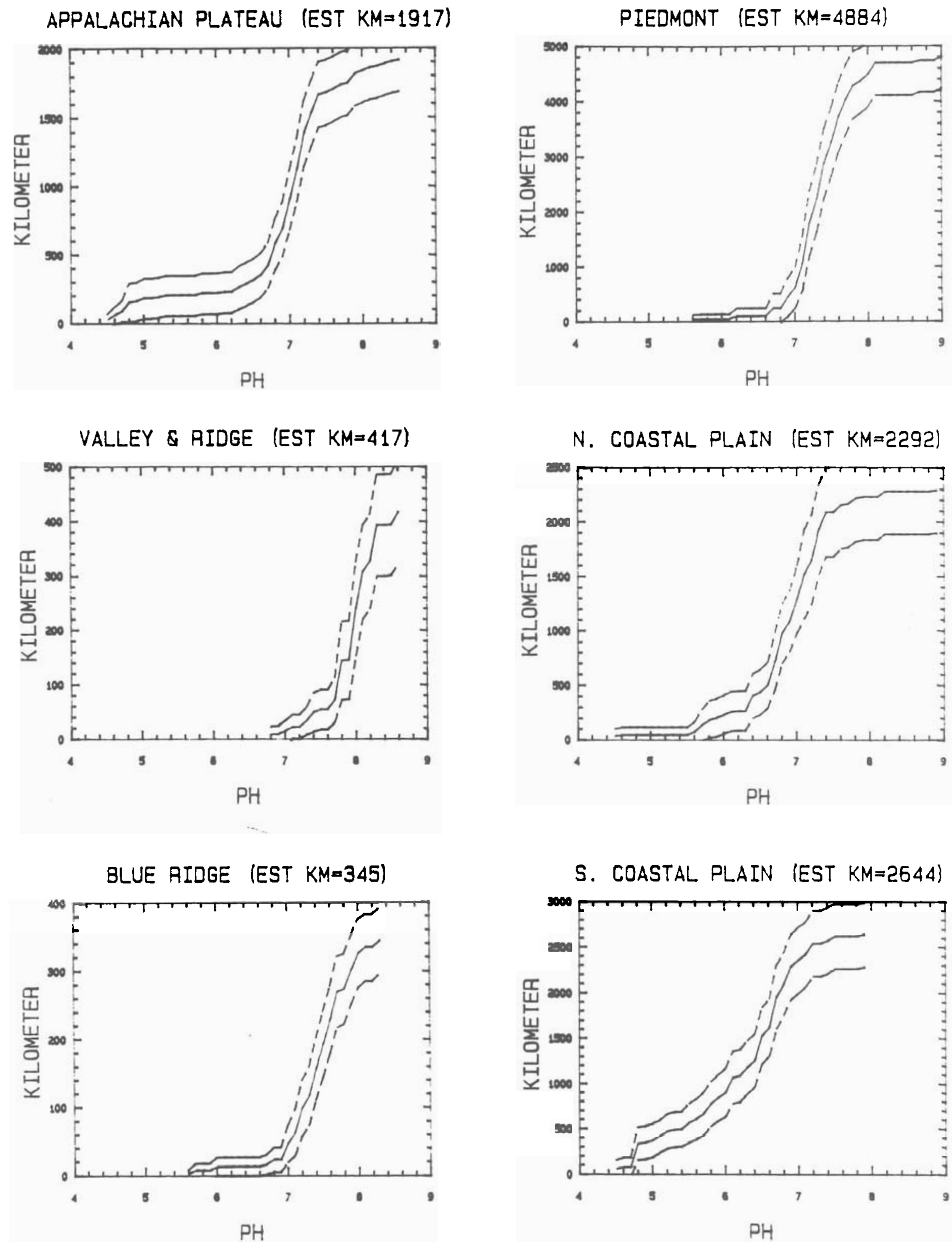


FIGURE III-19. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR PH VS. THE ESTIMATED TOTAL LENGTH OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (———). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

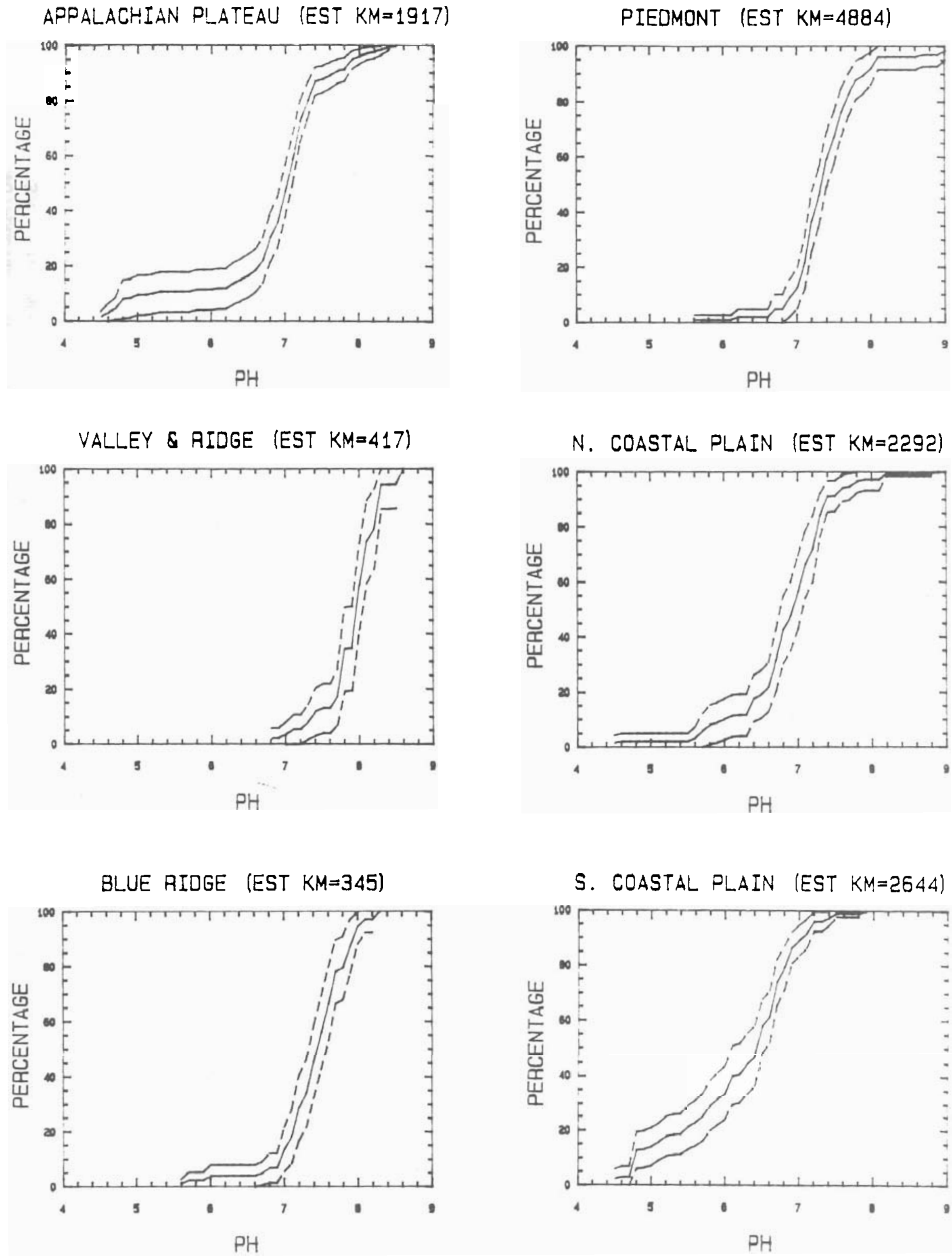


FIGURE III-20. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR PH VS. THE ESTIMATED PERCENTAGE OF TOTAL REACH LENGTH IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (____). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

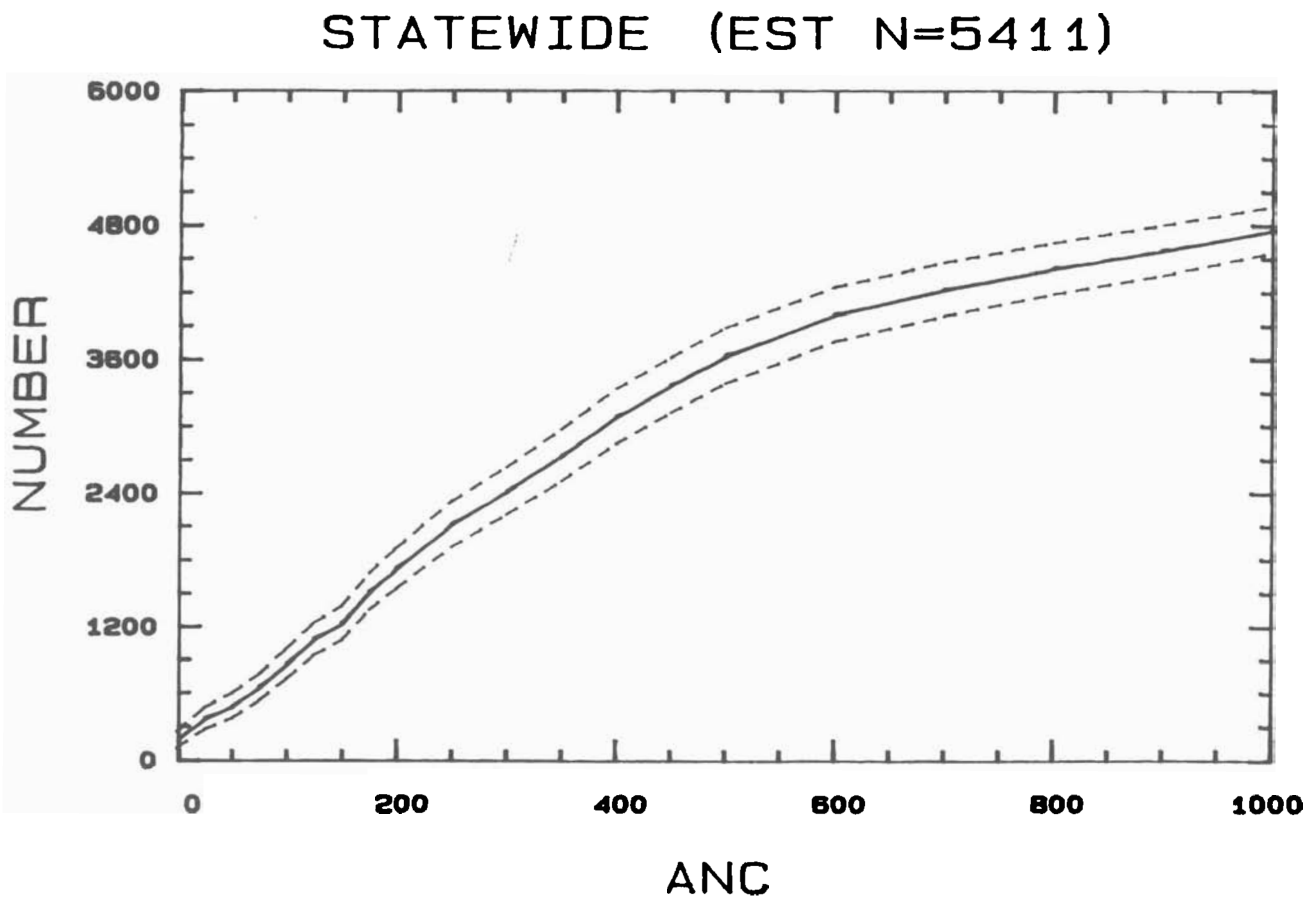


FIGURE III-21. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR ANC VS. THE ESTIMATED NUMBER OF REACHES IN THE STATEWIDE POPULATION OF INTEREST. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

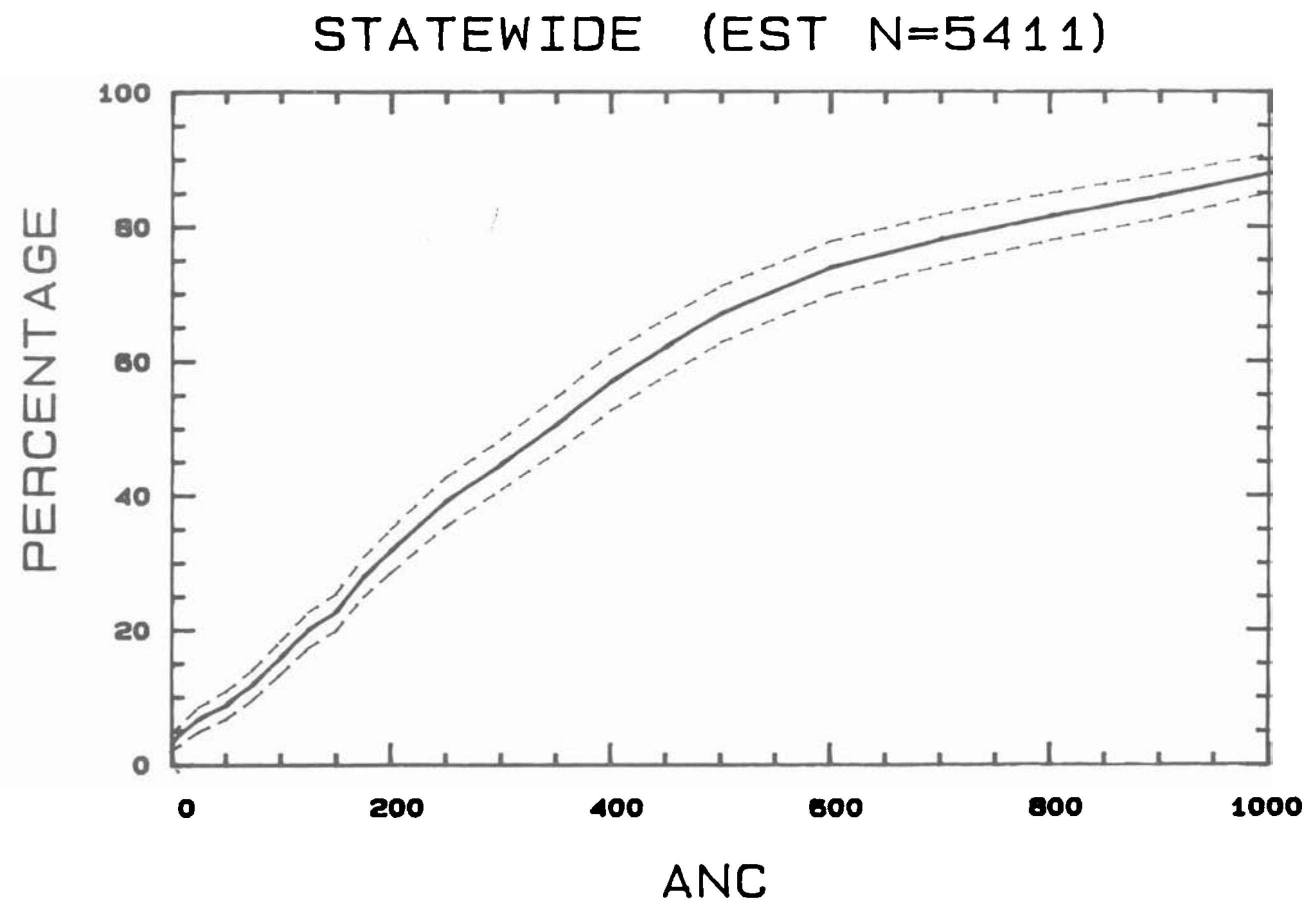


FIGURE III-22. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR ANC VS. THE ESTIMATED PERCENTAGE OF REACHES IN THE STATEWIDE POPULATION OF INTEREST. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

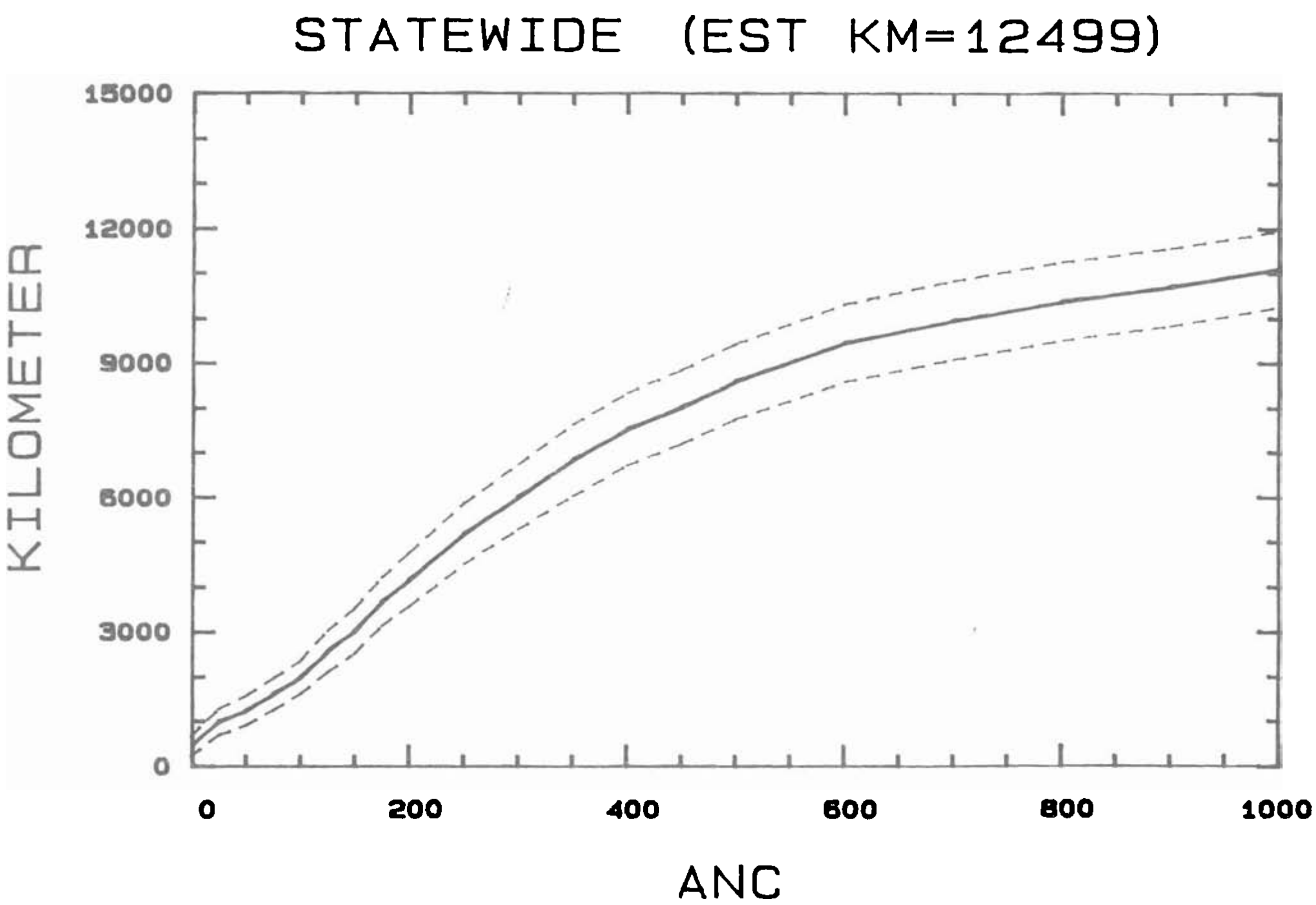


FIGURE III-23. **CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR ANC VS. THE ESTIMATED TOTAL LENGTH OF REACHES IN THE STATEWIDE POPULATION OF INTEREST.** The estimate is represented by the solid line (____). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

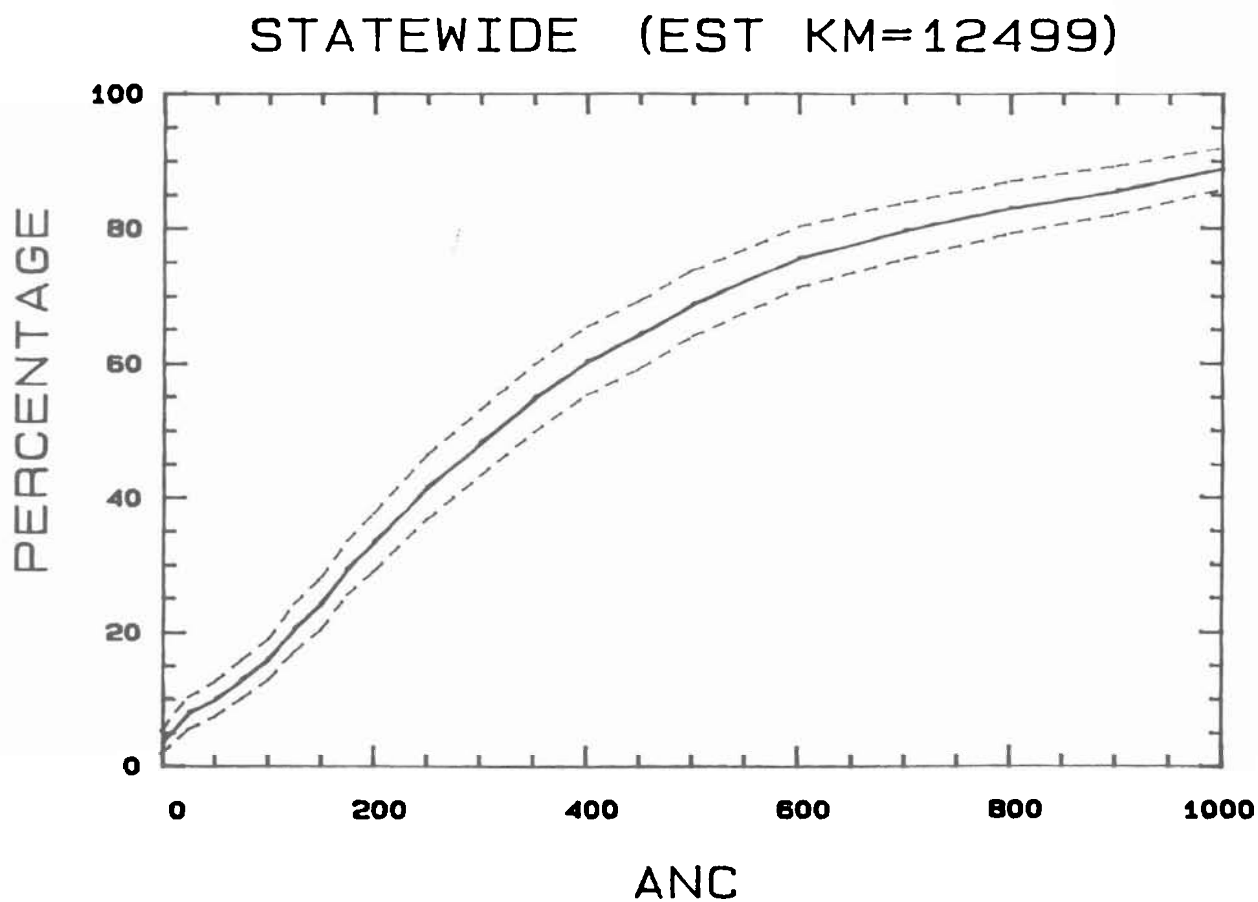


FIGURE III-24. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION FOR ANC VS. THE ESTIMATED PERCENTAGE OF TOTAL REACH LENGTH IN THE STATEWIDE POPULATION OF INTEREST. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

Comparisons of stratum-specific population estimates (Figures III-25 through III-28) for ANC again indicate that the South Coastal Plain had significantly larger estimated numbers and proportions of reaches and stream kilometers with low ANC than any other stratum. Over 25 percent of South Coastal Plain reaches (268 reaches, comprising 775 km) were estimated to have ANC $\leq$ 50 ueq L^{-1}, and nearly 75 percent (686 reaches, comprising 1967 km) were estimated to have ANC $\leq$ 200 ueq L^{-1}.

In the Appalachian Plateau, nearly 150 reaches (12.9 percent, comprising 301 km) were estimated to have ANC values $\leq$ 50 ueq L^{-1}, while nearly 600 reaches (51.9 percent, comprising 1022 km) were estimated to have ANC values below 200 ueq L^{-1}.

As for pH, ANC estimates for the North Coastal Plain and the Blue Ridge were similar. Few streams in the Piedmont were estimated to have relatively low ANC values. Very few streams in the Valley and Ridge were estimated to have relatively low ANC.

Representativeness of the Population of Interest

The estimated proportion of the total number of reaches in each stratum that is included in the population of interest ranges from 82.6 percent in the Blue Ridge stratum to 71.3 percent in the Valley and Ridge stratum (Table III-20). The estimated statewide average is 78.7 percent. The estimated proportion of total reach kilometers in a stratum that is represented in the population of interest ranges from 96.7 percent in the South Coastal Plain to 73.4 percent in the Valley and Ridge. The estimated statewide average is 87 percent of all reach kilometers.

Figures III-29 through III-31 present comparisons between the total population and the estimated population of interest for Strahler order, Shreve order, and drainage length, respectively. Distributions of the hydrologic measures presented in this analysis reflect the use of a 100 km^2 exclusion criterion for the maximum watershed size. In each frequency distribution, there is a point at which the relative difference between the total population and the population of interest diverge

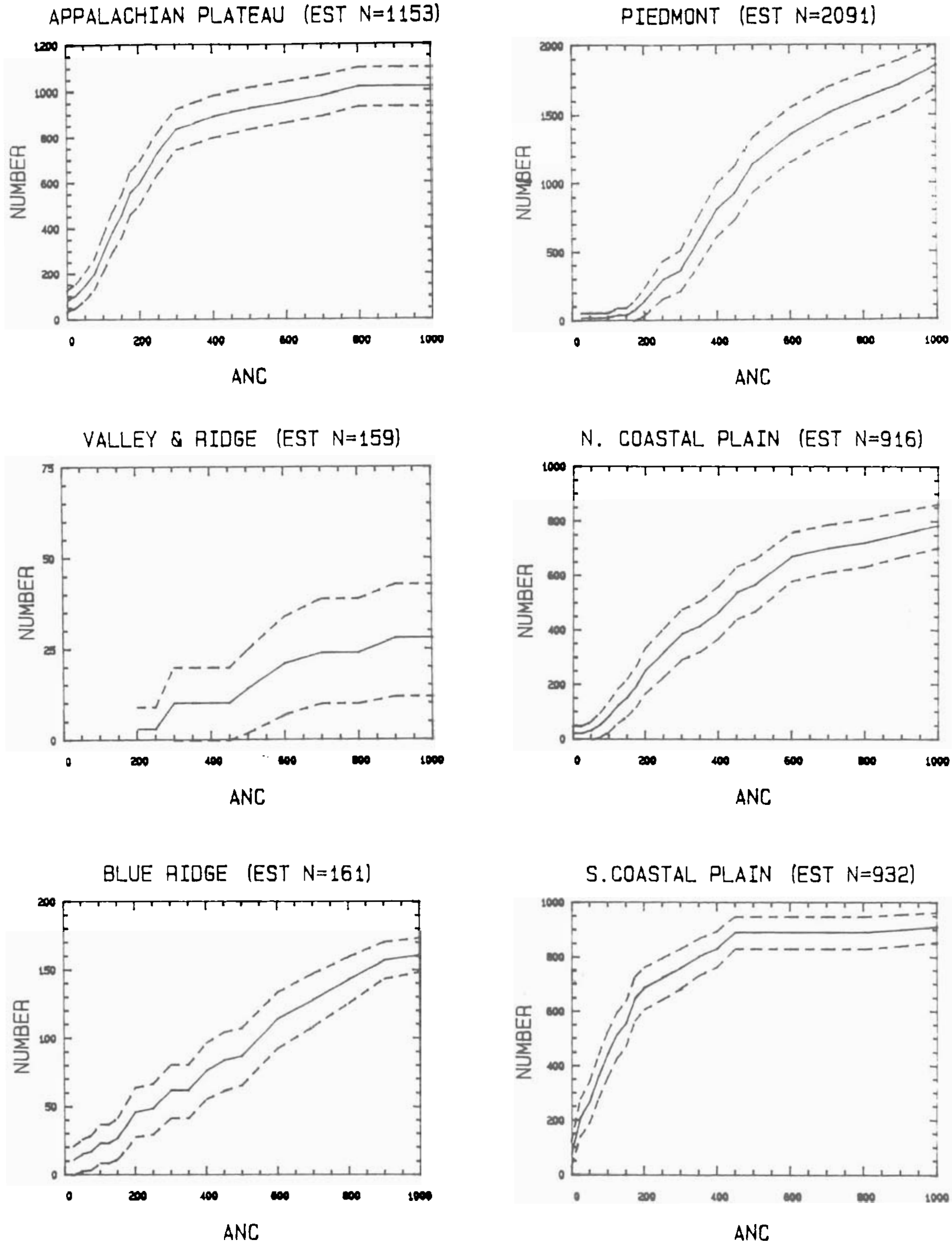


FIGURE III-25. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR ANC VS. THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (____). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

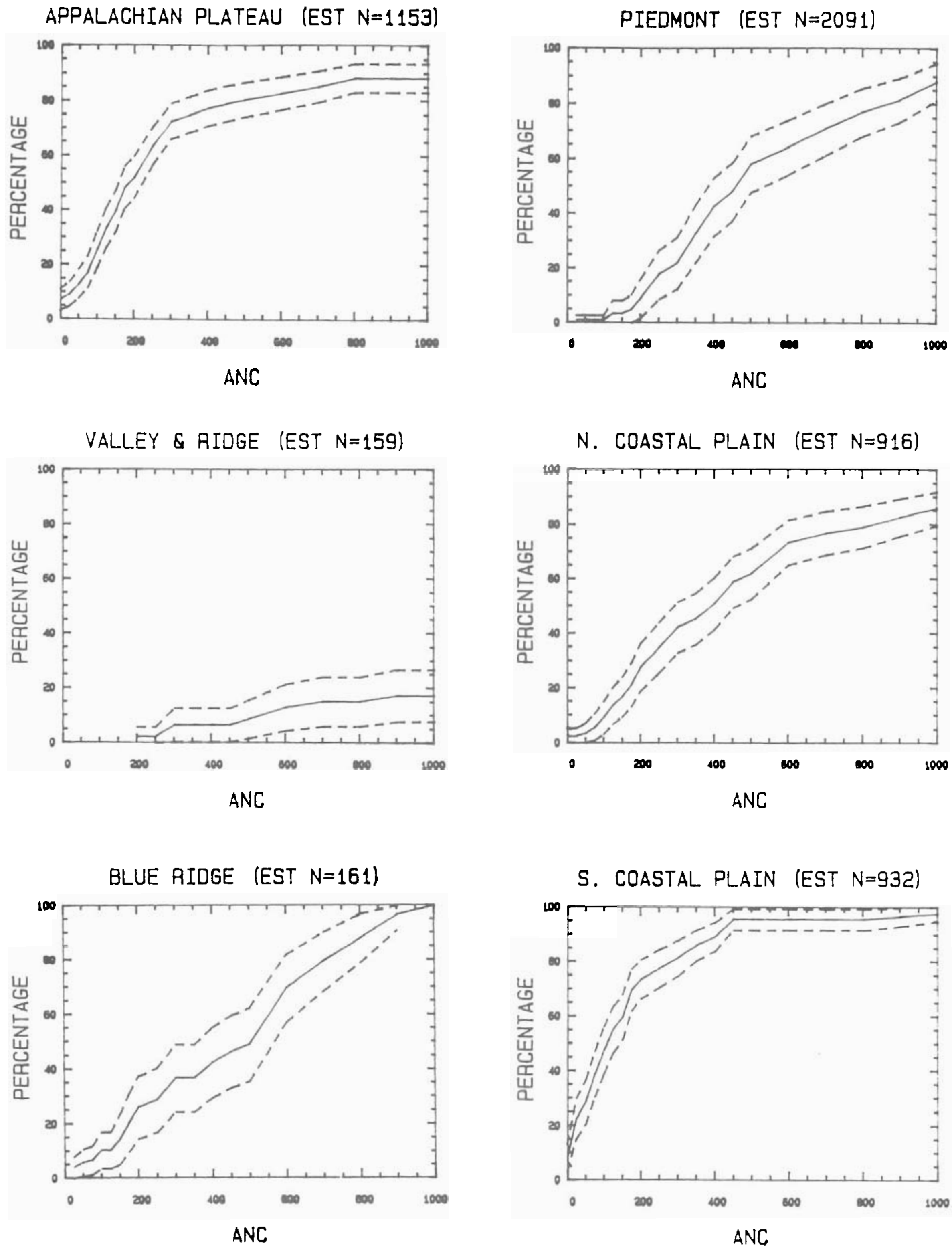


FIGURE III-26. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR ANC VS. THE ESTIMATED PERCENTAGE OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (———). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

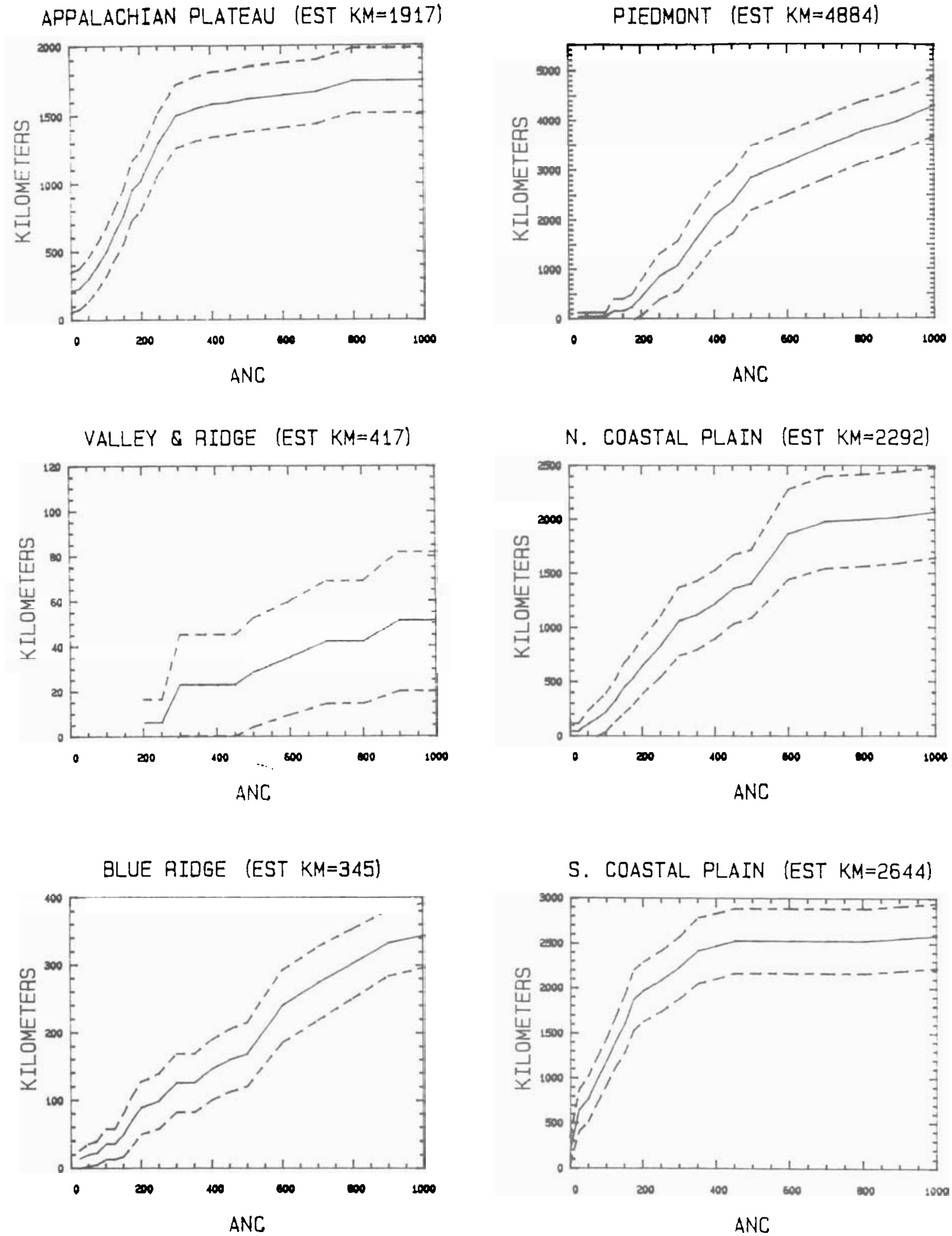


FIGURE III-27. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR ANC VS. THE ESTIMATED TOTAL LENGTH OF REACHES IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

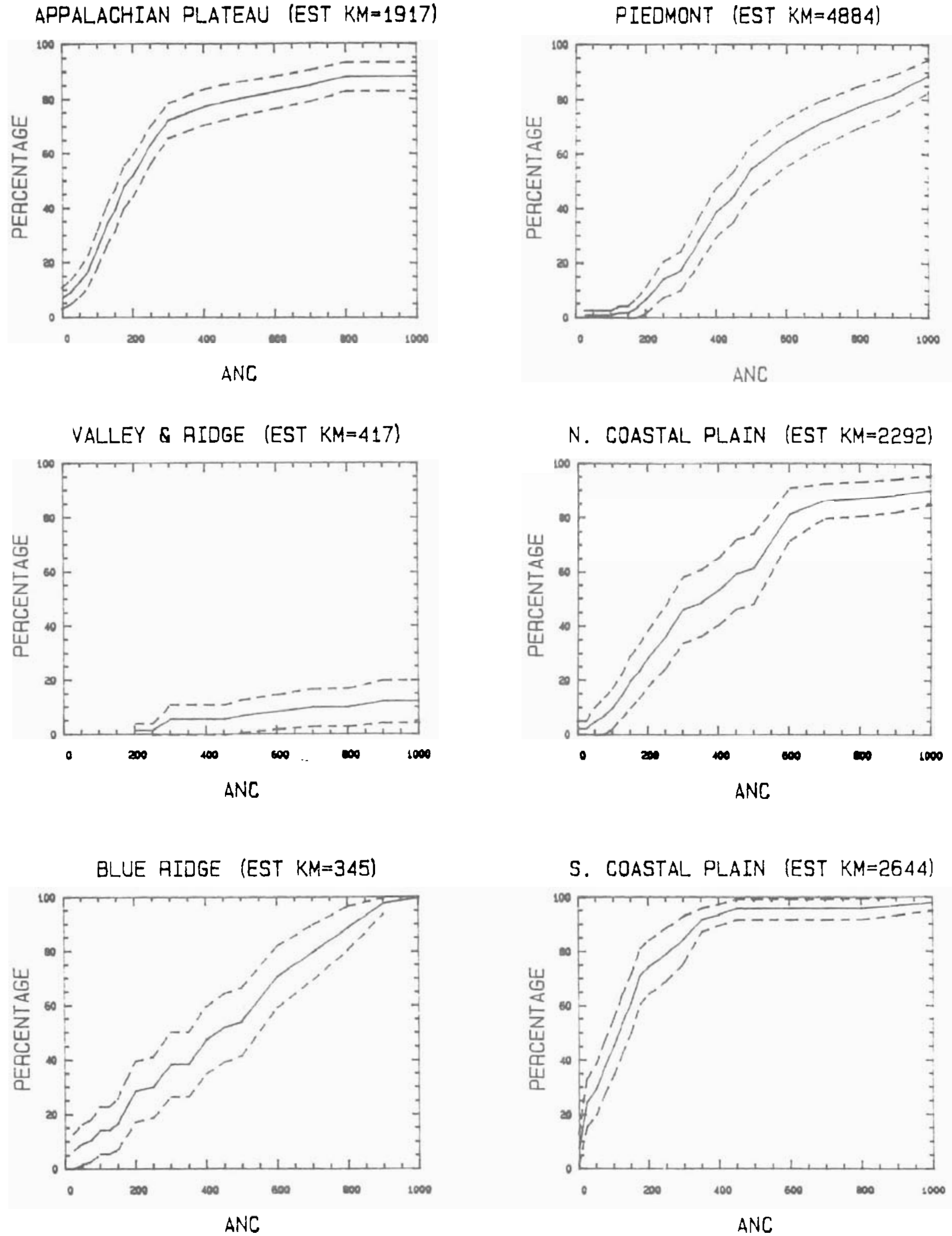


FIGURE III-28. CUMULATIVE RELATIVE FREQUENCY DISTRIBUTIONS FOR ANC VS. THE ESTIMATED PERCENTAGE OF TOTAL REACH LENGTH IN THE POPULATION OF INTEREST IN EACH OF THE SIX MSSCS SAMPLING STRATA. The estimate is represented by the solid line (——). The upper and lower 95 percent confidence limits are denoted by the dashed lines (---).

TABLE III-20. COMPARISON OF THE ESTIMATED SIZE OF THE POPULATION OF INTEREST WITH THE SIZE OF THE TOTAL POPULATION. Confidence intervals (95%) on estimated values are given in parentheses below the estimates.

STRATUM	TOTAL POPULATION* Number	TOTAL POPULATION* Length (km)	ESTIMATED SIZE OF POPULATION OF INTEREST Number	ESTIMATED SIZE OF POPULATION OF INTEREST Length (km)	ESTIMATED PERCENT OF TOTAL Number	ESTIMATED PERCENT OF TOTAL Length (km)
Appalachian Plateau	1448	2400.7	1153	1917.4	79.6	79.9
			(±68)	(±223.0)	(±0.5)	(±9.3)
Valley & Ridge	223	568.3	159	416.9	71.3	73.4
			(±18)	(±95.5)	(±8.1)	(±16.8)
Blue Ridge	195	433.3	161	344.6	82.6	79.5
			(±13)	(±47.6)	(±6.7)	(±11.0)
Piedmont	2585	5341.4	2091	4884.3	80.9	91.4
			(±117)	(±561.1)	(±0.5)	(±10.5)
North Coastal Plain	1282	2881.4	916	2291.8	71.5	79.5
			(±66)	(±391.4)	(±0.5)	(±13.6)
South Coastal Plain	1142	2733.9	932	2643.6	81.6	96.7
			(±49)	(±356.0)	(±0.4)	(±13.0)
Statewide	6875	14359.0	5411	12498.6	78.7	87.0
			(±159)	(±809.9)	(±0.2)	(±5.6)

*The total population includes all non-tidal stream reaches with lower confluences in Maryland with the exception of reaches on the Potomac and Susquehanna Rivers.

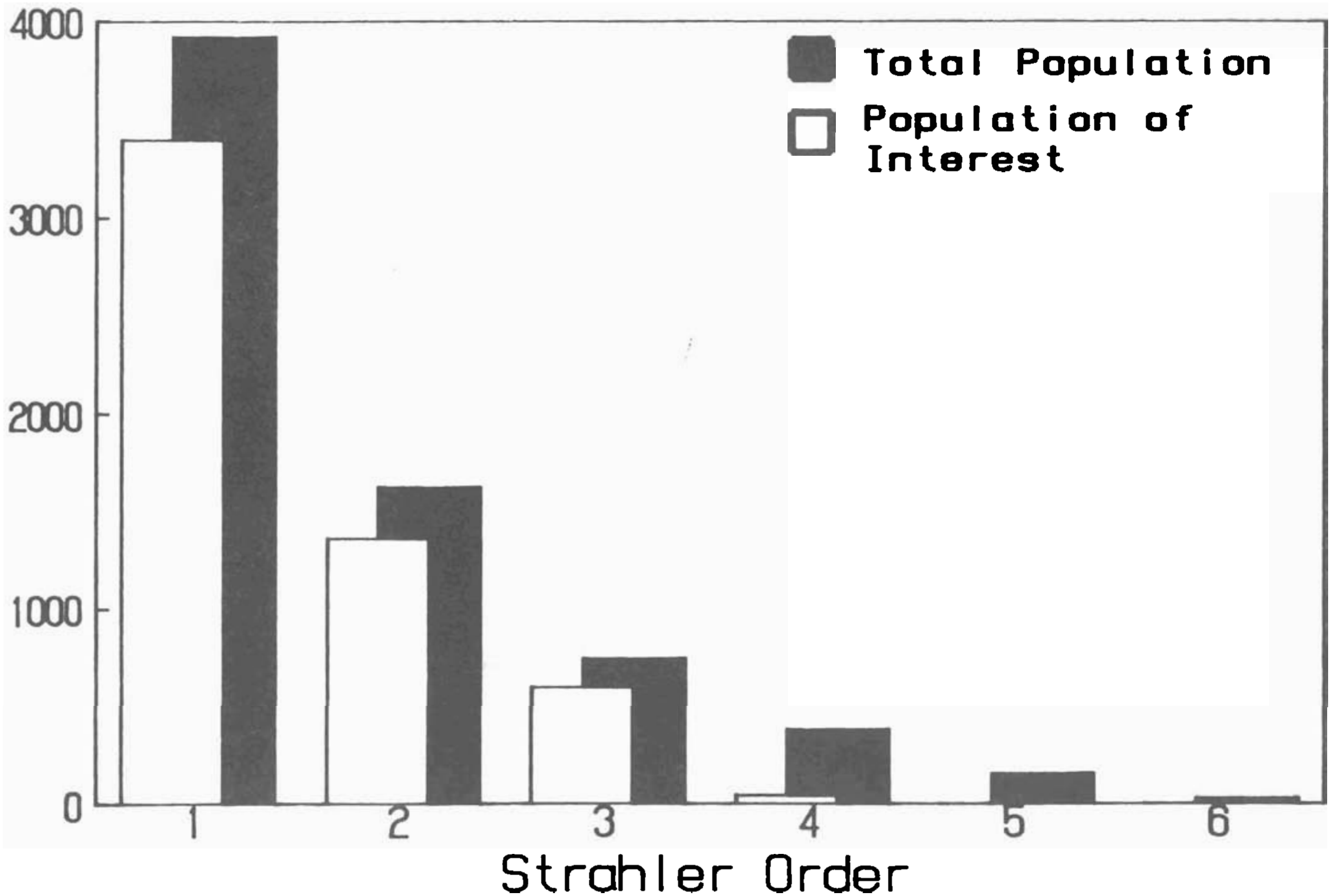


FIGURE III-29. COMPARISON OF THE DISTRIBUTIONS OF STRAHLER ORDER BETWEEN THE TOTAL POPULATION OF NON-TIDAL REACHES AND THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST.

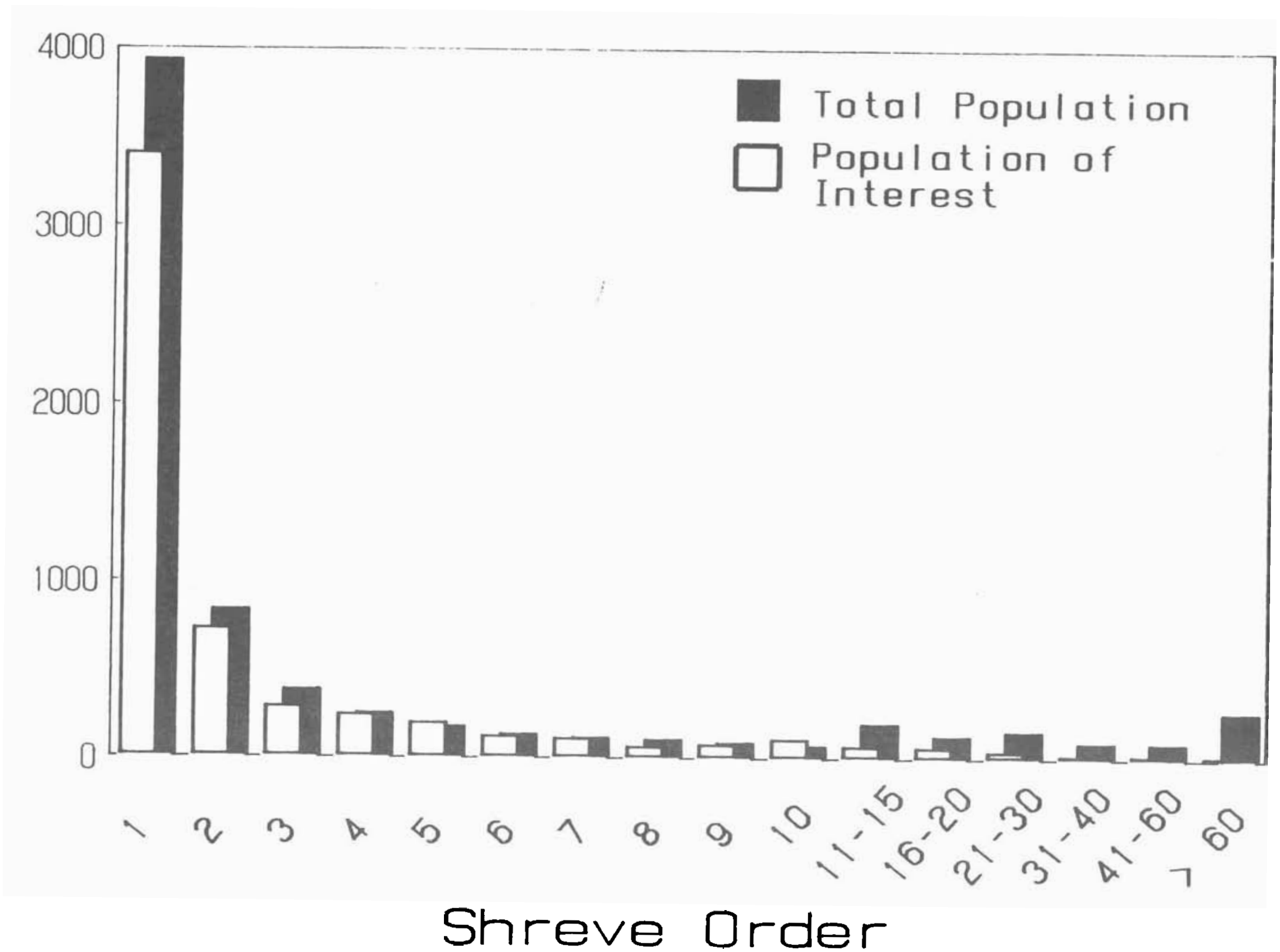


FIGURE III-30. COMPARISON OF THE DISTRIBUTIONS OF SHREVE ORDER BETWEEN THE TOTAL POPULATION OF NON-TIDAL REACHES AND THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST.

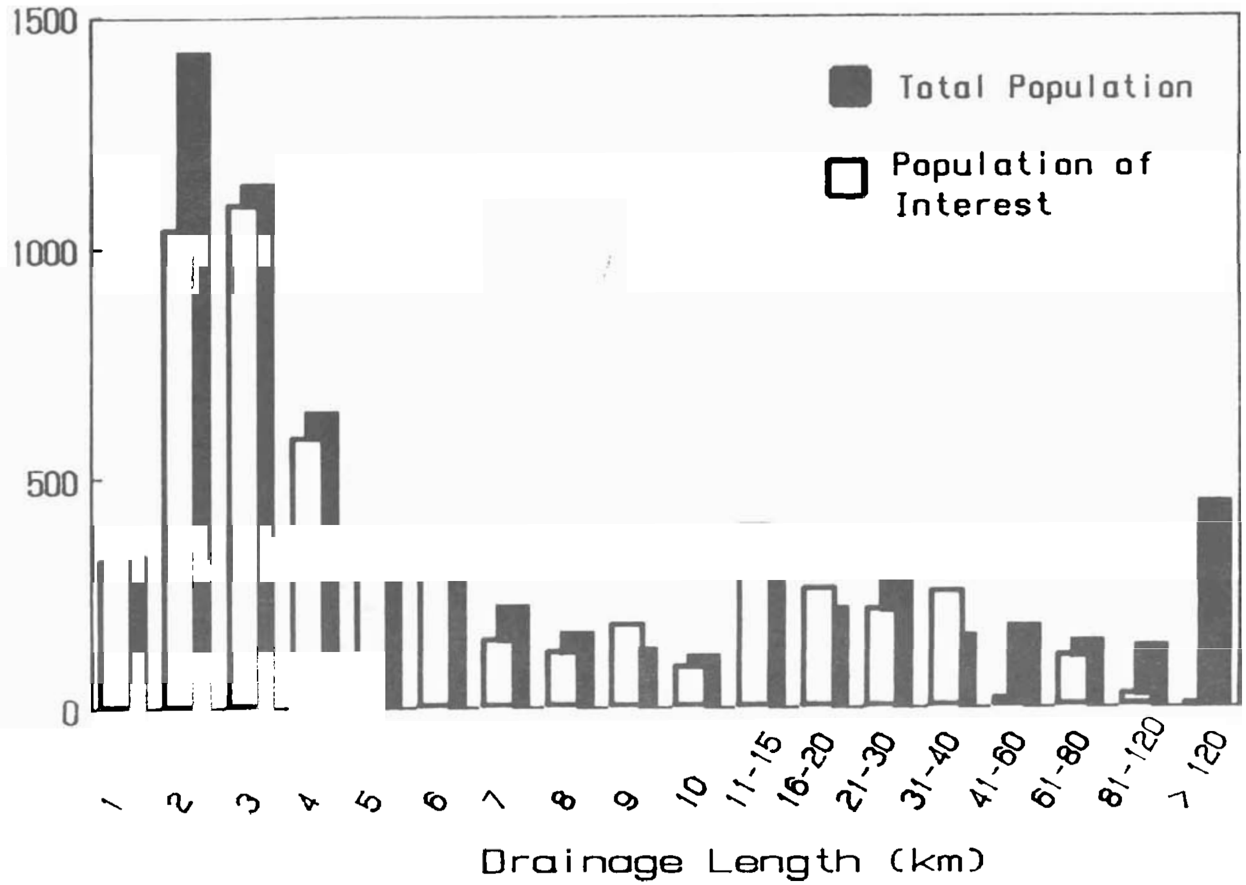


FIGURE III-31. COMPARISON OF THE DISTRIBUTIONS OF DRAINAGE LENGTH BETWEEN THE TOTAL POPULATION OF NON-TIDAL REACHES AND THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST.

(e.g., 40 km drainage length). Prior to this point, differences between the size of stream reaches in the estimated population of interest and the total population reflect the effects of other reach selection criteria. In some size categories, the estimated population of interest is greater than the total population. This indicates that the sample from which the population of interest was developed slightly over-represented some reach size categories.

In terms of Strahler order (Figure III-29), the population of interest has adequate representation of first through third order reaches, but does not closely represent fourth and higher order reaches. Fifth and sixth order reaches are not included in the population of interest; however, they comprise only a small proportion of all reaches in the state. In terms of Shreve order (Figure III-30), reach orders up to 10 are adequately represented; reach orders between 11 and 20 are somewhat under-represented, but present; and reach orders over 20 are nearly absent from the population of interest. Reaches with drainage lengths of up to 40 km, and from 61-80 km are adequately represented in the population of interest. Drainage lengths from 41 to 60 km are under-represented, as are those greater than 81 km. (Figure III-31).

CLASSIFICATION ANALYSES

Methods

To facilitate data in spection 6 classes of stream reach chemistry were defined for pH ($\leq$5.00, 5.01-5.5, 5.51-6.00, 6.01-6.50, 6.51-7.00, >7.0) and seven classes were defined for ANC ($\leq$50, 50-100, 100.1-200, 200.1-300, 300.1-400, 400.1-600, >600). Histograms of reaches in pH and ANC classes were developed. Maps depicting simplified groups of these data were prepared to present the geographic distribution of the stream reach chemistry classes. A principal components analysis was performed using standardized values of three watershed parameters (watershed area, drainage length, and drainage density) and the six water chemistry measurements recorded for each reach.

Results

Classifications of pH and ANC estimates are presented for the statewide population of interest in Figures III-32 and III-33 and for individual strata in Figures III-34 and III-35. This simple approach to classification further illustrates the differences and similarities among strata noted during data description and population estimation. Low pH and low ANC reaches occur in all strata except the Valley and Ridge.

The spatial distribution of pH (Figure III-36) indicates the proportion of very low pH (larger symbols) reaches is high on the eastern shore of the South Coastal Plain and in the western Appalachian Plateau. Reaches on the Western Shore of the South Coastal Plain, although relatively low in pH, have somewhat higher pH than those on the Eastern Shore.

The spatial distribution of reaches classified by ANC is presented in Figure III-37. The concentration of low alkalinity reaches in the South Coastal Plain and Appalachian Plateau is evident. There also appears to be a south-north cline of increasing alkalinity within the Coastal Plain. The Blue Ridge stratum is also delineated by this classification. In the Piedmont, there appear to be two areas of concentration of moderate (200-400 ueq L^{-1}) ANC streams in the northeast and west-central areas of the stratum.

Figure III-38 helps explain the observations that high concentrations DOC tend to occur in the North Central Plain. There is an apparent concentration of relatively high DOC reaches associated with the urbanized areas of Baltimore-Washington metropolitan corridor. These high levels of DOC observed at many sites are likely due to anthropogenic influences.

The principal components analysis was used to provide a means by which the number of dimensions (parameters) in the data could be reduced while retaining a maximum amount of variance. Table III-21 summarizes the principal components analysis for the MSSCS data. The first three

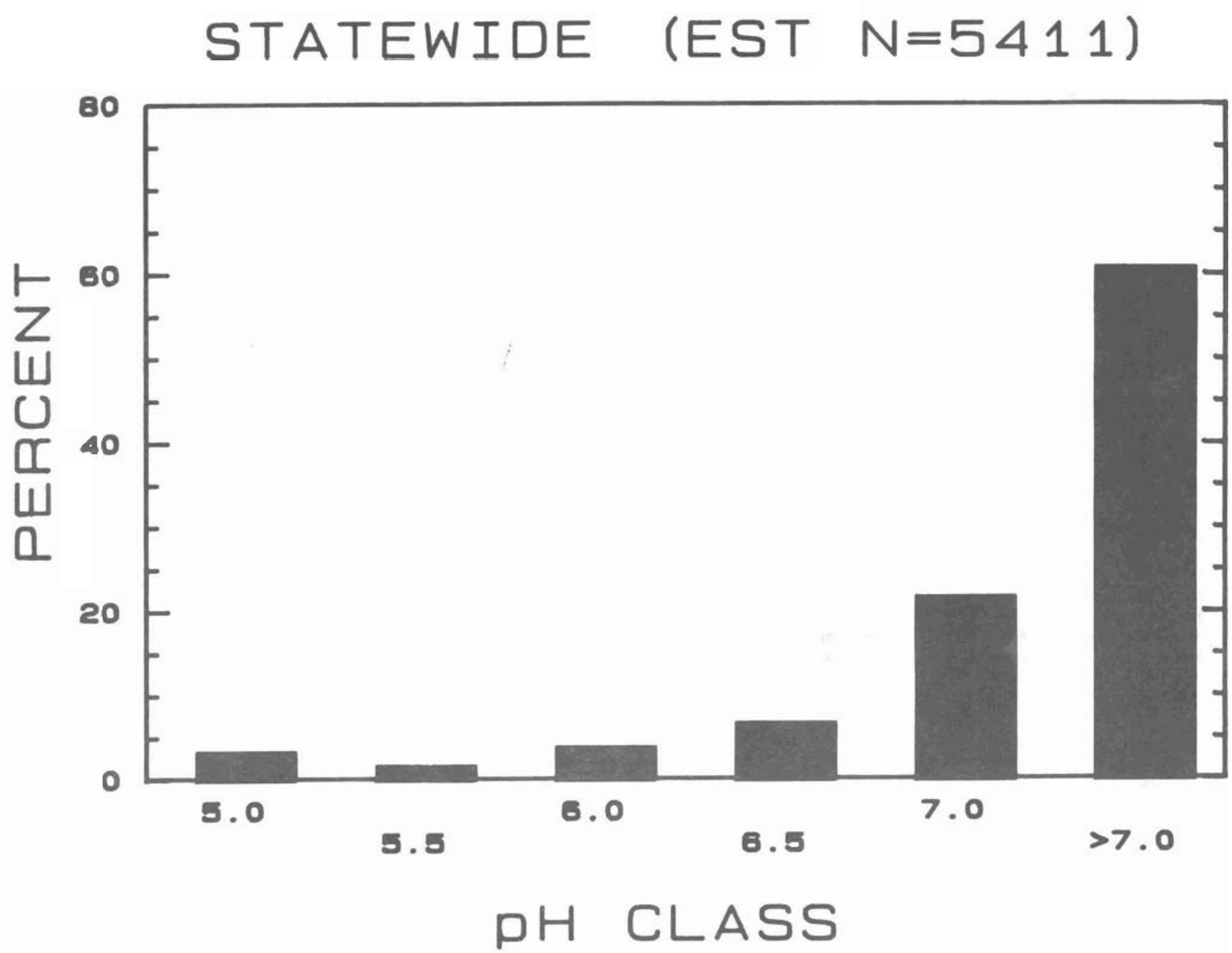


FIGURE III-32 STATEWIDE RELATIVE FREQUENCIES FOR THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST WITHIN EACH OF SIX pH CLASSES. Numbers on the x-axis indicate the upper boundary of each pH class.

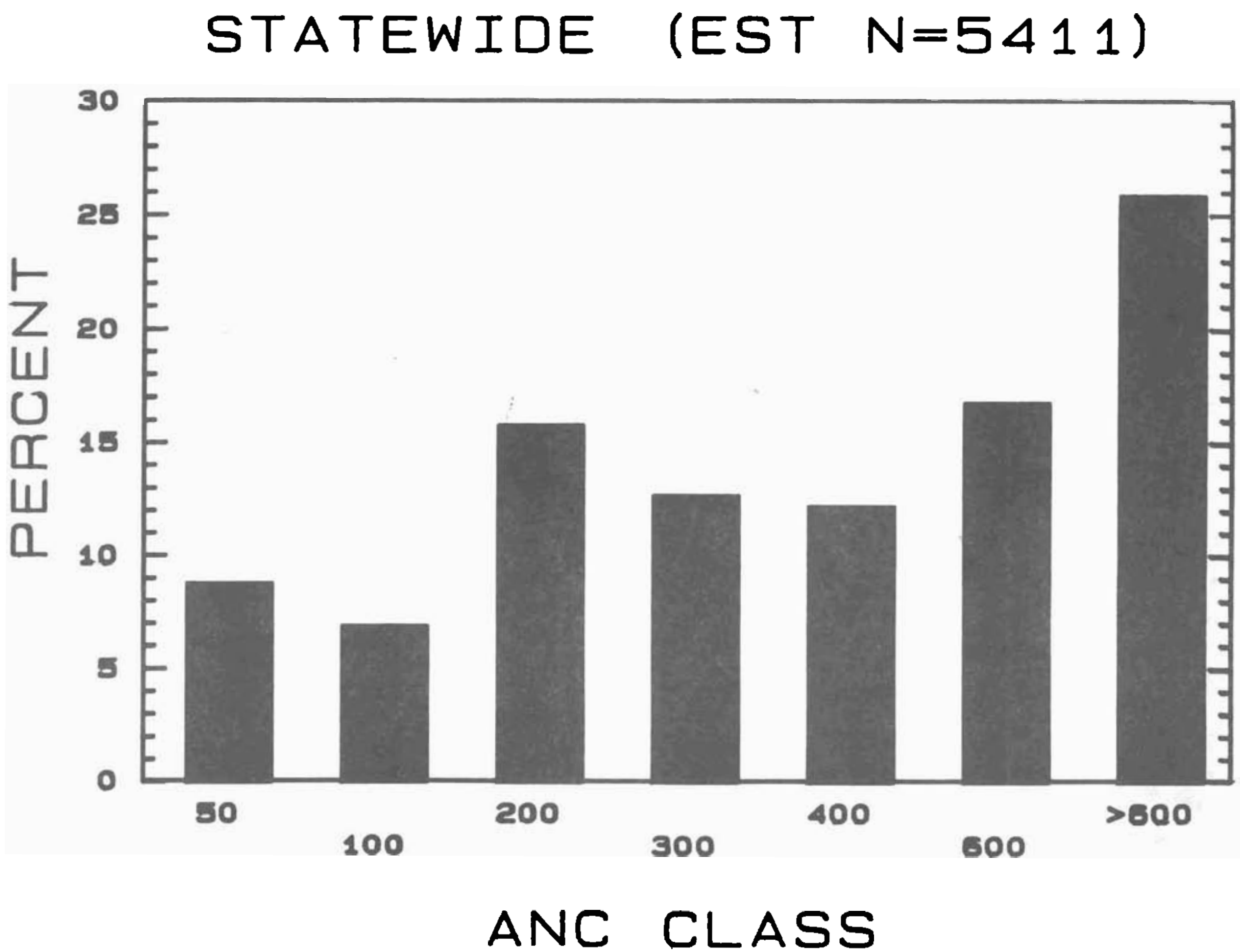


FIGURE III-33. STATEWIDE RELATIVE FREQUENCIES FOR THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST WITHIN EACH OF SEVEN ANC CLASSES. Numbers on the x-axis indicate the upper boundary of each ANC class.

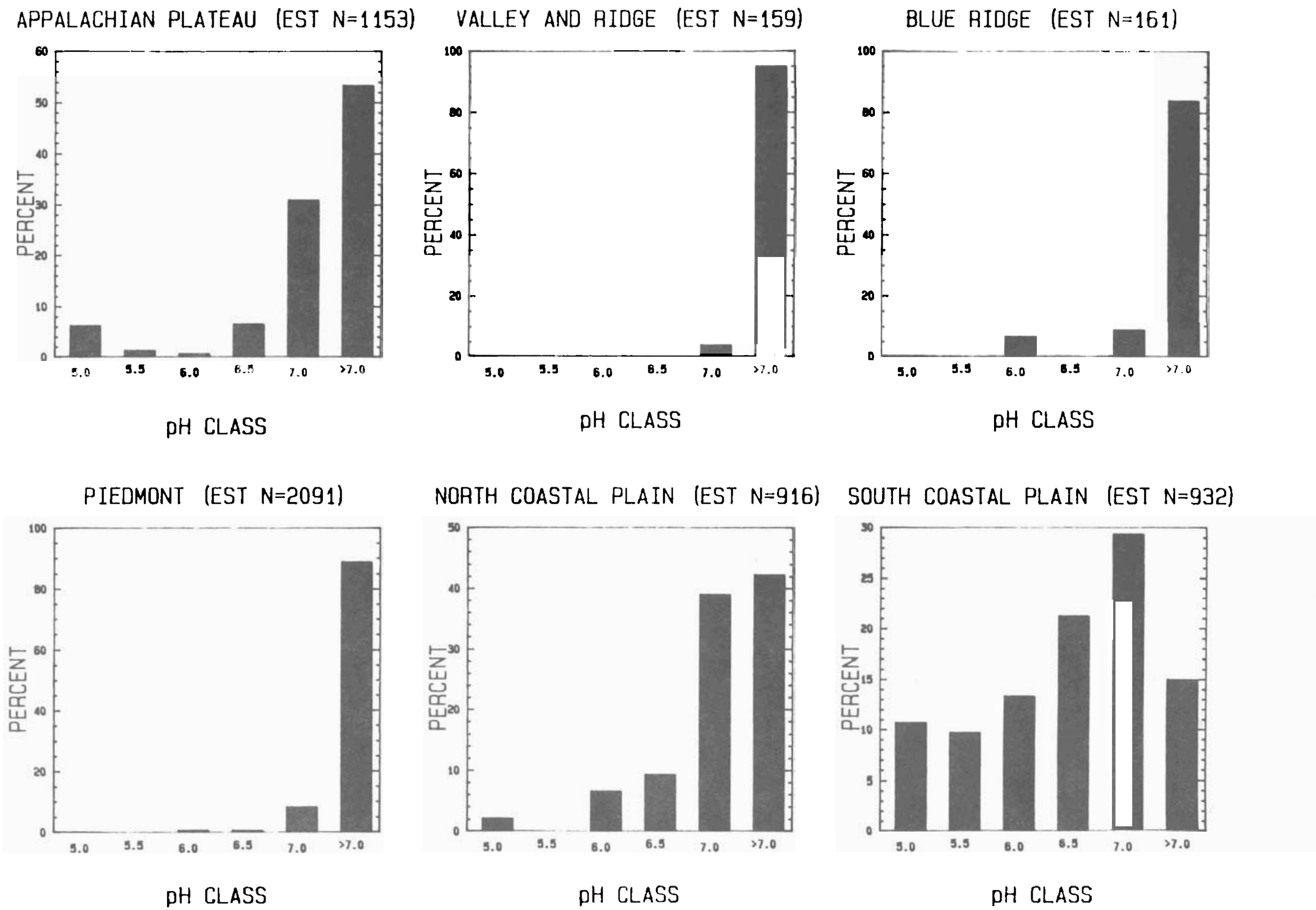


FIGURE III-34. SAMPLING STRATUM RELATIVE FREQUENCIES FOR THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST WITHIN EACH OF SIX pH CLASSES. Numbers on the x-axis indicate the upper boundary of each ANC class.

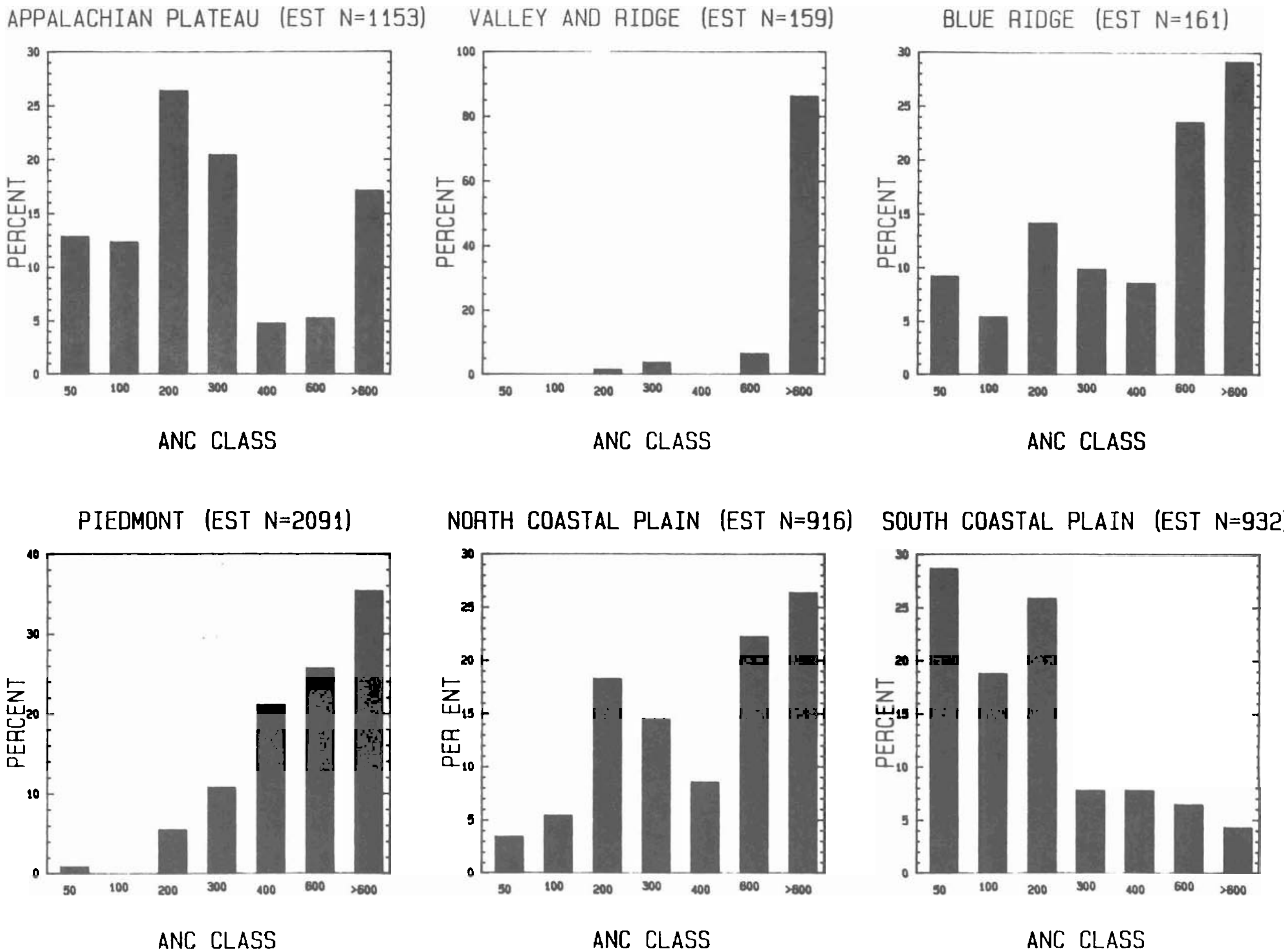


FIGURE III-35. SAMPLING STRATUM RELATIVE FREQUENCIES FOR THE ESTIMATED NUMBER OF REACHES IN THE POPULATION OF INTEREST WITHIN EACH OF SEVEN ANC CLASSES. Numbers on the x-axis indicate the upper boundary of each ANC class.

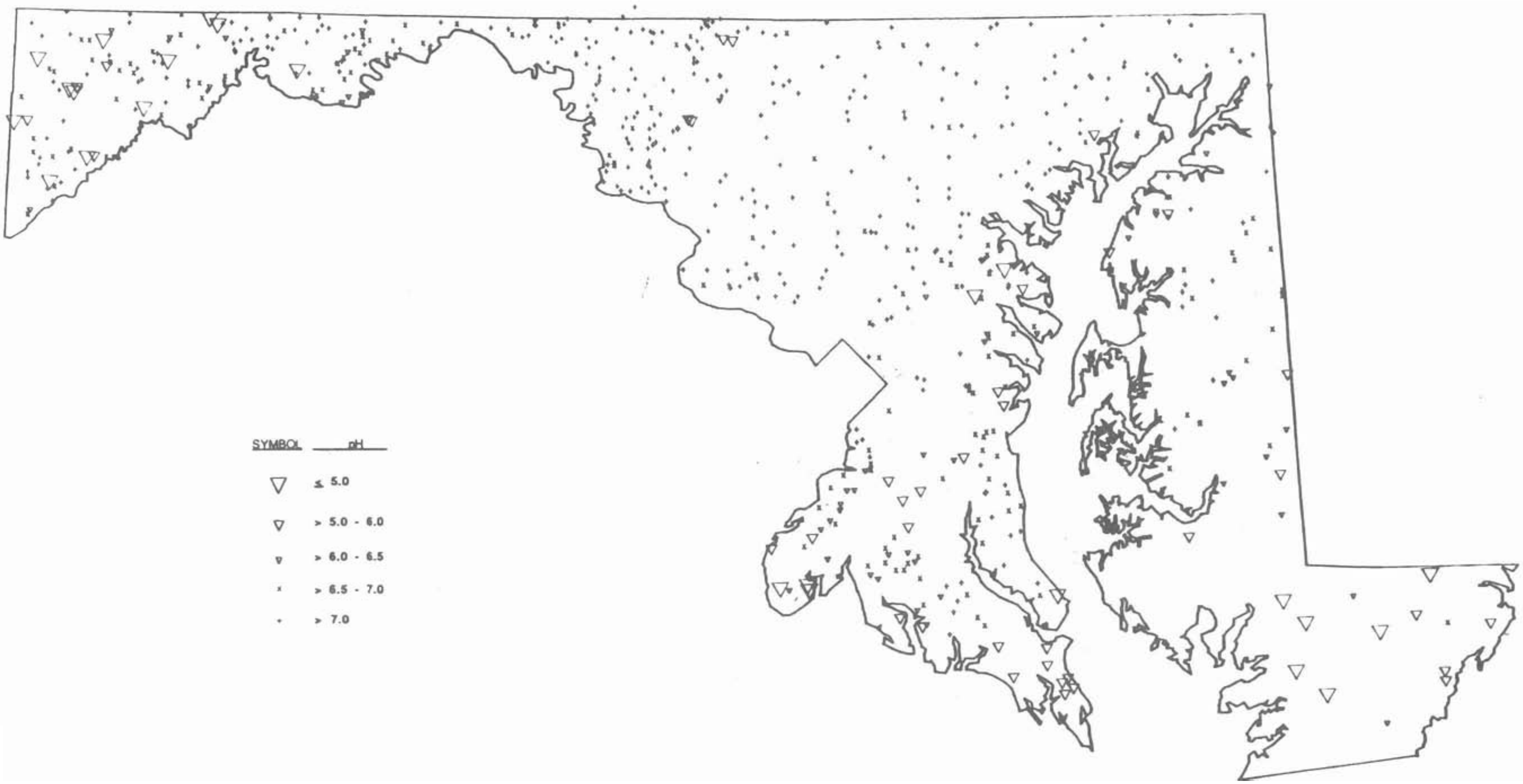


FIGURE III-36. SPATIAL DISTRIBUTION OF RANDOMLY SAMPLED MSSCS REACHES CLASSIFIED BY pH.

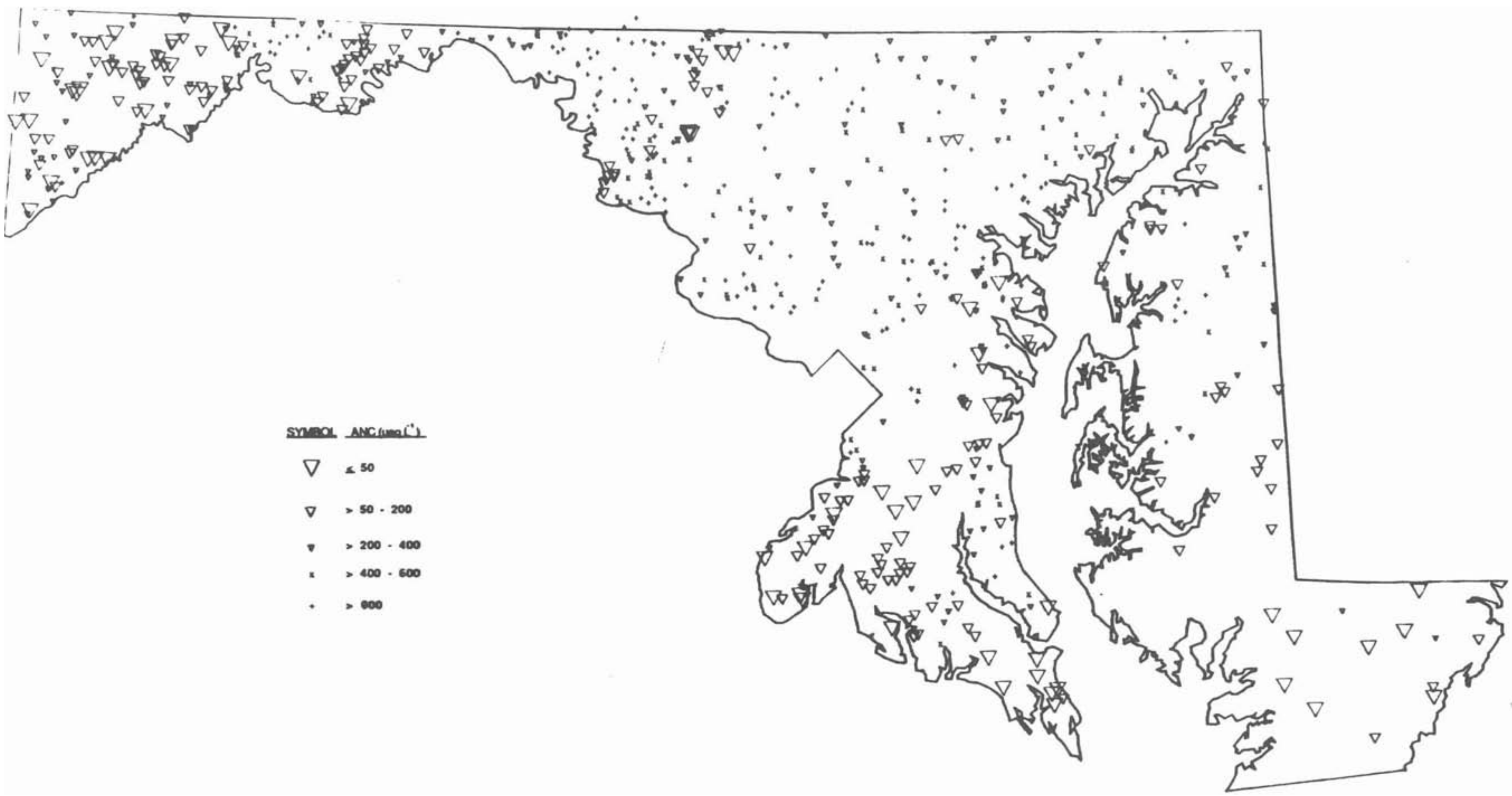


FIGURE III-37 SPATIAL DISTRIBUTION OF RANDOMLY SAMPLED MSSCS REACHES CLASSIFIED BY ANC.

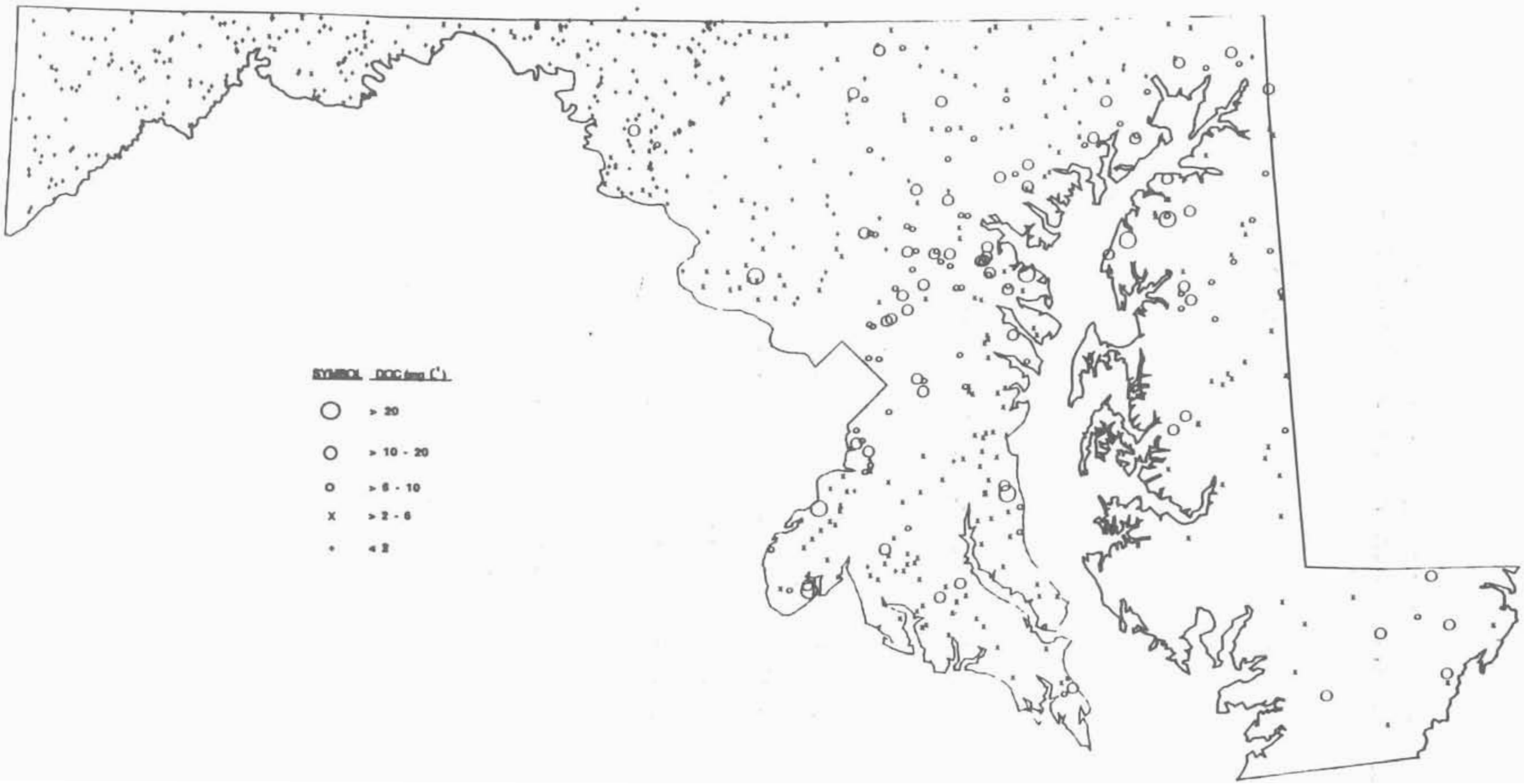


FIGURE III-38. SPATIAL DISTRIBUTION OF RANDOMLY SAMPLED MSSCS REACHES CLASSIFIED BY DOC

TABLE III-21. RESULTS OF PRINCIPAL COMPONENTS ANALYSIS OF WATERSHED AND WATER CHEMISTRY DATA FOR RANDOMLY SAMPLED MSSCS REACHES

PRINCIPAL COMPONENT	EIGENVALUE	PROPORTION OF VARIANCE EXPLAINED
1	3.1661	0.3518
2	1.9626	0.2181
3	1.6188	0.1799
4	0.9958	0.1106

PRINCIPAL COMPONENT WEIGHTS

VARIABLE	PC1	PC2	PC3	PC4
WATERSHED AREA	0.0390	0.6992	0.0596	-0.0944
DRAINAGE LENGTH	0.0360	0.7025	-0.0214	0.0536
DRAINAGE DENSITY	0.0319	-0.0064	-0.3399	0.8618
pH	0.3771	0.0912	-0.2218	0.2417
ANC	0.5410	-0.0573	0.1101	-0.0343
DIC	0.5339	-0.0670	0.1324	-0.0554
DOC	-0.1011	0.0054	0.6097	0.3527
COLOR	-0.1227	0.0165	0.6240	0.2416
CONDUCTIVITY	0.5010	-0.0346	0.2014	-0.0070

principal component dimensions; buffering system, watershed, and organics, are useful in summarizing differences or similarities among the sampling strata. Figure III-39 presents a plot of the stratum centroids in the three principal component dimensions. This plot indicates that the Valley and Ridge is quite different from the other strata with respect to its buffering system. The South Coastal Plain has a noticeably low level of buffering. The Appalachian Plateau and Blue Ridge appear to have similar chemistries (both buffering and organics) with some differences in hydrologic characteristics. The North Coastal Plain appears to be intermediate between the Appalachian Plateau and Piedmont in terms of buffering but relatively high in organics.

The principal components analysis results indicate that the carbonate chemistry system is the major source of variability in the data. The first principal component explains 35 percent of the variance and is dominated by ANC, DIC, and conductivity with a moderate contribution from pH. The second principal component represents the contribution of watershed hydrologic variables to the total variability in the data set. This component explains 22 percent of the variance and is largely controlled by watershed area and drainage length. The third principal component explains 18 percent of the variance in the data. It represents the organic components of water chemistry, DOC, and color. Together the first three principal components explain 75 percent of the variance in the data.

The analysis of principal components supports the use of physiographic, geologic, and soils information to stratify water sampling efforts. The spatial presentations of reach ANC and pH classes indicate that patterns in water chemistry exist within strata. Geological and soils information of a finer scale than that represented by stratum boundaries may be useful in explaining some of the observed sub-regional patterns. Such an analysis was, however, beyond the scope of the MSSCS.

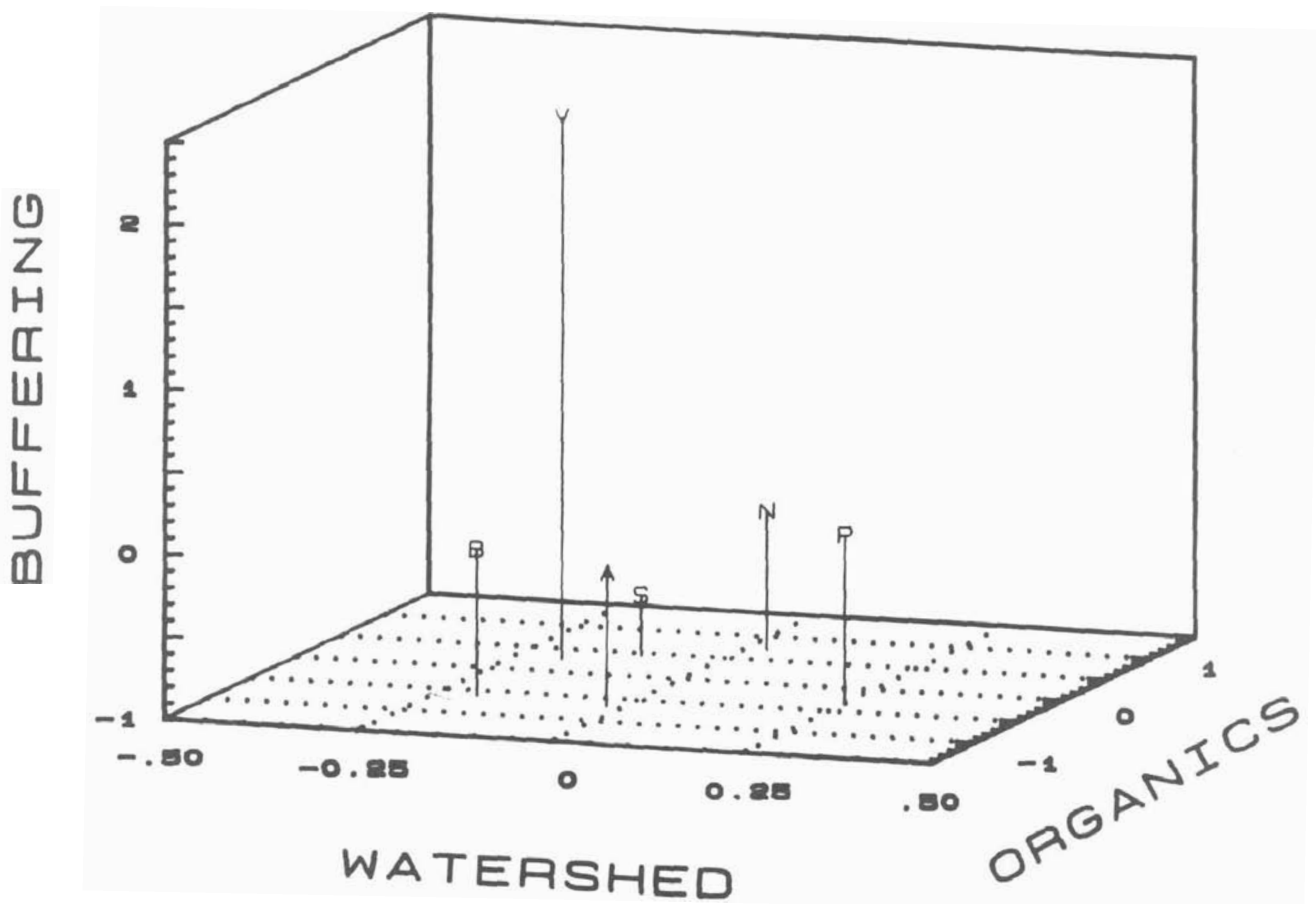


FIGURE III-39. **LOCATION OF SAMPLING STRATUM CENTROIDS WITH RESPECT TO THE FIRST THREE PRINCIPAL COMPONENTS.** Letters on the vertical lines denote the first letter in the name of each stratum. Axis labels represent the following principal components described in Table III-21: Buffering = PC1; Watershed = PC2; Organics = PC3.

CHAPTER IV

DISCUSSION

The results of the MSSCS indicate that the number and extent of acidic and acid-sensitive streams vary considerably from region to region in the state. In particular, the Coastal Plain and western Maryland contain relatively high proportions of streams with pH $\leq$ 6.5 or ANC $\leq$ 200 ueq L^{-1} during spring. In contrast, relatively few streams in the Valley and Ridge and Piedmont have either low pH or low ANC.

Similar results were obtained in earlier attempts to assess the extent of streams in Maryland that are potentially susceptible to acidification (Harman 1984; Janicki and Cummins 1983; Janicki and Greening, 1987). These earlier studies, using existing information and data collected during a pilot survey, indicated potential sensitivity of streams to acidification in the Coastal Plain and the Appalachian Plateau. The similarity of the results from a survey specifically designed to determine the number and extent of acidic and acid-sensitive streams during spring to these other studies suggests there is some merit in examining existing data for spatial trends in surface water chemistry. Such a result is not surprising, given that geology and soil characteristics are major determinants of stream baseflow chemistry.

Table IV-1 compares the MSSCS data to the USEPA National Stream Survey (NSS) data for the Southern Blue Ridge region which comprises portions of Georgia, North Carolina, South Carolina, and Tennessee. Statewide estimates of the number of stream kilometers and the proportion of total stream length with low pH ($\leq$ 6.0) and low ANC ($\leq$ 50 ueq L^{-1}) are greater in Maryland than in the Southern Blue Ridge region. These differences appear to be greatest in South Coastal Plain, North Coastal Plain, and Appalachian Plateau. Thus, the extent of low pH and low ANC streams in Maryland's Coastal Plain and Appalachian Plateau appears to be greater than in the Southern Blue Ridge, which was previously identified by the U.S. EPA as being an area of concern regarding acidification. When the remainder of the NSS data become available, further comparisons of the MSSCS data to those from other regions can be made.

TABLE IV-1. COMPARISON OF MSSCS DATA AND NATIONAL STREAM SURVEY DATA FOR THE SOUTHERN BLUE RIDGE PROVINCE[1]

		POPULATION ESTIMATES[2]															
	REFERENCE	LENGTH (km)								PROPORTION (% of length)							
VARIABLE	VALUE	SBR	STATE	AP	V&R	BR	P	NC	SC	SBR	STATE	AP	V&R	BR	P	NC	SC
pH	< 6.0	0	1419	223	0	14	46	235	902	0	11	12	0	4	1	10	34
	< 7.0	3707	5228	906	16	47	610	1288	2362	42	42	47	4	14	12	56	89
ANC	< 0	0	453	205	0	0	0	48	200	0	4	11	0	0	0	2	8
(ueq L^{-1})	≤ 50	561	1249	301	0	20	46	107	775	6	10	16	0	6	1	5	29
	≤ 200	6666	4169	1022	6	90	437	648	1967	74	33	53	1	26	9	28	74

1 From Malanchuck and Turner (1987)

2 SBR = Southern Blue Ridge, State = Maryland, AP = Appalachian Plateau Stratum, V&R = Valley and Ridge Stratum, BR = Blue Ridge Stratum, P = Piedmont Stratum, NC = North Coastal Plain Stratum, SC = South Coastal Plain Stratum

The MSSCS pH data also indicate that, compared to other regions of the state, larger proportions of streams in the Coastal Plain and western Maryland exhibited relatively low pH values. The MSSCS sampling program was conducted under spring conditions, which likely reflect lower pH conditions than in other seasons due to the influence of the annual hydrological cycle (Messer, et al. 1986). However, the MSSCS data (and the NSS data) do not reflect worst-case conditions, because pH minima typically occur during major hydrological events (e.g., snowmelt and precipitation).

Studies of the occurrence of episodic reductions in stream pH in response to major hydrologic events have indicated that baseflow ANC is a critical determinant of the probability of occurrence of episodic stream chemistry changes (e.g., DeWalle et al., 1987; Lynch et al., 1986). Campbell et al. (1987) reported that pH reductions in Lyons Creek, located in the Maryland Coastal Plain, occurred during precipitation events when, prior to the event, baseflow ANC was as high as 400 ueq L^{-1}. In general, streams with low baseflow ANC can be expected to have a higher probability of exhibiting episodic pH reductions than streams with higher baseflow ANC. However, a quantitative assessment of the number and extent of streams in Maryland which undergo episodic pH reductions requires other critical data inputs, including information on stream hydrology, watershed characteristics and processes, and atmospheric loading estimates.

Results from the MSSCS indicate that, during spring, several drainage systems in Maryland contain streams with water quality that may be detrimental to resident or anadromous fish populations (Table I-1). Figure IV-1 shows the distribution of sampled reaches around the Chesapeake Bay that exhibit pH values $\leq$ 6.5. Although on a statewide basis only 16.9% of the stream reaches are estimated to have pH values $\leq$ 6.5, 55.5% of the reaches in the South Coastal Plain and 18.6% of those in the North Coastal Plain are estimated to be at or below this critical pH value. Streams sampled in the Coastal Plain include tributaries to such historically important anadromous fish spawning areas as the Wicomico, Nanticoke, Choptank, Magothy, Severn, South, Patuxent, and Chester rivers.

FIGURE IV-1. pH VALUES OF THE SAMPLED REACHES IN THE NORTH AND SOUTH COASTAL PLAIN STRATA.

Figure IV-2 illustrates the distribution of sampled reaches in western Maryland with pH values $\leq$ 6.0, a conservative estimate of the level at which freshwater fisheries can be detrimentally affected by acidification (Table I-1). An estimated 9.8% of the stream reaches statewide have pH values less than 6.0; including 34% of those in the South Coastal Plain and 8.6% of those in the Appalachian Plateau. The Appalachian Plateau contains several important freshwater recreational fishing areas, including upper portions and tributaries of the Youghiogheny, Casselman, and Savage rivers.

Figure IV-3 presents a comparison of stream chemistry data for 23 special interest streams in the Coastal Plain that were sampled in the spring of both 1983 and 1987. Data for each stream indicate that pH values measured in 1987 are higher than the median of values from the same stream in 1983. Single pH samples collected in 1987 are higher than the maximum observed in 1983 for 9 of the 23 streams. Data for ANC in these streams indicate that in 15 of the 23 streams, ANC values were higher than the median value of alkalinity observed in 1983. In 7 cases, ANC values measured in 1987 were higher than alkalinity values observed in 1983. In one case, the ANC value observed in 1987 was lower than any alkalinity values observed in 1983. These data apparently reflect the effects on stream chemistry of the relatively greater amounts of precipitation in 1983 (Table IV-2).

Comparisons of MSSCS data with historic data from USGS monitoring stations throughout Maryland (summarized by Janicki and Greening, 1987) were made to assess the validity of the spring index sample approach used in the MSSCS. Figures IV-4 through IV-6 summarize these comparisons. USGS data used in these comparisons cover varying periods of record. In 10 of the 13 streams compared in the Coastal Plain, 1987 pH data fall within the historical range of values. In two of the remaining three streams, pH values measured in 1987 were higher, and one was lower, than any measured previously at these sites. For those streams where alkalinity data are available, historical values are similar to those measured in 1987.

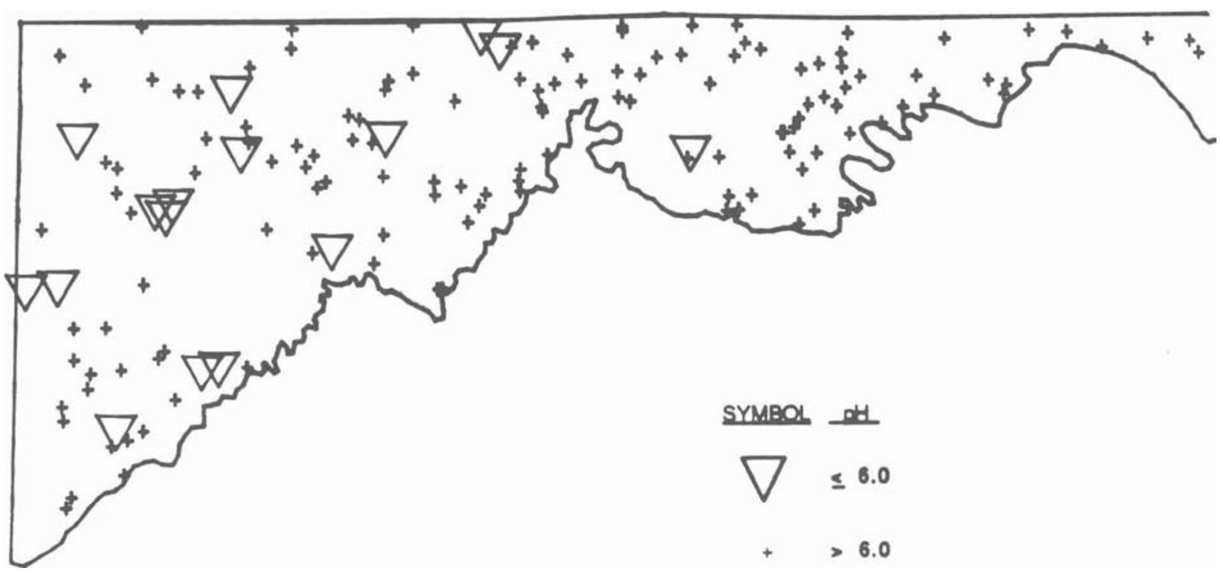
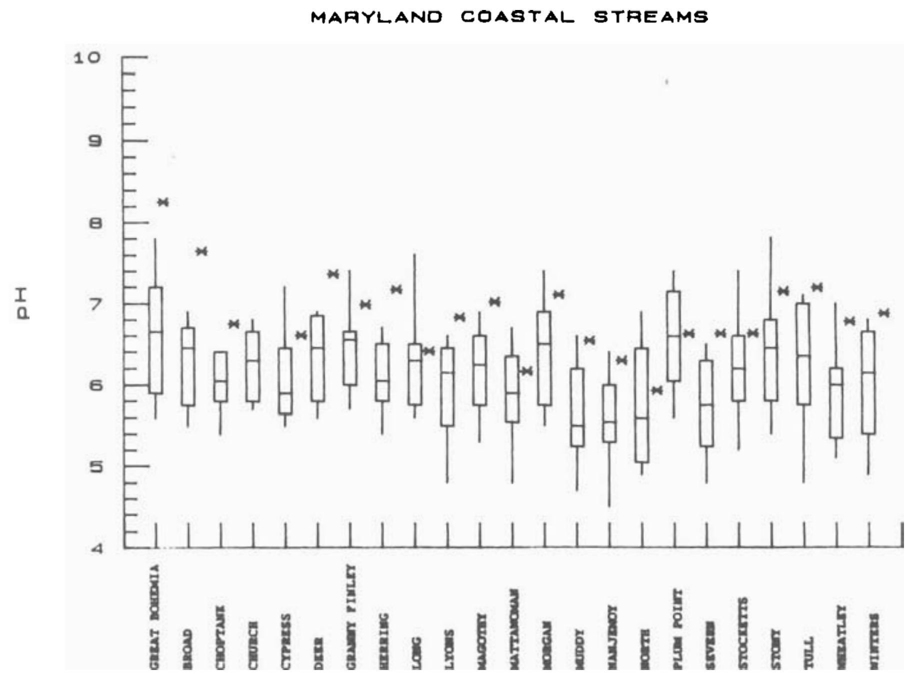


FIGURE IV-2. pH VALUES OF THE SAMPLED REACHES IN THE APPALACHIAN PLATEAU STRATUM.



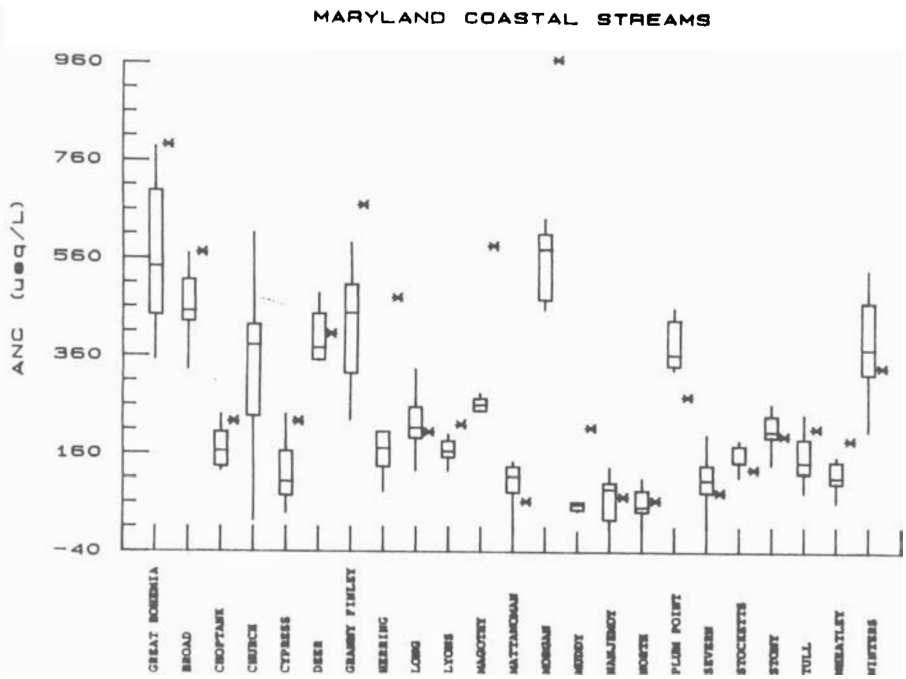
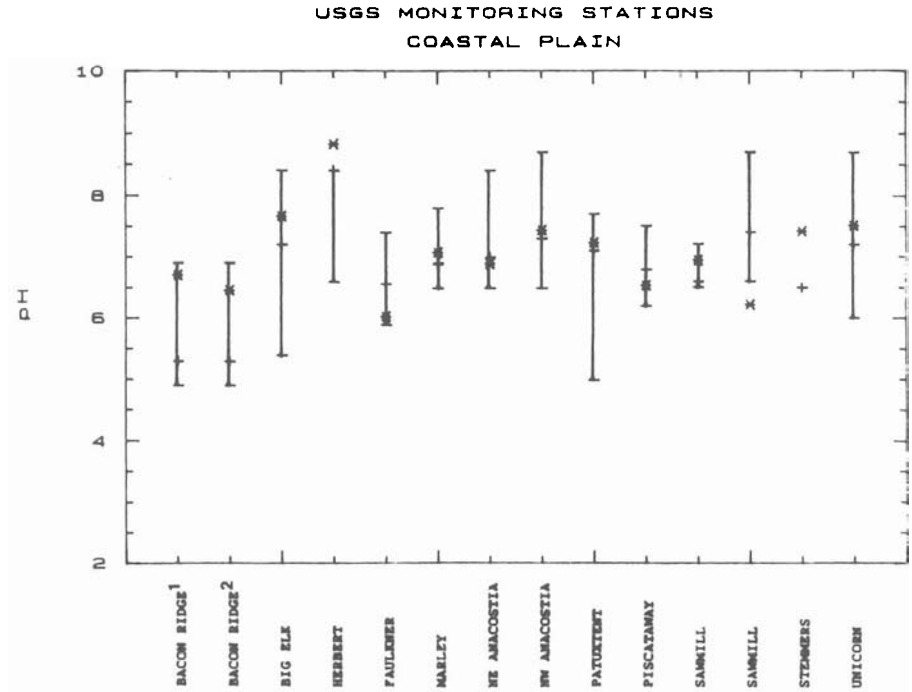
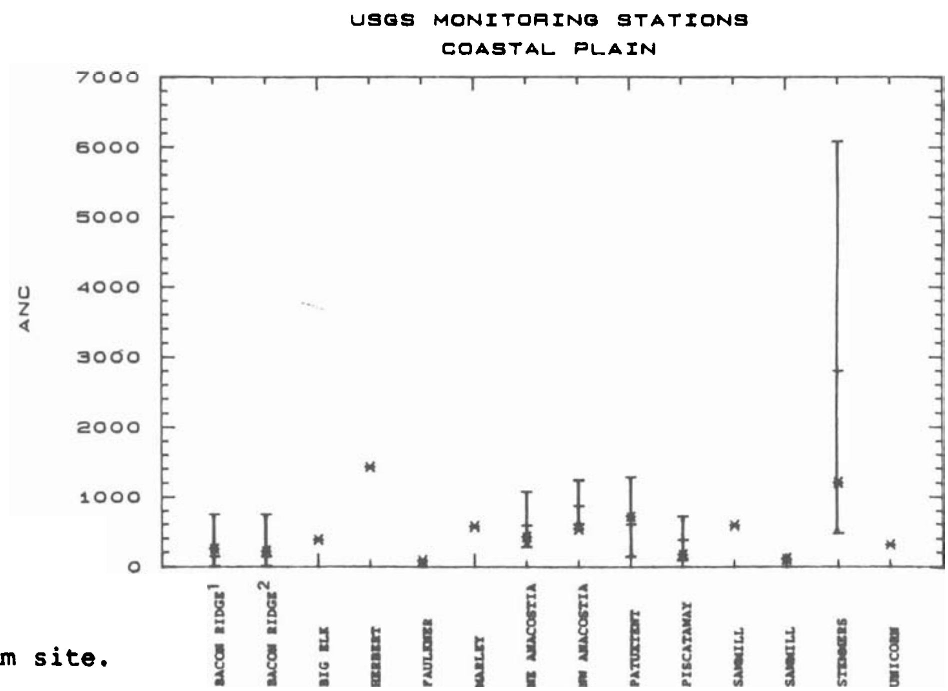


FIGURE IV-3. COMPARISON OF SPRING 1983 pH AND ALKALINITY MEASUREMENTS FROM 23 COASTAL STREAMS WITH 1987 MSSCS DATA. Box and whisker plots show the range, median, and upper and lower quartiles for pH and alkalinity measured in 1983. To the right of each plot of 1983 data, an asterisk (*) displays 1987 pH and ANC data collected from that site during the MSSCS. (After Janicki and Cummins 1983). (Note: Church Creek was not sampled in 1987)

TABLE IV-2. PRECIPITATION AT BALTIMORE, MD. DURING SPRING 1983 AND SPRING 1987 COMPARED WITH AVERAGE PRECIPITATION FOR THE PREVIOUS 30 YEARS

	PRECIPITATION (Inches)		
	1983	1987	30-YEAR AVERAGE
March	6.80	0.99	3.66
April	6.55	1.86	3.29
May	5.47	4.16	3.47

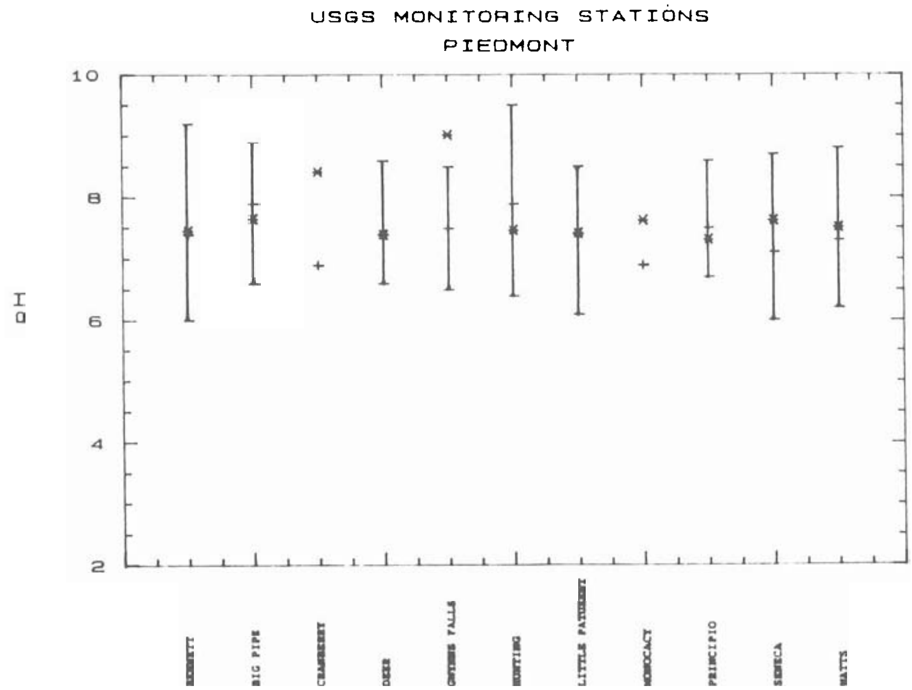




[1]Upstream site.

[2]Downstream site.

FIGURE IV-4. COMPARISON OF pH AND ALKALINITY MEASUREMENTS FROM USGS MONITORING STATIONS WITH MSSCS DATA FOR 14 COASTAL PLAIN STREAMS. Vertical bars indicate the range and crosses (+) indicate the mean of USGS data. To the right of each plot of USGS data, an asterisk (*) displays 1987 pH and ANC data collected from that site during the MSSCS.



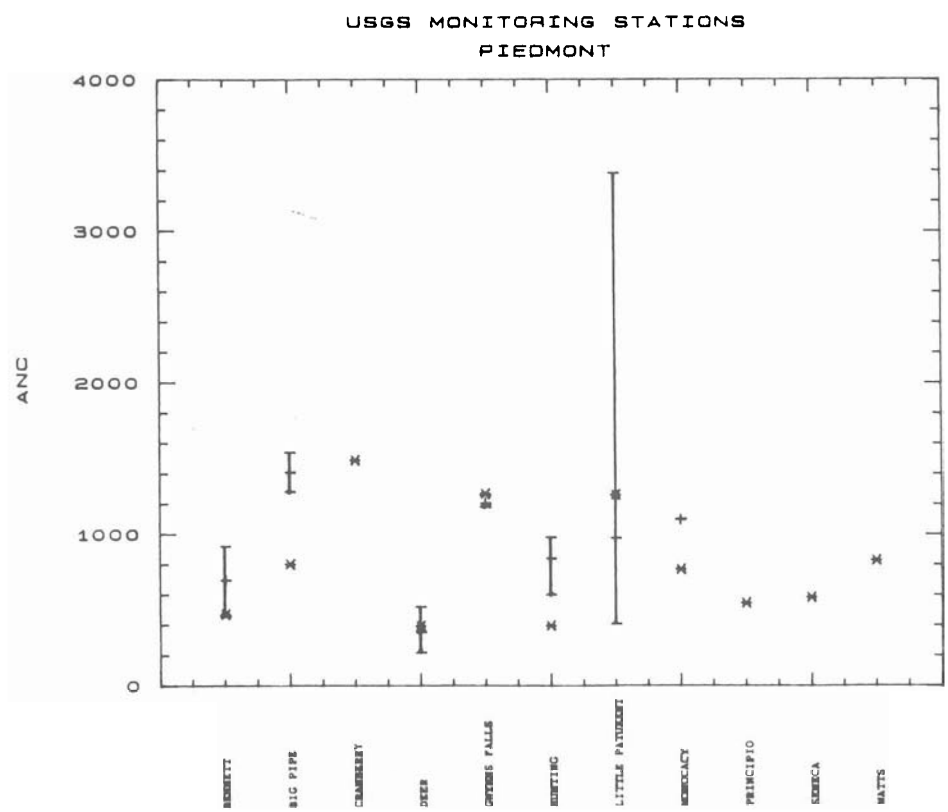
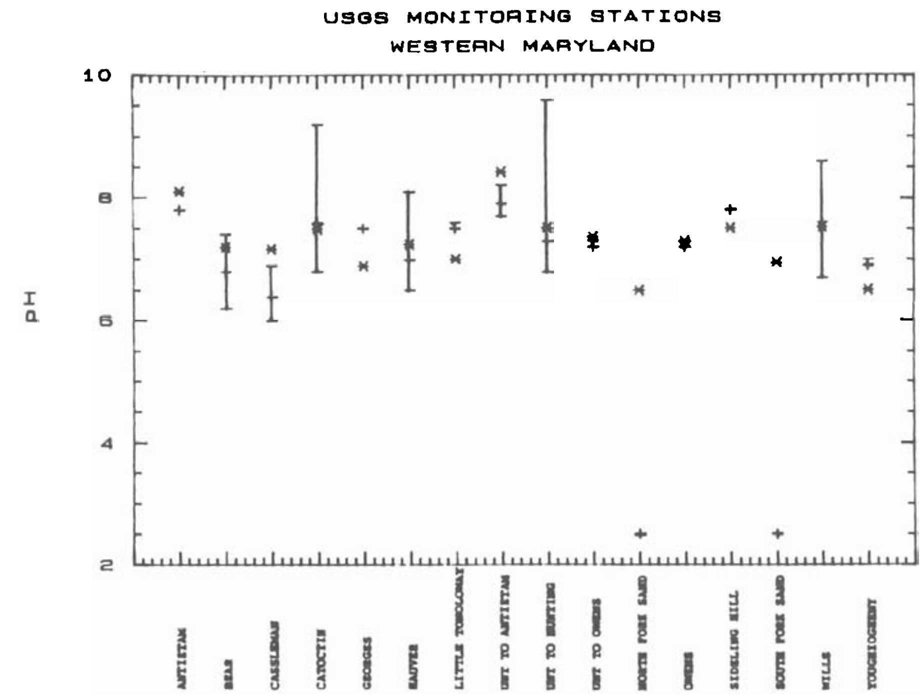


FIGURE IV-5. COMPARISON OF pH AND ALKALINITY DATA FROM USGS MONITORING STATIONS WITH 1987 MSSCS DATA FOR 11 PIEDMONT STREAMS. Vertical bars indicate the range and crosses (+) indicate the mean of USGS data. Asterisk (*) indicate 1987 MSSCS data.



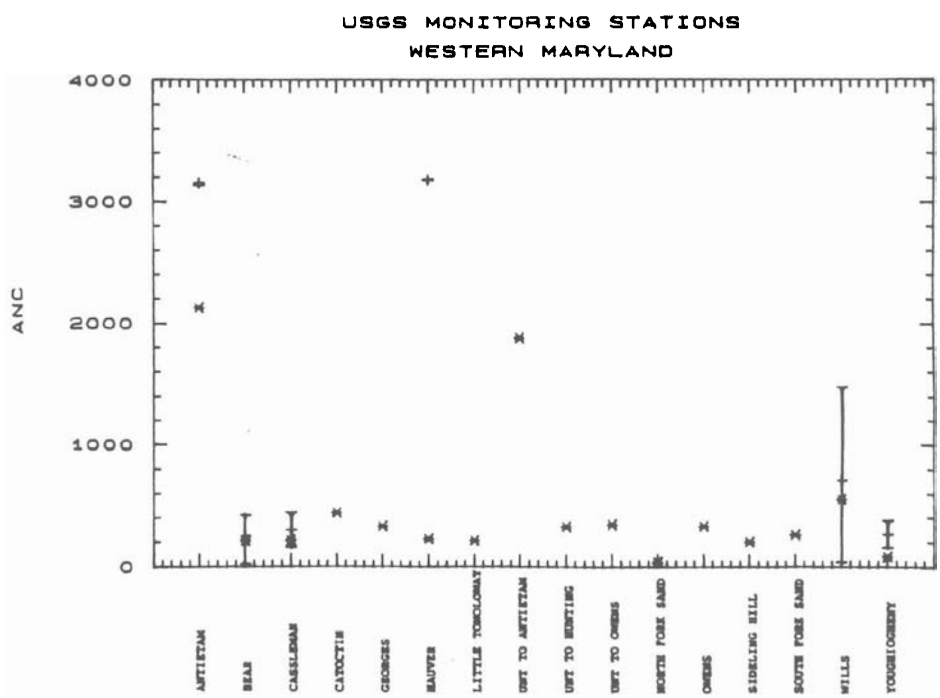


FIGURE IV-6. COMPARISON OF pH AND ALKALINITY DATA FROM USGS MONITORING STATIONS WITH 1987 MSSCS DATA FOR 16 STREAMS IN WESTERN MARYLAND. Vertical bars indicate the range and crosses (+) indicate the mean of USGS data. Asterisk (*) indicate 1987 MSSCS data.

Data for 11 streams in the Piedmont indicate that pH and ANC in 1987 also were similar to the historical USGS data (Figure IV-5).

With the exception of the North and South Forks of Sand Run (two streams that had very low pH values historically), pH data collected in Western Maryland in 1987 were similar to historical data (Figure IV-6). Historic ANC values were available from only six sites in western Maryland. In 1987, ANC was lower than historical measurements in three of these streams.

CHAPTER V

C O N C L U S I O N S

In addition to the population estimates previously described, the following major conclusions may be stated from this survey:

- Streams that are sensitive to acidification (ANC $\leq$ 200 ueq L^{-1}) may be found throughout Maryland, except in the Valley and Ridge Stratum.

- The South Coastal Plain and the Appalachian Plateau Strata have large proportions of streams that are sensitive to acidification.

- Fish resources may be at risk from acidification in the Appalachian Plateau and the North and South Coastal Plain Strata.

- A greater proportion of low pH (pH $\leq$ 6.0) or very acid-sensitive (ANC $\leq$ 0 ueq L^{-1}) streams occur in Maryland than in the Southern Blue Ridge Province (sampled in the National Stream Survey). In particular, the South Coastal Plain and Appalachian Plateau have much larger proportions of acidic and very acid-sensitive streams than does the Southern Blue Ridge Province.

- The majority of streams with low to moderate pH are not apparently affected by organic acidity.

CHAPTER VI
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APPENDIX A

S U R V E Y   I M P L E M E N T A T I O N

Implementation of the MSSCS involved seven distinct activities:

- Development of a stream reach data base,
- Selection of stream reaches for water sample collection,
- Acquisition of site-specific information and permission to collect samples,
- Recruitment and organization of volunteers to supply manpower for sample collection activities,
- Establishment and implementation of logistic support for water sample collection,
- Analyses of water samples, and
- Development of a data base containing geographic and chemical data for the sampled reaches.

Each of these topics is discussed in detail in this appendix.

DEVELOPMENT OF STREAM REACH DATA BASE

A stream reach data base was developed to provide the basis for the selection of sampling sites and to record data associated with individual reaches during reach selection, field sampling, and laboratory analyses. The completed data base contains all data describing reach sampling status, hydrologic parameters, chemistry (if sampled), and pertinent QA/QC information.

The sampling unit employed during the MSSCS was a stream reach. Stream reaches were defined as segments of blue-line drainage features, depicted on United States Geological Survey (USGS) 1:250,000-scale topographic maps, that originate at downstream confluences with other stream reaches, reservoirs, tidal waters, or the Potomac or Susquehanna Rivers, and extend upstream to the end of the blue-line stream, a reservoir, or a confluence with another blue-line drainage feature.

Prior to identifying locations for water sample collection, a statewide reach list, or census, was developed of all non-tidal stream reaches in Maryland (except mainstem reaches of the Potomac and Susquehanna rivers). Tidally influenced stream reaches were identified from wetlands boundary maps developed by the Wetlands Division, Maryland Water Resources Administration. The tidally influenced segments of these reaches were eliminated from subsequent sampling. All remaining stream reaches having their lower confluences occurring within Maryland were digitized to determine the length and location of each reach.

REACH SELECTION

Historic water quality data for Maryland streams were evaluated to determine the most desirable distribution of the sampling effort among the six sampling strata (Figure I-2 of the text). Mean alkalinity data presented by Janicki and Greening (1987) were used to estimate the proportion of "sensitive" stream reaches (those having mean alkalinities below 200 ueq/l) in each of the strata. These proportions and the number of stream reaches per stratum were used to distribute the available sampling effort (no more than approximately 600 reaches could be sampled) among the strata in such a way as to minimize the relative error of statewide population estimates. The following equation was used to establish the "optimum" allocation of sampling effort among strata:

$$n_h = n \frac{N_h \sqrt{P_h Q_h}}{\sum_{h=1}^{L} N_h \sqrt{P_h Q_h}}$$

Where:

n_h = the number of reaches to be sampled from stratum h
n = the total number of reaches to be sampled
N_h = the total number of reaches in stratum h
P_h = the proportion of sensitive reaches in stratum h
Q_h = $1-P_h$
L = the total number of strata

Reaches were randomly selected from the list of reaches in each county-stratum, and a determination was made as to their membership in the population of interest. Selection continued until a sufficient number of reaches in the population of interest had been identified for each sampling stratum. The population of interest included all stream reaches that met the following criteria:

- Are non-tidal,
- Have drainage areas less than 100 km^2,
- Have reach lengths greater than 300 meters,
- Are unaffected by acid mine drainage or major point-source discharges, and
- Are not discharge streams from impoundments.

Stream reaches affected by industrial discharges and acid mine drainage were excluded from sampling whenever such information was obtained through communications with Project Foresters of the Maryland Forest, Park, and Wildlife Service; from observations made by volunteer samplers; from mapped information; or from the State of Maryland, Office of Environmental Programs regarding NPDES permits.

In addition to the randomly selected reaches, special interest reaches were identified throughout the state. Special interest reaches included stream reaches in three categories:

- Sites that state agency personnel requested to have sampled,
- Sites with historical water quality and flow data, and
- Sites previously included in acidification effects research.

SITE-SPECIFIC INFORMATION

To ensure that samples were collected from the selected reaches, it was necessary to identify and contact owners of adjacent property to obtain permission to collect water samples and to provide volunteer samplers with adequate information to guide them to the proper sampling site. The development of this site-specific information proceeded in several distinct steps.

Initially, all selected reaches were located and identified on USGS 7.5-minute topographic maps. Copies of these maps were distributed to the Project Foresters of the Maryland Forest, Park, and Wildlife Service in each county. Project Foresters also received blank copies of two questionnaires for each selected reach:

- A site access permission questionnaire was used to record the name of the landowner of the property adjacent to the preferred sample collection site and to provide a record of contact made with property owners; and
- A chemical discharges questionnaire was used to determine if, in the knowledge of the Project Forester or landowner, any chemical discharge or acid mine drainage affected the reach.

Project Foresters used county tax-map records to identify the owners of property adjacent to selected sampling locations. They then contacted the owners of privately owned sites or representatives of agencies responsible for managing state-owned sites to obtain site access permission. Project Foresters recorded the responses of land owners or managers on the questionnaires and returned completed copies of the questionnaires and maps to the project staff at IS&T. The IS&T project staff contacted managers of sites owned by Federal agencies to obtain access permission. Sites where access permission was granted were scheduled for sample collection.

When Project Foresters were unable to obtain access to an adequate number of sites within a county-stratum, members of the IS&T project staff pursued two courses to increase the number of permitted sites. First, attempts were made to contact property owners via telephone for all selected sites where a telephone number was available. Such attempts were continued until a sufficient number of sites were permitted (i.e., access permission was granted) or until the date of the scheduled sampling event. Second, certified letters were sent to all property owners who could not be contacted by telephone, but for whom addresses were known. A total of 79 certified letters were sent, resulting in 36 affirmative responses that allowed sampling of 40 reaches (some property owners controlled access to multiple reaches).

All contacts with property owners were documented on a master list for each county-stratum. These lists were used to determine the number of permitted sites to visit for water sample collection on each sampling date.

VOLUNTEER RECRUITMENT AND ORGANIZATION

Volunteers were recruited and organized with the assistance of J.W. Gracie and Associates (JWGA). Volunteer recruitment included the following activities:

- Issuing press releases to all newspapers in Maryland,
- Corresponding with conservation, fishing and hunting, and environmental organizations in Maryland to describe the program and assess their interest in participation,
- Presenting a slide show to organizations that responded favorably,
- Corresponding with volunteers, and
- Mobilizing volunteers on sample collection dates.

Press releases were sent to over 100 newspapers, magazines, and newsletters throughout the state; letters were sent to over 90 organizations; four direct-mail solicitations were sent to members of conservation organizations; and thirty-one presentations were made by JWGA and IS&T staff members at meetings of interested groups. As a result of these efforts, 353 individuals volunteered to participate as samplers. Of these, 223 (63%) actually participated on at least one sample collection date. A total of approximately 300 volunteer days were expended in collecting water samples.

WATER SAMPLE COLLECTION

Sample collection was coordinated regionally, with one or two field headquarters located within each of eight sampling regions. Sampling regions were selected to maximize logistic efficiency during sample collection and to facilitate adherence to a sampling schedule designed to maintain phenologically constant timing of water sample collection. The boundaries of sampling regions are shown in Figure A-1. Facilities that were used as field headquarters in the survey are listed in Table A-1.

On sampling dates, volunteers were assembled at field headquarters sites. IS&T personnel trained volunteers in sample collection protocols, provided a brief overview of map reading skills, and discussed safety issues. Teams of volunteers were assigned a number of stream reaches to sample. For each reach, volunteers were provided with information packets containing site maps, copies of site access permission forms, and written protocols for sample collection. Kits containing all supplies necessary for sample collection also were distributed. Volunteer samplers were assigned to collect duplicate samples from at least 10% of all reaches sampled on each sample date.

Volunteer samplers collected 93% of the samples taken from randomly selected and special interest stream reaches during the survey. The remaining 7% of the samples were collected by IS&T personnel. Twenty-seven fewer reaches were sampled than were selected for sampling, because some sites were unsampleable (e.g., dry or unsafe) and access permission could not be obtained for enough sites in a few county-strata.

Volunteer sampling teams were accompanied by field procedure auditors to 72 (12%) of the 598 streams they sampled. Auditors completed questionnaires that addressed the accuracy with which selected reaches were located, the choice of appropriate sample collection locations within the reaches, application of sample collection protocols, and sample handling practices.

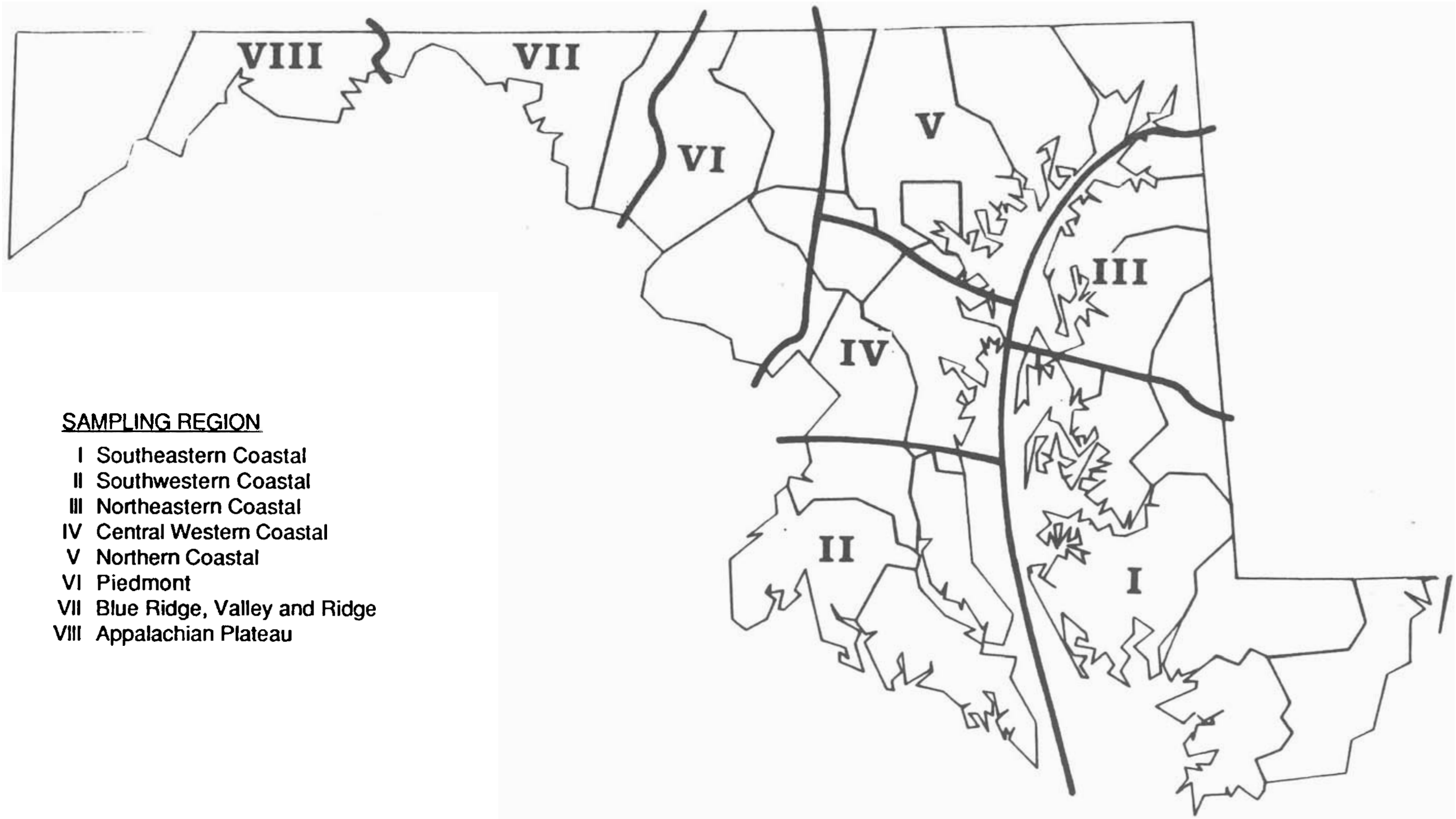

FIGURE A-1. MSSCS FIELD SAMPLING REGIONS.

TABLE A-1. FIELD OPERATIONS SCHEDULE

SAMPLING REGION	DATES SAMPLED	FIELD HEADQUARTERS LOCATION
I	March 7, 14	Salisbury State College, Salisbury Easton High School, Easton
II	March 14, 21	Charles County Community College, La Plata
III	March 21, 28	Kennedyville Community Hall, Kennedyville
IV	March 28, April 4	Bowie State College, Bowie
V	April 4, 11	Susquehannock Environmental Center, Bel Air Towson Methodist Church, Towson
VI	April 11, 25*	Mt. Airy Middle School, Mt. Airy
VII	April 25, May 2	Hagerstown Hospital, Hagerstown
VIII	May 2, 9	Rocky Gap State Park, Rocky Gap New Germany State Park, New Germany

*Samples were not collected on the holiday weekend of April 18.

Teams returned to the field headquarters to deliver collected samples. Upon return, the volunteer samplers were interviewed by an IS&T representative to ensure that any field conditions that might affect water quality were noted, and to verify that the samples were indeed collected from the designated reaches. All samples then were transported to the IS&T laboratory in Sterling, VA, for analysis.

LABORATORY ACTIVITIES

Analysis of sample chemistry began the day after sample collection, to ensure analysis of dissolved inorganic carbon (DIC) and pH within specified holding times (Table II-3 of the text). All DIC and pH analyses were completed within 36 hours of sample collection, as were conductivity and true color analyses; although, analyses of the last two parameters were not required within that period. All analyses of acid neutralizing capacity (ANC) and acidity were completed within 7 days of sample collection. All analyses of dissolved organic carbon (DOC) were completed within 14 days of sample collection. All parameters for all samples were analyzed prior to expiration of their respective holding times.

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APPENDIX B

QUALITY ASSURANCE / QUALITY CONTROL FOR THE MARYLAND SYNOPTIC STREAM CHEMISTRY SURVEY

One of the objectives of the MSSCS was to provide a comprehensive Quality Assurance and Quality Control (QA/QC) program to assure that all data used in development of population estimates were correct and of definable levels of precision. To satisfy this objective, QA/QC procedures were employed throughout all sample collection and analysis activities to identify data that were not of suitable quality for inclusion in subsequent analyses.

Data so identified were eliminated from analysis only if they also were identified as outliers (i.e., displayed anomalous characteristics) during subsequent data screening. This appendix describes the methods used to identify and evaluate potentially compromised samples and data, to screen data for outliers, and to control the quality of laboratory procedures. It also presents the QA/QC results and indicates how these data were used in development of population estimates.

METHODS

During the design of the MSSCS, procedures were developed to ensure the accuracy and precision of all data for stream reaches identified for water sample collection. Data generated during the survey were incorporated into two data bases (geographic and water chemistry) that were related by the stream reach identification number. All QA/QC information relevant to data values for each stream reach were included in the appropriate data base.

Geographic Data Base

Stream reach information was developed as described in Appendix A. Information incorporated into the geographic data base included the following: stream reach and watershed area data derived from 1:250,000 and 1:24,000 scale USGS topographic maps, comments made by the Project Foresters regarding land use, NPDES permitted discharge location information, notes on conditions observed by volunteer samplers, and geographic observations made by field auditors. Information obtained from Project Foresters, volunteer samplers, and field auditors was entered into the data base for each site where such observations were available. A listing of the geographic coordinates of all NPDES permitted discharges in Maryland was obtained and used to identify NPDES point sources located within 0.5 km of a reach. When an NPDES discharge was located within 0.5 km of several reaches, the discharge was considered to enter the nearest reach. The following NPDES discharges were not associated with stream reaches in the data base:

- Discharges greater than 0.5 km distant from a non-tidal reach indicated on the 1:250,000-scale USGS maps,
- Discharges into tidal or estuarine waters, and
- Discharges entering directly into the Potomac or Susquehanna Rivers at a distance greater than 0.5 km from a tributary to those rivers.

Stream reach location data were checked for accuracy and completeness by verifying drainage system connections and by visually comparing maps of stream reach locations with USGS 1:250,000-scale Mylar transparency overlay maps of drainage features. All errors discovered in this process were corrected prior to selection of stream reaches for sampling.

Watersheds of all streams selected for sampling were delineated and measured on the 1:250,000-scale maps to determine watershed area. Within each county-stratum, the area of a minimum of 10 percent of the watersheds of sampled streams were delineated and measured for a second time to determine the error rate associated with determination of watershed area. Percent relative standard deviations (i.e., %RSD or coefficients of variation) were calculated using the original and replicated watershed areas. A statewide arithmetic mean %RSD was calculated, as was an arithmetic mean %RSD for each of the strata.

Water Chemistry Data Base

In addition to the results of chemical analyses of stream water samples, the following QA/QC data generated during collection and analyses of samples were incorporated into the water chemistry data base:

- Observations made by volunteer samplers,
- Results of field sample collection audits, and
- Observations of sample condition upon receipt at the laboratory.

Analytical results and QA/QC comments regarding samples and analyses were entered into a raw data base. This data base was manually and electronically inspected to ensure the accuracy of the data as it was stored electronically (data verification) and the reasonableness and internal consistency of the data values (data validation).

Volunteer Sampler Observations

Upon returning with samples to the regional base sites, volunteer samplers were interviewed to ascertain whether or not the samples were collected from the designated reaches and to determine if any conditions such as construction or agricultural activities that could affect the quality of the samples existed in the vicinity of the sampling site. The results of the interviews were recorded and comments were attached to individual sample records in either the geographic or chemical data bases, as appropriate.

Field Auditor Observations

Systems audits of field sampling operations were conducted to document the accuracy of volunteer sampler adherence to prescribed protocols during sample collection. This audit was applied uniformly throughout the program, with the exception that no audits were conducted during the final week of sample collection. Audit results were reviewed weekly to maximize the usefulness of the audit in revising training presentations to prevent errors in application of sampling protocols or in locating sites. Systems audits were conducted at 11.5% of the streams sampled by volunteers. Auditors, who were trained in sample collection protocols, used checklists to ensure that all essential elements of the sample collection process were observed and documented. The results of these systems audits were recorded. Appropriate comments were inserted into the water chemistry data base for each sample where water quality may have been compromised during sample collection.

Sample Condition

Samples were delivered to the laboratory on the day they were collected. The temperature of each shipping container was checked upon receipt to verify sample preservation. The stream identifier for each sample was recorded and a laboratory sample number was assigned. A permanent sample label log was kept for verification of sample information. Samples that contained visible sediment or an air bubble $\geq$ 10 ml (in 1000 ml of sample), or that had damaged bottles or illegible labels were identified and their condition recorded in the data base.

Data Verification

All analytical results, as well as data generated by volunteer samplers and auditors, were transcribed by computer key entry. Verification of analytical data entry was performed by duplicate transcription into two separate computer files. Differences between the two files were resolved by reference to the original records. Reports were prepared that included all data for each batch of samples. These batch reports were transferred to the data base management system on computer diskettes. Printed copies of these files were used as journals for recording the results of QA evaluations. Occasional errors, such as erroneously recorded site identifications, typographical errors, or missing QA information were corrected from laboratory log books or field notes.

Data Validation

After data were fully verified, the data set was validated. Because of the limited number of parameters, validation of chemistry data using mass balance and ion balance models was not possible. Validation employed reasonableness checks utilizing regional data and known correlation data for MSSCS parameters from the National Surface Water Survey-Eastern Lake Survey (Linthurst, et al, 1986). Validation of ANC results used cross checks of double endpoint alkalinity values, calculated alkalinity values, and a pH-DIC relational model to identify possible outlier values. ANC values not within acceptance criteria were recalculated. In some cases titration files were corrected for outlier titration values. The complete chemistry data base for the MSSCS comprised three separate components: a raw data base, a verified data base, and a validated data base. The validated data base, containing sample data and quality assurance and quality control data, was used for data analysis and interpretation.

Data Screening

Data screening, a preliminary data analysis activity, was conducted to identify measurements that had values outside of their expected ranges, with reference to univariate and/or bivariate characteristics of the distribution of chemistry and geographic data. QA/QC data associated with outlier chemistry values were used to eliminate potentially compromised outlier values from the data set prior to the development of population estimates. Similarly, outlier values for geographic data were verified or corrected prior to development of population estimates.

RESULTS

Geographic Data

All errors associated with identification of stream reaches, identification of reach confluences, and lengths of stream reaches were corrected prior to selection of stream reaches for sample collection. Duplicate delineation and measurement of watershed areas of reaches selected for sample collection indicated that in four of the six strata (North Coastal Plain, Piedmont, Valley and Ridge, and Appalachian Plateau), mean %RSD values were less than 10.0%, the QA goal for watershed area determination. The mean %RSD exceeded 10.0% in the Blue Ridge (10.9%) and South Coastal Plain (11.3%) strata. However, higher %RSD values were expected in these areas. Watershed areas in the Blue Ridge were generally smaller than those in other strata, thereby increasing the relative magnitude of discrepancies between measurements. Lack of topographic relief and the resulting difficulty in defining the boundaries of watersheds in the South Coastal Plain are responsible for the comparatively high %RSD in this stratum. The statewide arithmetic mean %RSD for watershed area determination was 8.1% (based on 85 sites).

Of 1021 NPDES discharges identified in Maryland, 468 were associated with 393 reaches in the data base. NPDES permits were associated with 25 of the reaches selected as part of the random sample. These discharge locations were plotted on the 1:24,000-scale maps used to identify the preferred sample collection location. If the discharge location was upstream of the location where the sample was collected, the sample was excluded from further analysis. Sixteen reaches were excluded from analysis based on the presence of NPDES discharges identified after sample collection.

Water Chemistry Data

Incorrect reaches were sampled in eleven instances, as determined by auditors and interviews with volunteers. In five of these cases, after the mistake was discovered a sample was collected from the correct reach. In these cases, the geographic and chemistry data for the correct reach were used in development of population estimates. In five of the remaining cases of mistaken reach identity, the geographic data for the reach actually sampled were associated with the water chemistry data from the sampled reach, and these data were used in population estimation procedures. In the final case, the incorrectly sampled reach was not part of the population of interest, because it was too small to be represented on the 1:250,000-scale maps. In this case, the chemistry data for this incorrectly sampled reach were not used in development of population estimates.

The chemistry data were analyzed by one-way analysis of variance to detect bias that may have been caused by data from samples that were identified as potentially compromised. Thirty-four pH values were identified as potentially compromised by entrainment of sediments or air in the sample, by having been collected with inadequate rinsing of the sample container, or by having been collected downstream from a potential source of contamination such as a bridge or highway culvert. Eight of these samples were from the South Coastal Plain, five were from the North Coastal Plain, six were from the Piedmont, three were from the Valley and Ridge, and 12 were from the Appalachian Plateau stratum. None of the samples collected in the Blue Ridge stratum were identified as potentially compromised. No significant differences were observed between potentially compromised samples and the remainder of the samples for each stratum and for all strata together, at the 5% level of significance.

Thirty-three ANC values were identified as potentially compromised (eight in the South Coastal Plain, four in the North Coastal Plain, six in the Piedmont, three in the Valley and Ridge, and 12 in the Appalachian Plateau). One-way analysis of variance indicated that the differences between the potentially compromised samples and the remaining samples were not significant ($\alpha = 0.05$) for the South Coastal Plain, North Coastal Plain, and Valley and Ridge strata and for all strata combined. Unequal variances of the potentially compromised and uncompromised data sets for the Piedmont and Appalachian Plateau required the use of non-parametric analysis of these data. The Kolmogrov-Smirnov two-sample test was not significant for either stratum ($\alpha = 0.05$).

Laboratory QA/QC

All instruments used in laboratory analyses (a Dohrman-Xertex DC 80 Carbon Analyzer, Orion Models 611 and 940 pH Meters with Orion No. 8104 glass combination electrodes, and a YSI Model 32 conductivity bridge), were calibrated at the start of each day of sample analysis. Independent quality control check standards were analyzed immediately following calibration, after analysis of every 8-10 samples in a batch, and at the end of the analytical batch to confirm calibration. Criteria for successful QCCS were as follows:

PARAMETER	QCCS VALUE	ACCEPTABLE RANGE
pH	4.00 units	$\pm$0.10 units
DIC	2.000 or 20.0 mg L^{-1}	$\pm$10%
DOC	1.00 or 10.0 mg L^{-1}	$\pm$10%
Conductivity	14.7 or 147.2 us/cm	$\pm$2.0%
ANC	Blank	$\leq$ 10 ueq L^{-1}

Instruments failing to meet these criteria during sample analysis were recalibrated and affected samples were reanalyzed.

Sample holding times prior to analysis were 36 hours for pH and DIC, 7 days for color and conductivity, and 14 days for ANC and DOC. All analyses were completed within the required holding times.

Detection limits (DL's) were determined monthly during the survey. The average DL's were as follows: DIC = 0.062 mg L^{-1}, DOC = 0.11 mg L^{-1}, conductivity = 0.20 uS/cm. The average sensitivity for the ANC - Gran titration was 9.7 ueq L^{-1}, which was calculated from the mean of the absolute values for blank titrations. The detection limit for color was approximately 2 PCU, which was the mean of three blank measurments performed by two technicians. Detection limits are not applicable to pH determinations.

Analytical precision for each parameter was determined from the analysis of laboratory duplicate (split) samples. Results of the duplicate analyses are as follows:

PARAMETER	NUMBER OF DETERMINATIONS	PRECISION
pH	40	±0.02 pH units
DIC	40	1.21% RSD
DOC	36	3.33% RSD
Conductivity	42	0.17% RSD
ANC	41	4.05% RSD

Analytical precision for true color was only successfully determined for two samples, due to the frequency of occurrence of color measurements below the detection limit of the method. Precision estimates for color therefore were not meaningful, because only two sets of measurements exceeded the detection limit of the method.

Performance audit samples (samples with known analytical characteristics) were used to assess analytical accuracy independent of quality control check standards. Both natural and synthetic audit samples were used in each MSSCS batch. These samples represented both low and high values of ANC and conductivity. Synthetic audit materials were prepared prior to receipt of each sample batch. Natural audit samples used were collected from Bagley Lake in the State of Washington and Baker Pond in Massachusetts.

Natural audit materials were assayed at three referee laboratories. Analytical results for the referee laboratories (n=10) were compared to the overall mean results of analyses at the IS&T laboratory. The results indicate the following biases: -0.08 units for pH, +7.98% for DIC, +12.2% for DOC, +10.0% for conductivity, and -1.3% for ANC.

Results of the analysis of synthetic audit samples (n=28) were compared to the theoretical composition of each sample. The synthetic audit samples were not analyzed independently. Biases were: +6.6% for DIC, +5.98% for DOC, +8.23% for conductivity and +5.03% for ANC.

Field duplicate samples were analyzed for 11.35% of routine samples analyzed. Field duplicates differed from laboratory duplicates in that they were second field collections, collected by the same sample team, within moments of the routine sample collection. Thus, the differences in analyte concentrations between a routine sample and its field duplicate included analytical imprecision, short-term variation in stream chemistry, and system variability due to the process of sample collection, handling, and shipment. Results of the field duplicate analyses are as follows:

PARAMETER	NUMBER OF DETERMINATIONS	MEAN PRECISION
pH	73	±0.11 pH Units
DIC	73	2.67% RSD
DOC	73	11.27% RSD
Conductivity	73	1.67% RSD
ANC	73	6.47% RSD

True color in all field routine-duplicate pairs was below quantification and does not support a calculation of precision.

Data Screening

For each of the six chemical-physical parameters measured for water samples (i.e., pH, ANC, DIC, DOC, conductivity, and color) a univariate frequency tabulation was prepared and obvious outlier values were identified. Outlier values also were identified using bivariate scatter plots of parameters that were found to be correlated ($r \geq 0.45$). The sampling QA information on each outlier value was reviewed for evidence of sample contamination reported by either the sampler (e.g., reaches affected by agricultural activities or construction at the time of sampling) or by laboratory personnel, (e.g., excess air or sediment in the sample, leaky sample container). If evidence of potential sample contamination was found for an outlier, then the data for that sample (all parameters) were excluded from further analyses. A total of eight samples were excluded from further analyses using outlier identification coupled with examination of sample QA data.

Data for reach order, reach watershed area, and reach drainage length were reviewed using outlier identification procedures similar to those used for chemistry data. Extreme values and outliers were identified. The maps from which the data had been developed were consulted and the outlier values confirmed or corrected. Samples were not excluded from the data base as a result of this review.

A total of 559 samples were collected from stream reaches selected as part of the stratified random sample for the MSSCS. Following elimination of outliers (eight samples) and samples affected by NPDES discharges (16 samples), samples from 535 reaches were considered acceptable for subsequent use in developing population estimates and data analyses.

REFERENCES

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APPENDIX C

P O P U L A T I O N   E S T I M A T I O N   E Q U A T I O N S

For each county-stratum, h, define the following variables:

n_h = The number of reaches randomly selected from the original list frame for examination as sampling sites,

N_h = The number of reaches in the list frame (after eliminating reaches smaller than 0.3 km, reaches draining impoundments, or reaches directly affected by NPDES discharges) from which the random sample was drawn.

For each of the n_h selected reaches ($i = 1, 2, ..., n_h$), define the following variables:

$$e_{i,h} = \begin{cases} \text{"0" if reach i was excluded prior to attempting to sample the reach;} \\ \text{"1" otherwise,} \end{cases}$$

$$f_{i,h} = \begin{cases} \text{"0" if reach i was excluded for a reason discovered at the time the reach was to be sampled;} \\ \text{"1" otherwise,} \end{cases}$$

$$x_{i,h} = e_{i,h} \bullet f_{i,h},$$

$L_{i,h}$ = length of reach i,

$$w_{i,h} = x_{i,h} \bullet L_{i,h}.$$

For each county - stratum, compute estimates of the total population of interest ($\hat{X}_h$) and total number of kilometers of interest ($\hat{W}_h$):

$$\hat{X}_h = \frac{N_h}{n_h} \sum_{i=1}^{n_h} x_{i,h} \, ,$$

$$\hat{W}_h = \frac{N_h}{n_h} \sum_{i=1}^{n_h} w_{i,h}$$

Variances of these two estimates are computed as follows:

$$\mathrm{VAR}\,(\hat{X}_h) = N_h^2 \bullet \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \bullet \left[\sum_{i=1}^{n_h} \left[\left(x_{i,h} - \frac{\hat{X}_h}{N_h}\right)^2\right]\right] \Big/ (n_h - 1) \, ,$$

$$\mathrm{VAR}\,(\hat{W}_h) = N_h^2 \bullet \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \bullet \left[\sum_{i=1}^{n_h} \left[\left(w_{i,h} - \frac{\hat{W}_h}{N_h}\right)^2\right]\right] \Big/ (n_h$$

For stratum or statewide population estimates:

H = number of county-stratum within the stratum or state,

$$\hat{X} = \sum_{h=1}^{H} \hat{X}_h ,$$

$$\hat{W} = \sum_{h=1}^{H} \hat{W}_h ,$$

$$VAR(\hat{X}) = \sum_{h=1}^{H} VAR(\hat{X}_h) ,$$

$$VAR(\hat{W}) = \sum_{h=1}^{H} VAR(\hat{W}_h) .$$

To compute the number of reaches or kilometers less than or equal to a specific parameter value:

$$g \quad = \quad \text{specific parameter value,}$$

$$d_{i,h} \quad = \quad \begin{cases} \text{"1" if the mean (over duplicates) sample value was} \le g, \\ \text{"0" otherwise,} \end{cases}$$

$$y_{i,h} \quad = \quad x_{i,h} \cdot d_{i,h},$$

$$z_{i,h} \quad = \quad w_{i,h} \cdot d_{i,h}$$

Estimates of the total number of reaches or kilometers at or below level g for a county-stratum are computed as follows:

$$\hat{Y}_h \quad = \quad \frac{N_h}{n_h} \sum_{i=1}^{n_h} y_{i,h} .$$

$$\hat{Z}_h \quad = \quad \frac{N_h}{n_h} \sum_{i=1}^{n_h} z_{i,h} .$$

Variance and covariance estimates are calculated as follows:

$$VAR(\hat{Y}_h) = N_h^2 \cdot \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \cdot \left[\sum_{i=1}^{n_h}\left[\left(y_{i,h} - \frac{\hat{Y}_h}{N_h}\right)^2\right]\right] \Big/ (n_h - 1) \; .$$

$$COV(\hat{X}_{h}, \hat{Y}_h) = N_h^2 \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \cdot \frac{\sum_{i=1}^{n_h}\left[\left(x_{i,h} - \frac{\hat{X}_h}{N_h}\right) \cdot \left(y_{i,h} - \frac{\hat{Y}_h}{N_h}\right)\right]}{(n_h - 1)} \; .$$

$$VAR(\hat{Z}_h) = N_h^2 \cdot \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \cdot \left[\sum_{i=1}^{n_h}\left[\left(z_{i,h} - \frac{\hat{Z}_h}{N_h}\right)^2\right]\right] \Big/ (n_h - 1) \; .$$

$$COV(\hat{W}_{h}, \hat{Z}_h) = N_h^2 \left[\frac{1}{n_h} - \frac{1}{N_h}\right] \cdot \frac{\sum_{i=1}^{n_h}\left[\left(w_{i,h} - \frac{\hat{W}_h}{N_h}\right) \cdot \left(z_{i,h} - \frac{\hat{Z}_h}{N_h}\right)\right]}{(n_h - 1)} \; .$$

For stratum or statewide estimates of number of reaches or kilometers at or below level g:

$$\hat{Y} = \sum_{h=1}^{H} \hat{Y}_h \quad ,$$

$$\hat{Z} = \sum_{h=1}^{H} \hat{Z}_h \quad ,$$

$$VAR(\hat{Y}) = \sum_{h=1}^{H} VAR(\hat{Y}_h) \quad ,$$

$$VAR(\hat{Z}) = \sum_{h=1}^{H} VAR(\hat{Z}_h) \quad ,$$

$$COV(\hat{X}, \hat{Y}) = \sum_{h=1}^{H} COV(\hat{X}_h, \hat{Y}_h) \quad ,$$

$$COV(\hat{W}, \hat{Z}) = \sum_{h=1}^{H} COV(\hat{W}_h, \hat{Z}_h) \quad .$$

Estimates of the proportion of reaches or kilometers at or below level g are computed as follows:

$$\hat{P}_y = \frac{\hat{Y}}{\hat{X}} ,$$

$$\hat{P}_z = \frac{\hat{Z}}{\hat{W}} .$$

Variances of the probabilities are estimated from the following equations:

$$\mathrm{VAR}\left(\hat{P}_y\right) = (\hat{P}_y)^2 \bullet \left[\frac{\mathrm{VAR}\,(\hat{Y})}{(\hat{Y})^2} + \frac{\mathrm{VAR}\,(\hat{X})}{(\hat{X})^2} - \frac{2\mathrm{COV}(\hat{X},\hat{Y})}{\hat{X} \cdot \hat{Y}} \right] ,$$

$$\mathrm{VAR}\left(\hat{P}_z\right) = (\hat{P}_z)^2 \bullet \left[\frac{\mathrm{VAR}\,(\hat{Z})}{(\hat{Z})^2} + \frac{\mathrm{VAR}\,(\hat{W})}{(\hat{W})^2} - \frac{2\mathrm{COV}(W,Z)}{\hat{W} \cdot \hat{Z}} \right] .$$

Confidence limits are computed as follows:

$$95\%\ \text{Confidence limits of } \hat{P}_y = \hat{P}_y \pm 2 \bullet \sqrt{VAR(\hat{P}_y)} \quad ,$$

$$95\%\ \text{Confidence limits of } \hat{P}_z = \hat{P}_z \pm 2 \bullet \sqrt{VAR(\hat{P}_z)} \quad .$$

APPENDIX D

P O P U L A T I O N   E S T I M A T I O N   R E S U L T S

The following tables present statewide and stratum-specific population estimates for pH and ANC. The following are definitions for column headings in Tables D-1 through D-14:

- Y est = the estimated number of reaches below the specified level of pH or ANC
- MIN Y = the lower boundary of the 95% confidence interval for Y est
- MAX Y = the upper boundary of the 95% confidence interval for Y est
- Py = the estimated proportion of reaches in the population of interest below the specified level of pH or ANC
- MIN Py = the lower boundary of the 95% confidence interval for Py
- MAX Py the upper boundary of the 95% confidence interval for Py
- Z est = the estimated number of stream kilometers below the specified level of pH or ANC
- MIN Z = the lower boundary of the 95% confidence interval for Z est
- MAX Z = the upper boundary of the 95% confidence interval for Z est
- Pz = the estimated proportion of stream kilometers below the specified level of pH or ANC
- MIN Pz = the lower boundary of the 95% confidence interval for Pz
- MAX Pz = the upper boundary of the 95% confidence interval for Pz

TABLE D-1. ESTIMATED STATEWIDE DISTRIBUTION OF ANC IN STREAMS

Estimated number of reaches = 5411 ± 159

Estimated total length of streams (km) = 12499 ± 810

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	32	-4	68	0.0059	0.0000	0.0126	94.1	-22.4	210.7	0.0075	0.0000	0.0169
-25	66	18	113	0.0122	0.0034	0.0209	158.1	25.8	290.3	0.0126	0.0020	0.0232
0	181	110	252	0.0334	0.0203	0.0466	453.1	232.6	673.5	0.0363	0.0187	0.0538
25	370	271	469	0.0685	0.0502	0.0867	991.0	690.3	1291.6	0.0793	0.0554	0.1032
50	483	373	594	0.0893	0.0690	0.1096	1249.0	913.3	1584.7	0.0999	0.0734	0.1265
75	651	529	772	0.1203	0.0980	0.1426	1612.3	1254.8	1969.7	0.1290	0.1007	0.1573
100	863	729	998	0.1595	0.1349	0.1842	1991.6	1619.0	2364.2	0.1593	0.1295	0.1892
125	1087	940	1234	0.2009	0.1741	0.2277	2569.4	2110.5	3028.4	0.2056	0.1701	0.2410
150	1230	1077	1382	0.2273	0.1996	0.2549	3029.4	2523.2	3535.6	0.2424	0.2043	0.2805
175	1513	1348	1678	0.2796	0.2499	0.3094	3678.4	3137.2	4219.6	0.2943	0.2541	0.3345
200	1725	1545	1905	0.3188	0.2864	0.3512	4169.4	3575.4	4763.4	0.3336	0.2905	0.3767
250	2119	1914	2323	0.3916	0.3552	0.4280	5192.8	4510.2	5875.5	0.4155	0.3674	0.4635
300	2419	2207	2631	0.4470	0.4096	0.4845	6020.9	5291.8	6749.9	0.4817	0.4325	0.5309
350	2738	2505	2971	0.5061	0.4651	0.5470	6838.8	6041.7	7635.8	0.5472	0.4969	0.5974
400	3087	2842	3332	0.5705	0.5279	0.6130	7535.7	6720.8	8350.6	0.6029	0.5520	0.6539
450	3368	3121	3615	0.6225	0.5802	0.6648	8035.1	7210.6	8859.7	0.6429	0.5923	0.6934
500	3630	3381	3880	0.6709	0.6290	0.7128	8605.2	7765.2	9445.3	0.6885	0.6394	0.7376
600	4003	3758	4248	0.7398	0.6998	0.7797	9460.8	8590.2	10331.4	0.7570	0.7116	0.8023
700	4230	3991	4469	0.7817	0.7438	0.8195	9963.8	9087.7	10839.8	0.7972	0.7555	0.8388
800	4417	4185	4648	0.8162	0.7809	0.8515	10390.2	9516.5	11263.9	0.8313	0.7926	0.8701
900	4580	4355	4804	0.8464	0.8136	0.8791	10705.1	9842.1	11568.1	0.8565	0.8207	0.8923
1000	4762	4555	4970	0.8801	0.8523	0.9080	11115.4	10266.2	11964.7	0.8893	0.8589	0.9197
1500	5077	4893	5260	0.9382	0.9191	0.9573	11777.8	10955.5	12600.0	0.9423	0.9223	0.9624
2000	5221	5056	5386	0.9649	0.9548	0.9750	12055.8	11248.1	12863.6	0.9646	0.9544	0.9748
2500	5231	5067	5395	0.9667	0.9571	0.9764	12073.0	11265.5	12880.4	0.9659	0.9560	0.9759
3000	5249	5086	5412	0.9701	0.9614	0.9788	12111.7	11304.8	12918.6	0.9690	0.9600	0.9781
4000	5292	5130	5454	0.9780	0.9705	0.9855	12215.8	11407.7	13024.0	0.9774	0.9694	0.9853
5000	5363	5204	5522	0.9911	0.9875	0.9946	12376.2	11567.2	13185.2	0.9902	0.9845	0.9959
6000	5411	5252	5570	1.0000	1.0000	1.0000	12498.6	11688.7	13308.5	1.0000	1.0000	1.0000

TABLE D-2. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE APPALACHIAN PLATEAU

Estimated number of reaches = 1153 ± 68

Estimated total length of streams (km) = 1917 ± 223

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	8	-7	23	0.0070	0.0000	0.0202	10.6	-9.2	30.3	0.0055	0.0000	0.0159
-25	33	3	62	0.0282	0.0025	0.0539	63.4	1.4	125.4	0.0331	0.0007	0.0654
0	82	36	128	0.0710	0.0316	0.1104	205.2	58.4	352.1	0.1070	0.0345	0.1795
25	107	55	158	0.0926	0.0481	0.1372	234.1	85.1	383.1	0.1221	0.0487	0.1955
50	149	89	209	0.1289	0.0774	0.1804	300.8	142.6	458.9	0.1569	0.0797	0.2340
75	199	131	267	0.1727	0.1144	0.2311	393.4	221.2	565.5	0.2052	0.1228	0.2876
100	293	212	373	0.2538	0.1860	0.3216	498.4	321.8	675.1	0.2599	0.1752	0.3447
125	385	298	473	0.3344	0.2613	0.4075	633.6	448.3	818.8	0.3304	0.2425	0.4183
150	454	362	546	0.3940	0.3177	0.4703	759.8	560.7	958.9	0.3963	0.3051	0.4875
175	556	461	652	0.4826	0.4051	0.5602	953.0	735.6	1170.5	0.4970	0.4053	0.5888
200	598	503	694	0.5189	0.4422	0.5956	1022.0	803.6	1240.5	0.5330	0.4424	0.6236
250	731	640	823	0.6342	0.5647	0.7037	1299.8	1074.0	1525.7	0.6779	0.6027	0.7531
300	835	745	925	0.7246	0.6601	0.7891	1498.9	1266.4	1731.3	0.7817	0.7191	0.8443
350	863	772	955	0.7491	0.6836	0.8146	1548.5	1313.1	1783.9	0.8076	0.7456	0.8696
400	892	800	985	0.7741	0.7085	0.8397	1585.6	1349.8	1821.3	0.8269	0.7650	0.8888
450	911	819	1003	0.7904	0.7256	0.8552	1598.3	1363.3	1833.2	0.8336	0.7718	0.8953
500	928	837	1019	0.8050	0.7422	0.8678	1623.8	1389.9	1857.8	0.8469	0.7874	0.9063
600	954	865	1043	0.8277	0.7676	0.8878	1649.1	1416.1	1882.1	0.8601	0.8023	0.9178
700	981	893	1069	0.8510	0.7939	0.9082	1672.5	1441.6	1903.4	0.8723	0.8152	0.9293
800	1018	933	1103	0.8831	0.8309	0.9353	1750.4	1516.8	1984.1	0.9129	0.8701	0.9557
900	1018	933	1103	0.8831	0.8309	0.9353	1750.4	1516.8	1984.1	0.9129	0.8701	0.9557
1000	1018	933	1103	0.8831	0.8309	0.9353	1750.4	1516.8	1984.1	0.9129	0.8701	0.9557
1500	1070	990	1150	0.9284	0.8858	0.9711	1812.3	1581.8	2042.7	0.9452	0.9096	0.9807
2000	1079	1000	1158	0.9360	0.8955	0.9765	1819.2	1589.5	2049.0	0.9488	0.9138	0.9838
2500	1089	1011	1167	0.9447	0.9066	0.9829	1836.4	1607.5	2065.2	0.9577	0.9261	0.9893
3000	1098	1021	1174	0.9523	0.9166	0.9880	1856.4	1627.4	2085.3	0.9682	0.9430	0.9934
4000	1116	1043	1190	0.9686	0.9392	0.9980	1883.0	1656.1	2109.8	0.9820	0.9648	0.9992
5000	1153	1085	1220	1.0000	1.0000	1.0000	1917.4	1694.5	2140.4	1.0000	1.0000	1.0000

TABLE D-3. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE VALLEY & RIDGE

Estimated number of reaches = 159 ± 18

Estimated total length of streams (km) = 417 ± 96

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
-25	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
25	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
50	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
75	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
100	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
125	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
150	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
175	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
200	3	-2	9	0.0217	0.0000	0.0583	6.2	-4.3	16.7	0.0149	0.0000	0.0403
250	3	-2	9	0.0217	0.0000	0.0583	6.2	-4.3	16.7	0.0149	0.0000	0.0403
300	10	0	20	0.0652	0.0033	0.1271	23.1	0.6	45.6	0.0554	0.0003	0.1105
350	10	0	20	0.0652	0.0033	0.1271	23.1	0.6	45.6	0.0554	0.0003	0.1105
400	10	0	20	0.0652	0.0033	0.1271	23.1	0.6	45.6	0.0554	0.0003	0.1105
450	10	0	20	0.0652	0.0033	0.1271	23.1	0.6	45.6	0.0554	0.0003	0.1105
500	14	2	25	0.0870	0.0163	0.1576	28.6	4.5	52.7	0.0687	0.0090	0.1283
600	21	7	34	0.1304	0.0460	0.2148	35.2	10.0	60.4	0.0844	0.0207	0.1481
700	24	10	39	0.1522	0.0621	0.2422	42.1	14.8	69.4	0.1009	0.0311	0.1707
800	24	10	39	0.1522	0.0621	0.2422	42.1	14.8	69.4	0.1009	0.0311	0.1707
900	28	12	43	0.1739	0.0789	0.2689	51.4	20.5	82.2	0.1232	0.0442	0.2023
1000	28	12	43	0.1739	0.0789	0.2689	51.4	20.5	82.2	0.1232	0.0442	0.2023
1500	38	20	55	0.2391	0.1322	0.3460	79.3	40.0	118.6	0.1902	0.0886	0.2918
2000	52	32	71	0.3261	0.2086	0.4436	91.0	51.5	130.6	0.2184	0.1121	0.3246
2500	52	32	71	0.3261	0.2086	0.4436	91.0	51.5	130.6	0.2184	0.1121	0.3246
3000	52	32	71	0.3261	0.2086	0.4436	91.0	51.5	130.6	0.2184	0.1121	0.3246
4000	76	54	98	0.4783	0.3531	0.6035	168.6	101.1	236.2	0.4045	0.2518	0.5571
5000	110	88	133	0.6957	0.5803	0.8110	294.5	206.7	382.2	0.7064	0.5564	0.8563
6000	159	141	177	1.0000	1.0000	1.0000	416.9	321.4	512.4	1.0000	1.0000	1.0000

TABLE D-4. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE BLUE RIDGE

Estimated number of reaches = 161 ± 12

Estimated total length of streams (km) = 345 ± 48

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
-25	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
25	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
50	15	3	26	0.0901	0.0166	0.1637	20.0	3.3	36.6	0.0579	0.0079	0.1079
75	17	4	29	0.1053	0.0282	0.1824	23.4	5.9	40.9	0.0678	0.0149	0.1207
100	23	9	37	0.1430	0.0565	0.2295	36.0	13.9	58.1	0.1045	0.0372	0.1718
125	23	9	37	0.1430	0.0565	0.2295	36.0	13.9	58.1	0.1045	0.0372	0.1718
150	27	12	42	0.1655	0.0730	0.2581	49.8	18.4	81.2	0.1445	0.0534	0.2357
175	36	19	53	0.2258	0.1221	0.3294	70.9	34.0	107.8	0.2057	0.0994	0.3120
200	46	28	64	0.2860	0.1744	0.3976	89.7	50.4	129.0	0.2603	0.1460	0.3745
250	49	30	67	0.3012	0.1898	0.4126	99.5	58.8	140.1	0.2886	0.1716	0.4057
300	62	42	81	0.3839	0.2654	0.5025	126.3	83.2	169.4	0.3666	0.2438	0.4893
350	62	42	81	0.3839	0.2654	0.5025	126.3	83.2	169.4	0.3666	0.2438	0.4893
400	76	56	97	0.4740	0.3499	0.5982	146.3	101.5	191.0	0.4245	0.2955	0.5534
450	84	62	105	0.5191	0.3941	0.6441	160.1	113.7	206.5	0.4645	0.3320	0.5970
500	87	66	108	0.5416	0.4167	0.6666	169.1	121.8	216.5	0.4908	0.3566	0.6250
600	114	93	134	0.7071	0.5927	0.8216	240.1	186.6	293.7	0.6968	0.5729	0.8207
700	128	109	148	0.7973	0.6950	0.8995	273.9	219.6	328.2	0.7947	0.6867	0.9028
800	143	126	160	0.8874	0.8063	0.9684	303.3	251.4	355.1	0.8800	0.7904	0.9696
900	157	144	171	0.9775	0.9392	1.0000	333.0	284.9	381.2	0.9663	0.9096	1.0000
1000	161	149	174	1.0000	1.0000	1.0000	344.6	297.1	392.2	1.0000	1.0000	1.0000

TABLE D-5. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE PIEDMONT

Estimated number of reaches = 2091 ± 116

Estimated total length of streams (km) = 4884 ± 561

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
-25	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
25	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
50	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
75	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
100	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
125	40	-14	93	0.0189	0.0000	0.0444	164.3	-79.9	408.5	0.0336	0.0000	0.0828
150	40	-14	93	0.0189	0.0000	0.0444	164.3	-79.9	408.5	0.0336	0.0000	0.0828
175	77	4	151	0.0370	0.0018	0.0722	245.6	-23.6	514.8	0.0503	0.0000	0.1044
200	138	38	238	0.0660	0.0181	0.1139	436.7	77.5	795.9	0.0894	0.0183	0.1605
250	294	155	433	0.1404	0.0745	0.2064	868.0	400.1	1336.0	0.1777	0.0878	0.2676
300	366	215	516	0.1749	0.1036	0.2461	1076.3	572.3	1580.3	0.2204	0.1249	0.3158
350	584	405	763	0.2792	0.1950	0.3634	1600.9	1015.7	2186.0	0.3278	0.2224	0.4331
400	809	615	1002	0.3866	0.2963	0.4769	2084.2	1473.4	2695.0	0.4267	0.3195	0.5339
450	932	734	1130	0.4458	0.3543	0.5373	2359.8	1734.8	2984.8	0.4831	0.3771	0.5892
500	1142	940	1343	0.5459	0.4545	0.6372	2839.7	2193.1	3486.2	0.5814	0.4796	0.6832
600	1350	1151	1549	0.6456	0.5575	0.7336	3138.2	2508.3	3768.2	0.6425	0.5434	0.7416
700	1501	1307	1695	0.7176	0.6345	0.8007	3461.4	2830.9	4092.0	0.7087	0.6146	0.8028
800	1616	1429	1803	0.7727	0.6954	0.8500	3762.4	3134.9	4389.8	0.7703	0.6825	0.8581
900	1719	1539	1899	0.8218	0.7503	0.8933	3981.2	3366.7	4595.8	0.8151	0.7346	0.8956
1000	1858	1697	2019	0.8884	0.8303	0.9465	4305.5	3704.7	4906.4	0.8815	0.8148	0.9482
1500	1993	1853	2133	0.9529	0.9132	0.9926	4644.8	4064.1	5225.4	0.9510	0.9070	0.9950
2000	2091	1975	2208	1.0000	1.0000	1.0000	4884.3	4323.2	5445.4	1.0000	1.0000	1.0000

TABLE D-6. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE NORTH COASTAL PLAIN

Estimated number of reaches = 916 ± 66

Estimated total length of streams (km) = 2292 ± 392

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	11	-10	32	0.0119	0.0000	0.0344	34.7	-31.4	100.9	0.0152	0.0000	0.0439
-25	11	-10	32	0.0119	0.0000	0.0344	34.7	-31.4	100.9	0.0152	0.0000	0.0439
0	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
25	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
50	33	-2	67	0.0356	0.0000	0.0729	107.4	-23.0	237.9	0.0469	0.0000	0.1025
75	53	9	96	0.0575	0.0100	0.1050	160.3	1.5	319.2	0.0700	0.0025	0.1374
100	84	29	139	0.0918	0.0328	0.1508	222.4	46.3	398.4	0.0970	0.0224	0.1716
125	125	62	188	0.1364	0.0695	0.2034	325.6	133.2	518.1	0.1421	0.0607	0.2235
150	153	85	222	0.1675	0.0942	0.2409	446.6	213.6	679.6	0.1949	0.0986	0.2911
175	195	118	271	0.2125	0.1316	0.2935	534.5	293.0	775.9	0.2332	0.1327	0.3337
200	253	170	337	0.2768	0.1898	0.3638	648.1	391.4	904.7	0.2828	0.1788	0.3868
250	319	230	408	0.3484	0.2563	0.4405	829.4	547.7	1111.1	0.3619	0.2467	0.4771
300	387	295	479	0.4227	0.3299	0.5155	1059.4	743.1	1375.8	0.4623	0.3404	0.5841
350	417	323	511	0.4552	0.3603	0.5501	1117.7	800.7	1434.7	0.4877	0.3649	0.6105
400	467	372	563	0.5104	0.4153	0.6055	1221.3	905.2	1537.5	0.5329	0.4084	0.6574
450	539	443	636	0.5889	0.4946	0.6832	1360.9	1041.4	1680.4	0.5938	0.4649	0.7227
500	568	472	664	0.6202	0.5272	0.7131	1411.0	1093.7	1728.4	0.6157	0.4863	0.7451
600	672	582	762	0.7343	0.6516	0.8170	1865.2	1448.0	2282.4	0.8139	0.7175	0.9102
700	704	616	791	0.7683	0.6893	0.8474	1980.9	1552.4	2409.4	0.8644	0.8003	0.9284
800	724	637	810	0.7904	0.7145	0.8663	1999.1	1572.2	2426.0	0.8723	0.8095	0.9351
900	756	673	840	0.8260	0.7581	0.8938	2026.2	1601.9	2450.6	0.8841	0.8236	0.9447
1000	786	706	866	0.8586	0.7972	0.9200	2071.8	1655.1	2488.5	0.9040	0.8488	0.9592
1500	883	812	953	0.9643	0.9321	0.9965	2253.2	1859.2	2647.2	0.9832	0.9648	1.0000
2000	906	838	974	0.9898	0.9705	1.0000	2273.1	1880.4	2665.7	0.9918	0.9764	1.0000
2500	906	838	974	0.9898	0.9705	1.0000	2273.1	1880.4	2665.7	0.9918	0.9764	1.0000
3000	916	850	982	1.0000	1.0000	1.0000	2291.8	1900.4	2683.1	1.0000	1.0000	1.0000

TABLE D-7. ESTIMATED DISTRIBUTION OF ANC IN STREAMS IN THE SOUTH COASTAL PLAIN

Estimated number of reaches = 932 ± 49

Estimated total length of streams (km) = 2644 ± 356

ANC	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
-50	13	-12	39	0.0142	0.0000	0.0414	48.8	-45.1	142.7	0.0185	0.0000	0.0542
-25	22	-8	53	0.0241	0.0000	0.0572	60.0	-36.3	156.2	0.0227	0.0000	0.0594
0	77	31	124	0.0831	0.0329	0.1333	200.1	51.3	349.0	0.0757	0.0187	0.1327
25	211	143	280	0.2267	0.1536	0.2999	649.8	414.7	885.0	0.2458	0.1576	0.3340
50	268	192	344	0.2873	0.2069	0.3678	775.3	525.3	1025.4	0.2933	0.1991	0.3875
75	362	282	443	0.3888	0.3048	0.4729	989.6	735.3	1244.0	0.3744	0.2761	0.4726
100	444	360	528	0.4763	0.3905	0.5622	1189.3	928.0	1450.6	0.4499	0.3458	0.5539
125	514	430	598	0.5517	0.4675	0.6359	1410.0	1128.6	1691.3	0.5334	0.4251	0.6416
150	556	472	640	0.5968	0.5143	0.6792	1608.9	1290.1	1927.7	0.6086	0.5006	0.7166
175	649	568	729	0.6961	0.6193	0.7728	1874.5	1537.6	2211.4	0.7091	0.6062	0.8120
200	686	609	763	0.7362	0.6649	0.8074	1966.7	1637.2	2296.2	0.7440	0.6442	0.8438
250	723	647	799	0.7761	0.7064	0.8457	2089.9	1751.0	2428.9	0.7906	0.6929	0.8883
300	759	685	833	0.8145	0.7496	0.8795	2236.9	1889.0	2584.7	0.8462	0.7601	0.9323
350	802	733	871	0.8609	0.8037	0.9181	2422.2	2055.4	2789.1	0.9163	0.8726	0.9599
400	832	765	899	0.8930	0.8396	0.9464	2475.2	2110.7	2839.8	0.9363	0.8972	0.9755
450	892	832	951	0.9572	0.9182	0.9961	2532.9	2173.4	2892.5	0.9582	0.9196	0.9967
500	892	832	951	0.9572	0.9182	0.9961	2532.9	2173.4	2892.5	0.9582	0.9196	0.9967
600	892	832	951	0.9572	0.9182	0.9961	2532.9	2173.4	2892.5	0.9582	0.9196	0.9967
700	892	832	951	0.9572	0.9182	0.9961	2532.9	2173.4	2892.5	0.9582	0.9196	0.9967
800	892	832	951	0.9572	0.9182	0.9961	2532.9	2173.4	2892.5	0.9582	0.9196	0.9967
900	902	844	959	0.9679	0.9333	1.0000	2562.8	2203.3	2922.3	0.9695	0.9357	1.0000
1000	912	857	966	0.9785	0.9498	1.0000	2591.7	2232.9	2950.4	0.9804	0.9526	1.0000
1500	932	883	980	1.0000	1.0000	1.0000	2643.6	2287.6	2999.6	1.0000	1.0000	1.0000

TABLE D-8. ESTIMATED STATEWIDE DISTRIBUTION OF pH IN STREAMS

Estimated number of reaches = 5411 ± 159

Estimated total length of streams (km) = 12499 ± 810

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	50	7	92	0.0092	0.0012	0.0171	124.8	0.9	248.6	0.0100	0.0001	0.0199
4.6	86	32	140	0.0159	0.0059	0.0259	192.4	52.6	332.3	0.0154	0.0042	0.0266
4.7	103	44	161	0.0190	0.0082	0.0298	221.3	75.2	367.4	0.0177	0.0060	0.0294
4.8	154	92	217	0.0285	0.0169	0.0401	541.5	302.7	780.2	0.0433	0.0244	0.0622
4.9	173	106	240	0.0320	0.0195	0.0444	560.4	320.2	800.6	0.0448	0.0258	0.0639
5.0	197	125	269	0.0364	0.0232	0.0496	608.1	362.8	853.4	0.0487	0.0292	0.0681
5.1	219	148	291	0.0406	0.0274	0.0537	654.5	414.9	894.1	0.0524	0.0333	0.0714
5.2	246	171	322	0.0455	0.0316	0.0594	714.7	465.9	963.5	0.0572	0.0374	0.0770
5.3	264	185	343	0.0488	0.0343	0.0634	747.6	495.4	999.8	0.0598	0.0397	0.0799
5.4	274	193	355	0.0507	0.0358	0.0656	753.6	501.3	1006.0	0.0603	0.0402	0.0804
5.5	305	218	392	0.0564	0.0404	0.0723	820.0	550.3	1089.7	0.0656	0.0442	0.0871
5.6	356	257	455	0.0658	0.0475	0.0841	944.4	648.5	1240.4	0.0756	0.0520	0.0991
5.7	387	285	490	0.0716	0.0527	0.0904	1067.2	741.1	1393.2	0.0854	0.0596	0.1111
5.8	451	342	559	0.0833	0.0633	0.1032	1238.0	891.2	1584.8	0.0990	0.0717	0.1264
5.9	487	375	598	0.0899	0.0694	0.1104	1326.2	971.6	1680.9	0.1061	0.0781	0.1341
6.0	531	414	647	0.0981	0.0767	0.1195	1419.0	1053.5	1784.5	0.1135	0.0847	0.1424
6.1	604	482	727	0.1117	0.0893	0.1342	1623.7	1239.7	2007.7	0.1299	0.0997	0.1601
6.2	643	513	772	0.1188	0.0951	0.1425	1709.9	1309.9	2109.9	0.1368	0.1054	0.1682
6.3	698	566	830	0.1290	0.1048	0.1532	1836.7	1433.0	2240.3	0.1469	0.1152	0.1787
6.4	790	654	925	0.1459	0.1211	0.1707	2072.6	1658.3	2486.8	0.1658	0.1334	0.1983
6.5	913	777	1050	0.1688	0.1439	0.1937	2412.6	1984.1	2841.1	0.1930	0.1601	0.2260
6.6	1014	873	1155	0.1874	0.1618	0.2130	2600.0	2166.7	3033.4	0.2080	0.1748	0.2413
6.7	1303	1138	1469	0.2409	0.2108	0.2710	3358.9	2827.3	3890.5	0.2687	0.2292	0.3082
6.8	1562	1391	1732	0.2886	0.2579	0.3194	3930.6	3388.7	4472.4	0.3145	0.2742	0.3548
6.9	1802	1620	1983	0.3329	0.3003	0.3656	4538.7	3934.7	5142.8	0.3631	0.3199	0.4064
7.0	2106	1910	2303	0.3893	0.3541	0.4244	5228.5	4586.5	5870.6	0.4183	0.3728	0.4639
7.1	2485	2271	2698	0.4592	0.4215	0.4968	6202.0	5433.8	6970.1	0.4962	0.4471	0.5453
7.2	3070	2831	3308	0.5673	0.5259	0.6087	7496.1	6654.1	8338.0	0.5998	0.5492	0.6503
7.3	3443	3200	3686	0.6363	0.5948	0.6777	8392.2	7534.4	9249.9	0.6715	0.6237	0.7192
7.4	3881	3641	4122	0.7173	0.6778	0.7568	9418.2	8547.7	10288.7	0.7535	0.7104	0.7967
7.5	4151	3915	4387	0.7671	0.7296	0.8046	9916.3	9054.4	10778.1	0.7934	0.7523	0.8345
7.6	4450	4219	4680	0.8223	0.7875	0.8571	10495.4	9630.1	11360.6	0.8397	0.8024	0.8771
7.7	4628	4404	4852	0.8553	0.8227	0.8878	10910.6	10047.3	11773.8	0.8729	0.8393	0.9065
7.8	4867	4660	5075	0.8995	0.8723	0.9268	11304.7	10458.4	12151.1	0.9045	0.8743	0.9347
7.9	5013	4816	5209	0.9264	0.9028	0.9499	11519.1	10684.5	12353.6	0.9216	0.8932	0.9500
8.0	5116	4924	5308	0.9454	0.9239	0.9670	11776.8	10940.8	12612.7	0.9422	0.9166	0.9679
8.1	5251	5072	5430	0.9704	0.9541	0.9867	12077.3	11249.8	12904.7	0.9663	0.9460	0.9866
8.2	5277	5099	5454	0.9752	0.9596	0.9908	12154.4	11328.4	12980.4	0.9725	0.9537	0.9912
8.3	5313	5137	5489	0.9819	0.9671	0.9967	12249.0	11422.9	13075.0	0.9800	0.9619	0.9981
8.4	5323	5148	5498	0.9837	0.9694	0.9981	12265.1	11439.5	13090.7	0.9813	0.9634	0.9993
8.5	5335	5161	5510	0.9860	0.9720	1.0000	12276.9	11451.6	13102.3	0.9823	0.9644	1.0000
8.6	5339	5164	5513	0.9866	0.9727	1.0000	12299.3	11473.6	13125.0	0.9841	0.9664	1.0000
8.7	5364	5197	5532	0.9914	0.9810	1.0000	12340.4	11526.6	13154.3	0.9873	0.9710	1.0000
8.8	5364	5197	5532	0.9914	0.9810	1.0000	12340.4	11526.6	13154.3	0.9873	0.9710	1.0000
8.9	5371	5205	5538	0.9927	0.9825	1.0000	12351.6	11538.0	13165.2	0.9882	0.9720	1.0000
9.0	5391	5229	5554	0.9963	0.9892	1.0000	12415.5	11604.9	13226.0	0.9933	0.9804	1.0000
9.1	5391	5229	5554	0.9963	0.9892	1.0000	12415.5	11604.9	13226.0	0.9933	0.9804	1.0000
9.2	5411	5252	5570	1.0000	1.0000	1.0000	12498.6	11688.7	13308.5	1.0000	1.0000	1.0000

TABLE D-9. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE APPALACHIAN PLATEAU

Estimated number of reaches = 1153 ± 68

Estimated total length of streams (km) = 1917 ± 223

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	16	-5	38	0.0141	0.0000	0.0326	30.1	-11.2	71.3	0.0157	0.0000	0.0372
4.6	33	3	62	0.0282	0.0025	0.0539	63.4	1.4	125.4	0.0331	0.0007	0.0654
4.7	49	13	86	0.0428	0.0110	0.0746	92.2	17.2	167.3	0.0481	0.0090	0.0872
4.8	57	18	97	0.0498	0.0159	0.0838	156.4	16.9	295.9	0.0816	0.0121	0.1510
4.9	66	24	109	0.0574	0.0207	0.0941	163.4	23.2	303.5	0.0852	0.0155	0.1549
5.0	74	30	119	0.0645	0.0259	0.1030	186.1	41.0	331.3	0.0971	0.0252	0.1689
5.1	74	30	119	0.0645	0.0259	0.1030	186.1	41.0	331.3	0.0971	0.0252	0.1689
5.2	82	36	129	0.0715	0.0313	0.1117	193.4	48.1	338.8	0.1009	0.0290	0.1728
5.3	91	42	139	0.0786	0.0368	0.1203	207.3	60.6	353.9	0.1081	0.0357	0.1805
5.4	91	42	139	0.0786	0.0368	0.1203	207.3	60.6	353.9	0.1081	0.0357	0.1805
5.5	91	42	139	0.0786	0.0368	0.1203	207.3	60.6	353.9	0.1081	0.0357	0.1805
5.6	91	42	139	0.0786	0.0368	0.1203	207.3	60.6	353.9	0.1081	0.0357	0.1805
5.7	91	42	139	0.0786	0.0368	0.1203	207.3	60.6	353.9	0.1081	0.0357	0.1805
5.8	99	49	149	0.0856	0.0424	0.1288	222.7	74.3	371.1	0.1161	0.0430	0.1893
5.9	99	49	149	0.0856	0.0424	0.1288	222.7	74.3	371.1	0.1161	0.0430	0.1893
6.0	99	49	149	0.0856	0.0424	0.1288	222.7	74.3	371.1	0.1161	0.0430	0.1893
6.1	107	55	160	0.0932	0.0479	0.1385	231.4	82.2	380.6	0.1207	0.0472	0.1942
6.2	107	55	160	0.0932	0.0479	0.1385	231.4	82.2	380.6	0.1207	0.0472	0.1942
6.3	124	68	181	0.1078	0.0593	0.1562	266.0	109.6	422.4	0.1387	0.0623	0.2152
6.4	150	88	211	0.1299	0.0770	0.1828	291.4	133.4	449.4	0.1520	0.0748	0.2292
6.5	176	109	243	0.1526	0.0954	0.2097	319.3	158.8	479.8	0.1665	0.0882	0.2448
6.6	209	138	280	0.1813	0.1205	0.2421	356.2	194.1	518.2	0.1857	0.1067	0.2648
6.7	279	198	360	0.2419	0.1731	0.3108	424.9	258.4	591.5	0.2216	0.1401	0.3032
6.8	356	267	444	0.3086	0.2341	0.3830	583.6	395.6	771.7	0.3044	0.2148	0.3940
6.9	416	323	509	0.3610	0.2834	0.4385	691.0	490.6	891.3	0.3604	0.2671	0.4536
7.0	535	437	633	0.4639	0.3836	0.5441	906.1	685.0	1127.2	0.4726	0.3762	0.5689
7.1	642	545	739	0.5570	0.4796	0.6345	1123.7	892.3	1355.1	0.5860	0.4954	0.6767
7.2	787	692	883	0.6831	0.6111	0.7551	1389.1	1148.9	1629.3	0.7244	0.6467	0.8021
7.3	865	772	958	0.7508	0.6836	0.8179	1534.0	1294.1	1773.9	0.8000	0.7322	0.8679
7.4	946	856	1036	0.8208	0.7597	0.8819	1668.7	1431.0	1906.4	0.8703	0.8199	0.9206
7.5	956	867	1046	0.8295	0.7693	0.8898	1685.8	1448.4	1923.2	0.8792	0.8305	0.9279
7.6	984	896	1071	0.8534	0.7962	0.9106	1710.8	1475.4	1946.3	0.8923	0.8449	0.9396
7.7	1001	915	1088	0.8685	0.8135	0.9235	1740.4	1505.3	1975.6	0.9077	0.8641	0.9513
7.8	1019	933	1104	0.8836	0.8311	0.9361	1755.3	1521.0	1989.5	0.9154	0.8731	0.9577
7.9	1070	990	1150	0.9284	0.8858	0.9711	1818.4	1587.1	2049.7	0.9483	0.9157	0.9810
8.0	1089	1011	1167	0.9447	0.9066	0.9829	1842.5	1612.8	2072.1	0.9609	0.9327	0.9891
8.1	1106	1031	1182	0.9599	0.9268	0.9929	1863.4	1635.1	2091.6	0.9718	0.9475	0.9961
8.2	1115	1041	1189	0.9674	0.9373	0.9975	1872.9	1645.5	2100.4	0.9768	0.9544	0.9992
8.3	1134	1063	1205	0.9837	0.9619	1.0000	1890.9	1665.5	2116.2	0.9861	0.9671	1.0000
8.4	1144	1075	1213	0.9924	0.9782	1.0000	1907.0	1683.2	2130.8	0.9945	0.9843	1.0000
8.5	1153	1085	1220	1.0000	1.0000	1.0000	1917.4	1694.5	2140.4	1.0000	1.0000	1.0000

TABLE D-10. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE VALLEY & RIDGE

Estimated number of reaches = 159 ± 18

Estimated total length of streams (km) = 417 ± 96

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.6	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.7	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.8	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.9	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.1	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.2	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.3	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.4	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.6	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.7	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.8	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.9	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.1	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.2	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.3	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.4	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.6	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.7	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
6.8	3	-2	9	0.0217	0.0000	0.0583	9.3	-6.4	25.0	0.0223	0.0000	0.0601
6.9	3	-2	9	0.0217	0.0000	0.0583	9.3	-6.4	25.0	0.0223	0.0000	0.0601
7.0	7	-1	15	0.0435	0.0000	0.0946	15.5	-3.2	34.2	0.0372	0.0000	0.0827
7.1	10	0	20	0.0652	0.0033	0.1271	22.8	0.7	44.8	0.0546	0.0004	0.1088
7.2	10	0	20	0.0652	0.0033	0.1271	22.8	0.7	44.8	0.0546	0.0004	0.1088
7.3	17	5	30	0.1087	0.0307	0.1867	33.8	8.6	58.9	0.0811	0.0179	0.1443
7.4	21	7	34	0.1304	0.0460	0.2148	49.3	13.8	84.9	0.1183	0.0316	0.2050
7.5	24	10	39	0.1522	0.0621	0.2422	54.8	18.5	91.2	0.1315	0.0420	0.2210
7.6	24	10	39	0.1522	0.0621	0.2422	54.8	18.5	91.2	0.1315	0.0420	0.2210
7.7	31	15	47	0.1957	0.0962	0.2951	72.1	31.4	112.7	0.1729	0.0717	0.2741
7.8	55	35	75	0.3478	0.2284	0.4672	144.1	71.8	216.5	0.3457	0.1929	0.4986
7.9	59	38	79	0.3696	0.2486	0.4905	145.9	73.6	218.1	0.3499	0.1970	0.5028
8.0	97	74	119	0.6087	0.4864	0.7310	239.3	153.7	324.9	0.5740	0.4158	0.7322
8.1	131	110	152	0.8261	0.7311	0.9211	307.2	221.3	393.2	0.7370	0.5866	0.8873
8.2	138	117	159	0.8696	0.7852	0.9540	326.2	240.0	412.4	0.7825	0.6367	0.9283
8.3	152	133	171	0.9565	0.9054	1.0000	393.1	300.2	486.0	0.9429	0.8548	1.0000
8.4	152	133	171	0.9565	0.9054	1.0000	393.1	300.2	486.0	0.9429	0.8548	1.0000
8.5	155	137	174	0.9783	0.9417	1.0000	394.5	301.9	487.1	0.9462	0.8582	1.0000
8.6	159	141	177	1.0000	1.0000	1.0000	416.9	321.4	512.4	1.0000	1.0000	1.0000

TABLE D-11. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE BLUE RIDGE

Estimated number of reaches = 161 ± 12

Estimated total length of streams (km) = 345 ± 48

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.6	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.7	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.8	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.9	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.1	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.2	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.3	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.4	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.6	4	-3	10	0.0225	0.0000	0.0608	3.6	-2.5	9.8	0.0105	0.0000	0.0287
5.7	7	-1	16	0.0451	0.0000	0.0985	8.3	-1.7	18.4	0.0242	0.0000	0.0539
5.8	7	-1	16	0.0451	0.0000	0.0985	8.3	-1.7	18.4	0.0242	0.0000	0.0539
5.9	7	-1	16	0.0451	0.0000	0.0985	8.3	-1.7	18.4	0.0242	0.0000	0.0539
6.0	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.1	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.2	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.3	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.4	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.5	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.6	11	0	21	0.0676	0.0030	0.1322	13.8	0.4	27.2	0.0400	0.0000	0.0800
6.7	13	2	24	0.0828	0.0142	0.1514	17.2	2.8	31.6	0.0499	0.0065	0.0933
6.8	17	4	29	0.1053	0.0282	0.1824	23.7	5.9	41.6	0.0689	0.0150	0.1227
6.9	17	4	29	0.1053	0.0282	0.1824	23.7	5.9	41.6	0.0689	0.0150	0.1227
7.0	25	11	40	0.1582	0.0702	0.2462	47.3	19.8	74.8	0.1372	0.0563	0.2180
7.1	33	17	49	0.2032	0.1042	0.3023	63.2	29.7	96.8	0.1835	0.0861	0.2809
7.2	49	30	67	0.3012	0.1898	0.4126	99.1	58.1	140.1	0.2877	0.1711	0.4043
7.3	63	43	83	0.3913	0.2701	0.5125	116.9	74.5	159.3	0.3393	0.2163	0.4622
7.4	84	62	105	0.5191	0.3941	0.6441	156.8	111.6	202.0	0.4550	0.3235	0.5866
7.5	97	76	118	0.6019	0.4793	0.7244	192.9	144.7	241.1	0.5598	0.4263	0.6934
7.6	115	95	135	0.7145	0.6002	0.8288	228.9	179.6	278.1	0.6641	0.5310	0.7972
7.7	128	109	148	0.7973	0.6950	0.8995	269.5	217.7	321.4	0.7821	0.6660	0.8982
7.8	132	113	151	0.8198	0.7218	0.9177	274.6	223.5	325.7	0.7968	0.6818	0.9119
7.9	143	126	160	0.8874	0.8063	0.9684	301.8	251.6	352.1	0.8758	0.7790	0.9726
8.0	154	139	168	0.9549	0.9015	1.0000	326.1	276.5	375.8	0.9463	0.8829	1.0000
8.1	157	144	171	0.9775	0.9392	1.0000	334.8	286.2	383.4	0.9716	0.9235	1.0000
8.2	157	144	171	0.9775	0.9392	1.0000	334.8	286.2	383.4	0.9716	0.9235	1.0000
8.3	161	149	174	1.0000	1.0000	1.0000	344.6	297.1	392.2	1.0000	1.0000	1.0000

TABLE D-12. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE PIEDMONT

Estimated number of reaches = 2091 ± 116

Estimated total length of streams (km) = 4884 ± 561

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.6	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.7	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.8	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
4.9	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.0	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.1	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.2	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.3	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.4	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.5	0	0	0	0.0000	0.0000	0.0000	0.0	0.0	0.0	0.0000	0.0000	0.0000
5.6	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
5.7	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
5.8	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
5.9	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
6.0	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
6.1	20	-19	58	0.0095	0.0000	0.0279	45.5	-43.2	134.2	0.0093	0.0000	0.0275
6.2	40	-14	93	0.0189	0.0000	0.0444	102.9	-36.8	242.6	0.0211	0.0000	0.0497
6.3	40	-14	93	0.0189	0.0000	0.0444	102.9	-36.8	242.6	0.0211	0.0000	0.0497
6.4	40	-14	93	0.0189	0.0000	0.0444	102.9	-36.8	242.6	0.0211	0.0000	0.0497
6.5	40	-14	93	0.0189	0.0000	0.0444	102.9	-36.8	242.6	0.0211	0.0000	0.0497
6.6	40	-14	93	0.0189	0.0000	0.0444	102.9	-36.8	242.6	0.0211	0.0000	0.0497
6.7	84	2	166	0.0402	0.0010	0.0795	241.0	-19.1	501.1	0.0493	0.0000	0.1019
6.8	84	2	166	0.0402	0.0010	0.0795	241.0	-19.1	501.1	0.0493	0.0000	0.1019
6.9	139	37	241	0.0666	0.0177	0.1154	439.6	92.9	786.2	0.0900	0.0211	0.1589
7.0	220	99	341	0.1051	0.0475	0.1628	609.5	238.2	980.7	0.1248	0.0512	0.1984
7.1	359	210	509	0.1718	0.1008	0.2428	1041.6	548.4	1534.8	0.2133	0.1193	0.3072
7.2	680	493	866	0.3249	0.2375	0.4123	1792.3	1200.0	2384.6	0.3670	0.2608	0.4732
7.3	882	686	1079	0.4219	0.3309	0.5130	2234.3	1622.9	2845.7	0.4574	0.3512	0.5636
7.4	1132	933	1330	0.5412	0.4514	0.6310	2877.9	2246.4	3509.3	0.5892	0.4892	0.6893
7.5	1346	1151	1541	0.6437	0.5580	0.7294	3266.5	2645.0	3888.0	0.6688	0.5735	0.7640
7.6	1562	1371	1752	0.7467	0.6664	0.8269	3720.3	3088.1	4352.5	0.7617	0.6746	0.8488
7.7	1688	1505	1872	0.8073	0.7330	0.8816	4033.9	3404.5	4663.3	0.8259	0.7484	0.9034
7.8	1853	1688	2019	0.8861	0.8252	0.9470	4291.9	3684.3	4899.5	0.8787	0.8093	0.9481
7.9	1911	1755	2067	0.9137	0.8601	0.9673	4377.4	3783.6	4971.3	0.8962	0.8304	0.9621
8.0	1947	1795	2098	0.9307	0.8814	0.9801	4493.3	3898.5	5088.1	0.9200	0.8605	0.9794
8.1	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.2	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.3	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.4	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.5	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.6	2026	1890	2162	0.9687	0.9332	1.0000	4696.3	4112.9	5279.7	0.9615	0.9167	1.0000
8.7	2052	1925	2178	0.9810	0.9548	1.0000	4737.3	4170.8	5303.8	0.9699	0.9285	1.0000
8.8	2052	1925	2178	0.9810	0.9548	1.0000	4737.3	4170.8	5303.8	0.9699	0.9285	1.0000
8.9	2052	1925	2178	0.9810	0.9548	1.0000	4737.3	4170.8	5303.8	0.9699	0.9285	1.0000
9.0	2072	1950	2193	0.9905	0.9721	1.0000	4801.2	4239.1	5363.3	0.9830	0.9500	1.0000
9.1	2072	1950	2193	0.9905	0.9721	1.0000	4801.2	4239.1	5363.3	0.9830	0.9500	1.0000
9.2	2091	1975	2208	1.0000	1.0000	1.0000	4884.3	4323.2	5445.4	1.0000	1.0000	1.0000

TABLE D-13. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE NORTH COASTAL PLAIN

Estimated number of reaches = 916 ± 66

Estimated total lnegth of streams (km) = 2292 ± 392

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	11	-10	32	0.0119	0.0000	0.0344	34.7	-31.4	100.9	0.0152	0.0000	0.0439
4.6	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
4.7	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
4.8	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
4.9	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.0	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.1	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.2	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.3	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.4	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.5	22	-7	50	0.0237	0.0000	0.0549	47.7	-22.0	117.5	0.0208	0.0000	0.0512
5.6	33	-3	69	0.0359	0.0000	0.0748	79.1	-12.8	171.0	0.0345	0.0000	0.0745
5.7	44	3	84	0.0478	0.0039	0.0916	138.8	-4.7	282.3	0.0606	0.0000	0.1216
5.8	55	9	100	0.0595	0.0103	0.1087	186.1	16.7	355.5	0.0812	0.0094	0.1530
5.9	62	14	109	0.0675	0.0162	0.1188	206.5	32.9	380.1	0.0901	0.0165	0.1637
6.0	84	30	138	0.0916	0.0333	0.1499	235.4	57.9	412.9	0.1027	0.0274	0.1781
6.1	106	47	165	0.1156	0.0525	0.1788	264.4	84.4	444.4	0.1154	0.0389	0.1919
6.2	115	54	177	0.1259	0.0600	0.1917	270.0	89.6	450.3	0.1178	0.0411	0.1945
6.3	115	54	177	0.1259	0.0600	0.1917	270.0	89.6	450.3	0.1178	0.0411	0.1945
6.4	152	88	217	0.1662	0.0979	0.2346	405.9	202.8	608.9	0.1771	0.0923	0.2619
6.5	170	102	237	0.1855	0.1140	0.2569	442.7	236.8	648.7	0.1932	0.1060	0.2803
6.6	203	131	274	0.2213	0.1466	0.2960	503.0	292.0	714.0	0.2195	0.1302	0.3088
6.7	287	200	373	0.3131	0.2218	0.4044	718.7	457.2	980.3	0.3136	0.2019	0.4253
6.8	405	313	497	0.4426	0.3487	0.5365	977.6	703.3	1251.9	0.4266	0.3044	0.5488
6.9	464	370	557	0.5066	0.4135	0.5997	1086.5	806.9	1366.2	0.4741	0.3489	0.5994
7.0	527	432	623	0.5760	0.4825	0.6696	1288.0	980.5	1595.5	0.5620	0.4281	0.6959
7.1	588	493	683	0.6424	0.5514	0.7334	1522.3	1114.8	1929.9	0.6643	0.5427	0.7859
7.2	652	557	748	0.7123	0.6234	0.8013	1650.1	1241.0	2059.2	0.7200	0.5995	0.8405
7.3	723	635	812	0.7898	0.7126	0.8671	1930.5	1516.9	2344.1	0.8423	0.7633	0.9213
7.4	797	717	878	0.8709	0.8116	0.9303	2088.0	1677.8	2498.2	0.9111	0.8546	0.9675
7.5	805	725	885	0.8797	0.8224	0.9369	2092.8	1682.8	2502.7	0.9132	0.8570	0.9693
7.6	843	768	919	0.9211	0.8749	0.9672	2157.1	1755.5	2558.7	0.9413	0.8927	0.9898
7.7	857	782	933	0.9364	0.8909	0.9819	2171.1	1769.9	2572.3	0.9474	0.8989	0.9959
7.8	887	817	957	0.9685	0.9391	0.9979	2215.4	1820.5	2610.2	0.9667	0.9245	1.0000
7.9	898	829	968	0.9811	0.9554	1.0000	2232.0	1837.3	2626.7	0.9739	0.9328	1.0000
8.0	898	829	968	0.9811	0.9554	1.0000	2232.0	1837.3	2626.7	0.9739	0.9328	1.0000
8.1	898	829	968	0.9811	0.9554	1.0000	2232.0	1837.3	2626.7	0.9739	0.9328	1.0000
8.2	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.3	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.4	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.5	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.6	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.7	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.8	909	842	976	0.9924	0.9782	1.0000	2280.6	1888.7	2672.5	0.9951	0.9860	1.0000
8.9	916	850	982	1.0000	1.0000	1.0000	2291.8	1900.4	2683.1	1.0000	1.0000	1.0000

TABLE D-14. ESTIMATED DISTRIBUTION OF pH IN STREAMS IN THE SOUTH COASTAL PLAIN

Estimated number of reaches = 932 ± 49

Estimated total length of streams (km) = 2644 ± 356

pH	Y est	MIN Y	MAX Y	Py	MIN Py	MAX Py	Z est	MIN Z	MAX Z	Pz	MIN Pz	MAX Pz
4.5	22	-8	53	0.0241	0.0000	0.0572	60.0	-36.3	156.2	0.0227	0.0000	0.0594
4.6	32	-3	67	0.0341	0.0000	0.0719	81.3	-22.8	185.4	0.0308	0.0000	0.0705
4.7	32	-3	67	0.0341	0.0000	0.0719	81.3	-22.8	185.4	0.0308	0.0000	0.0705
4.8	75	36	115	0.0807	0.0381	0.1232	337.3	156.6	518.1	0.1276	0.0607	0.1944
4.9	85	41	129	0.0914	0.0442	0.1385	349.2	167.1	531.4	0.1321	0.0646	0.1996
5.0	101	53	149	0.1084	0.0565	0.1602	374.2	189.2	559.2	0.1416	0.0726	0.2105
5.1	123	76	171	0.1325	0.0815	0.1835	420.6	243.2	598.0	0.1591	0.0918	0.2265
5.2	142	90	194	0.1524	0.0967	0.2081	473.5	284.0	663.0	0.1791	0.1072	0.2511
5.3	152	97	207	0.1632	0.1039	0.2225	492.6	299.7	685.5	0.1863	0.1128	0.2599
5.4	162	104	220	0.1740	0.1116	0.2364	498.6	305.5	691.8	0.1886	0.1148	0.2624
5.5	193	127	259	0.2068	0.1364	0.2772	565.0	349.7	780.3	0.2137	0.1322	0.2953
5.6	209	141	278	0.2246	0.1518	0.2975	608.9	386.0	831.9	0.2303	0.1457	0.3149
5.7	226	156	296	0.2424	0.1678	0.3171	667.2	430.0	904.4	0.2524	0.1633	0.3415
5.8	270	195	345	0.2901	0.2107	0.3696	775.3	527.2	1023.5	0.2933	0.1994	0.3872
5.9	299	221	377	0.3209	0.2386	0.4033	843.2	587.0	1099.4	0.3190	0.2217	0.4162
6.0	318	237	399	0.3409	0.2558	0.4259	901.6	633.2	1169.9	0.3410	0.2407	0.4414
6.1	360	276	445	0.3869	0.2990	0.4748	1068.6	777.5	1359.7	0.4042	0.2986	0.5099
6.2	370	285	455	0.3969	0.3084	0.4854	1091.8	799.4	1384.2	0.4130	0.3067	0.5194
6.3	408	321	495	0.4381	0.3485	0.5276	1184.0	890.3	1477.7	0.4479	0.3399	0.5558
6.4	437	351	524	0.4692	0.3807	0.5578	1258.6	965.8	1551.3	0.4761	0.3688	0.5834
6.5	517	435	599	0.5549	0.4733	0.6364	1533.9	1224.5	1843.3	0.5802	0.4829	0.6775
6.6	552	470	634	0.5925	0.5114	0.6737	1624.2	1312.3	1936.1	0.6144	0.5185	0.7103
6.7	640	560	721	0.6874	0.6114	0.7634	1957.0	1612.6	2301.4	0.7403	0.6559	0.8247
6.8	696	620	773	0.7473	0.6773	0.8174	2095.3	1756.5	2434.0	0.7926	0.7124	0.8728
6.9	762	691	833	0.8179	0.7569	0.8790	2288.6	1933.9	2643.3	0.8657	0.8086	0.9228
7.0	792	720	864	0.8500	0.7883	0.9117	2362.2	2001.8	2722.6	0.8936	0.8380	0.9492
7.1	852	786	918	0.9144	0.8633	0.9654	2428.3	2073.9	2782.7	0.9186	0.8652	0.9719
7.2	892	832	951	0.9571	0.9174	0.9967	2542.7	2181.0	2904.5	0.9619	0.9253	0.9984
7.3	892	832	951	0.9571	0.9174	0.9967	2542.7	2181.0	2904.5	0.9619	0.9253	0.9984
7.4	902	844	959	0.9678	0.9330	1.0000	2577.5	2215.6	2939.5	0.9750	0.9471	1.0000
7.5	922	870	973	0.9892	0.9688	1.0000	2623.5	2265.0	2981.9	0.9924	0.9779	1.0000
7.6	922	870	973	0.9892	0.9688	1.0000	2623.5	2265.0	2981.9	0.9924	0.9779	1.0000
7.7	922	870	973	0.9892	0.9688	1.0000	2623.5	2265.0	2981.9	0.9924	0.9779	1.0000
7.8	922	870	973	0.9892	0.9688	1.0000	2623.5	2265.0	2981.9	0.9924	0.9779	1.0000
7.9	932	883	980	1.0000	1.0000	1.0000	2643.6	2287.6	2999.6	1.0000	1.0000	1.0000

APPENDIX E

R A N D O M L Y   S E L E C T E D   S T R E A M   R E A C H

L O C A T I O N S   A N D   C H E M I C A L   D A T A

Tables E-1 through E-35 present the sample identification number, date of sample collection, location, chemistry data, and geographic data for each of the stream reaches sampled during the MSSCS. A single asterisk (*) before the Sample ID number in these tables indicates a special interest reach. A double asterisk (**) before the number indicates a randomly selected stream reach that also was selected as a special interest reach. The remaining reaches were randomly selected. Only data from the randomly selected stream reaches were used to develop population estimates.

TABLE E-1. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN ANNE ARUNDEL COUNTY

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
AA-S-001	28MAR87	38 46 01	76 37 48	6.84	203.60	5.180	164.800	2.954	2	14.2	2	3	20.1
AA-S-002	28MAR87	38 50 18	76 34 14	5.97	77.40	4.490	156.100	2.456	1	2.9	1	1	5.1
AA-S-003	28MAR87	38 46 23	76 39 14	6.68	159.80	3.350	148.700	2.529	0	7.3	2	2	8.5
AA-S-004	28MAR87	38 46 41	76 37 18	6.74	179.60	4.710	150.600	2.923	1	2.7	1	1	3.6
AA-S-005	28MAR87	38 46 50	76 36 05	6.64	170.80	5.330	169.700	2.594	2	9.0	1	1	14.6

TABLE E-2. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN CALVERT COUNTY

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
CA-S-001	14MAR87	38 31 23	76 38 13	6.84	302.30	3.100	161.200	4.561	2	1.9	1	1	1.6
CA-S-002	14MAR87	38 43 14	76 41 19	6.00	98.70	2.850	150.100	4.385	2	1.2	1	1	2.8
CA-S-003	14MAR87	38 40 14	76 36 55	6.91	245.10	2.630	135.900	3.786	1	3.8	1	1	5.8
CA-S-004	14MAR87	38 28 18	76 34 28	7.33	1044.80	4.430	170.400	13.240	3	3.5	1	1	3.3
CA-S-005	14MAR87	38 38 19	76 37 38	7.07	435.00	2.870	148.800	3.580	2	3.7	2	2	4.2
CA-S-006	14MAR87	38 38 19	76 33 38	6.86	432.60	21.830	123.200	6.429	2	5.9	2	3	6.1
CA-S-007	14MAR87	38 24 06	76 28 13	6.96	300.90	3.220	110.900	4.531	2	1.1	1	1	3.3
CA-S-008	14MAR87	38 24 02	76 25 05	4.87	-7.30	2.860	58.500	1.500	2	1.2	1	1	1.8
CA-S-009	14MAR87	38 34 40	76 38 52	6.71	223.90	2.620	154.700	5.586	2	3.3	1	1	3.7
CA-S-010	14MAR87	38 39 25	76 34 07	7.03	427.70	10.800	127.600	5.808	2	21.5	3	10	22.5
*CA-S-011	21MAR87	38 36 29	76 31 25	6.88	360.90	8.890	143.600	5.229	1	10.6	2	4	13.7
CA-S-012	21MAR87	38 32 24	76 33 15	7.44	957.50	3.180	144.500	11.860	1	2.9	1	1	2.1
CA-S-013	21MAR87	38 44 14	76 38 00	6.69	172.30	2.350	159.800	2.790	1	1.5	1	1	3.0
CA-S-014	21MAR87	38 42 10	76 38 23	7.12	314.70	4.490	147.700	4.382	1	5.6	1	1	7.8
CA-S-015	21MAR87	38 34 57	76 36 31	7.02	387.50	5.420	124.400	5.203	2	33.3	3	10	40.7
CA-S-016	21MAR87	38 38 30	76 37 29	7.12	423.70	5.300	148.300	5.932	2	4.0	2	2	5.3
CA-S-018	21MAR87	38 32 58	76 31 32	7.19	852.70	8.640	161.100	10.690	3	3.0	1	1	3.8
CA-S-021	21MAR87	38 25 44	76 28 34	7.19	444.10	4.400	117.800	5.811	3	1.5	1	1	3.0
CA-S-022	21MAR87	38 43 26	76 35 27	6.97	379.90	4.550	173.600	4.802	1	2.5	1	1	3.1
CA-S-025	21MAR87	38 35 49	76 33 33	6.51	120.30	3.210	98.300	2.345	1	1.3	1	1	1.8

TABLE E-3. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN CHARLES COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
CH-S-003	14MAR87	38 30 51	76 55 09	6.54	66.40	15.190	74.500	1.227	2	22.8	2	4	33.9
CH-S-004	14MAR87	38 34 17	77 03 51	6.70	106.80	4.200	86.000	1.741	1	3.3	1	1	4.8
CH-S-005	14MAR87	38 36 33	77 06 40	6.64	257.70	20.800	163.700	4.038	2	6.9	1	1	7.8
CH-S-006	14MAR87	38 25 26	77 13 28	4.98	-7.50	3.710	46.900	2.418	2	1.7	1	1	2.6
CH-S-007	14MAR87	38 32 20	77 07 52	5.13	5.30	2.050	63.700	1.872	2	2.0	1	1	4.0
CH-S-008	14MAR87	38 28 28	76 58 13	6.58	119.20	1.650	103.200	2.105	1	2.4	1	1	4.5
CH-S-009	14MAR87	38 36 11	77 03 01	6.25	63.00	4.850	115.800	1.239	2	2.1	1	1	1.9
CH-S-010	14MAR87	38 26 38	76 49 08	6.89	200.20	3.590	98.600	3.016	2	4.8	1	1	7.8
CH-S-011	14MAR87	38 28 58	76 49 57	6.33	52.10	2.310	59.100	1.309	1	2.0	1	1	1.7
CH-S-012	14MAR87	38 29 59	76 54 33	6.42	97.00	2.660	53.000	1.632	2	2.8	1	1	3.3
CH-S-013	14MAR87	38 25 53	77 08 43	4.58	-15.80	12.650	57.100	3.547	7	5.6	2	2	7.3
CH-S-017	14MAR87	38 25 10	77 08 26	4.35	-47.10	31.900	59.100	1.506	12	1.2	1	1	1.5
CH-S-018	14MAR87	38 32 22	76 53 35	6.60	72.60	2.100	97.500	1.257	1	1.2	1	1	2.3
CH-S-021	14MAR87	38 27 48	76 53 19	6.72	112.00	1.570	63.000	1.864	1	2.6	1	1	2.4
CH-S-022	21MAR87	38 33 43	76 51 04	5.07	8.50	7.550	176.000	3.662	3	11.1	2	2	13.6
CH-S-026	21MAR87	38 29 27	77 05 14	6.40	68.90	3.590	65.800	1.442	1	14.5	3	5	23.3
CH-S-027	21MAR87	38 28 52	76 55 11	6.80	163.30	3.270	78.700	2.470	1	2.8	1	1	3.5
CH-S-029	21MAR87	38 31 12	77 09 19	6.62	132.50	3.550	66.400	2.385	2	3.4	1	1	6.3
CH-S-030	28MAR87	38 37 23	76 52 02	5.80	44.30	5.970	79.200	1.444	2	3.0	1	1	4.5
CH-S-031	21MAR87	38 29 40	76 49 25	6.76	122.60	4.400	103.000	1.846	2	19.2	3	5	30.1
CH-S-032	21MAR87	38 30 14	76 51 11	6.14	69.60	3.400	93.400	2.032	2	2.5	1	1	4.6
CH-S-034	21MAR87	38 30 55	77 15 01	5.12	6.50	8.660	136.300	1.462	3	3.7	1	1	3.6
CH-S-036	21MAR87	38 26 38	76 56 25	6.05	51.10	4.680	98.800	1.703	1	10.3	2	3	12.5
CH-S-038	21MAR87	38 38 56	77 00 27	6.25	86.50	1.600	77.000	2.255	0	3.1	1	1	4.9
CH-S-039	21MAR87	38 39 16	77 04 39	6.86	186.40	4.620	110.300	3.131	2	5.5	2	2	8.1
CH-S-041	21MAR87	38 33 31	77 06 22	6.27	83.40	3.330	46.800	1.769	2	1.9	1	1	4.2
CH-S-042	28MAR87	38 38 40	76 48 53	5.77	16.60	5.280	84.600	1.013	1	6.5	2	2	7.2
CH-S-067	21MAR87	38 21 14	76 52 39	5.75	19.40	2.950	54.000	1.155	2	2.8	1	1	2.3
CH-S-126	14MAR87	38 27 16	76 57 44	6.49	150.60	2.350	128.700	3.226	1	3.7	1	1	5.9
* CH-S-156	21MAR87	38 28 46	76 51 14	6.67	82.20	4.010	81.600	1.344	2	4.5	2	2	8.5
* CH-S-200	21MAR87	38 37 01	77 02 53	6.31	47.80	5.010	134.400	1.147	2	75.8	2	15	116.8
* CH-S-269	21MAR87	38 34 45	77 04 46	6.35	53.50	4.680	126.800	1.179	2	105.7	3	23	151.9
CH-S-297	21MAR87	38 27 49	76 51 54	6.86	152.40	3.350	99.100	1.813	1	35.5	3	10	52.8
* CH-S-321	21MAR87	38 25 12	77 11 52	6.42	107.60	6.930	63.700	2.011	3	33.6	3	6	44.1

TABLE E-4. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN CAROLINE COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
** CN-S-006	07MAR87	38 42 41	75 48 16	6.04	86.60	2.210	140.200	3.604	1	9.6	2	2	24.0
CN-S-008	14MAR87	38 46 26	75 44 39	6.17	69.30	9.520	142.600	2.267	1	3.9	1	1	9.8
* CN-S-018	21MAR87	38 44 12	75 47 38	6.67	127.90	3.430	166.500	2.168	1	7.8	1	1	15.7

TABLE E-5. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN DORCHESTER COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
DO-S-001	07MAR87	38 31 49	76 01 58	5.96	166.60	4.840	161.500	6.764	9	5.4	1	1	15.2
DO-S-002	07MAR87	38 39 07	75 55 47	6.49	146.50	3.230	176.400	3.326	3	2.1	1	1	11.8
DO-S-003	07MAR87	38 40 15	75 45 50	5.88	66.30	3.130	129.400	3.201	3	9.6	2	2	20.8
DO-S-005	14MAR87	38 34 38	75 45 44	6.08	85.30	4.170	133.600	2.700	3	3.0	1	1	11.0

TABLE E-6. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN PRINCE GEORGES COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
PG-S-002	14MAR87	38 40 22	76 45 01	6.69	87.60	2.460	127.700	1.283	2	2.2	1	1	3.6
PG-S-003	21MAR87	38 38 51	77 01 48	6.27	73.00	5.140	120.300	1.737	2	2.5	1	1	3.0
PG-S-004	14MAR87	38 40 06	76 54 29	5.50	15.20	3.680	65.200	1.864	2	4.6	1	1	7.9
PG-S-006	21MAR87	38 42 55	76 43 00	6.38	70.20	1.910	154.200	1.531	1	4.1	1	1	4.9
PG-S-008	21MAR87	38 43 43	76 48 19	6.04	40.30	2.840	143.000	1.319	1	3.3	1	1	5.8

TABLE E-7. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN SOMERSET COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHE ARE
SO-S-001	07MAR87	38 13 06	75 43 39	4.71	8.90	2.580	86.200	3.113	27	6.3	1	1	25
SO-S-003	14MAR87	38 09 44	75 38 17	4.73	0.60	16.550	98.500	2.954	33	13.1	1	1	36

TABLE E-8. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN SAINT MARYS COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
SM-S-001	14MAR87	38 10 30	76 24 00	5.22	6.90	8.770	63.400	1.576	2	1.9	1	1	2.8
SM-S-002	14MAR87	38 18 56	76 44 02	7.06	445.90	4.770	108.400	5.940	3	8.4	2	2	9.7
SM-S-003	14MAR87	38 11 19	76 22 28	5.89	162.20	13.270	130.900	6.002	7	1.3	1	1	2.4
SM-S-004	14MAR87	38 12 05	76 24 28	5.41	30.50	2.420	60.300	3.308	1	0.4	1	1	1.2
SM-S-006	14MAR87	38 21 12	76 39 11	6.64	199.60	2.120	78.100	2.809	3	10.0	2	3	13.6
SM-S-007	14MAR87	38 14 29	76 27 00	5.86	42.20		51.100	2.243	3	3.4	1	1	5.7
SM-S-008	14MAR87	38 24 09	76 45 32	6.44	171.10	14.740	81.000	3.796	1	1.3	1	1	2.5
SM-S-011	14MAR87	38 22 16	76 49 37	6.44	123.80	4.300	109.800	2.480	3	2.9	1	1	6.4
SM-S-014	14MAR87	38 26 02	76 41 56	7.47	1227.80	17.620	181.000	15.230	2	1.7	1	1	2.9
SM-S-015	14MAR87	38 20 19	76 47 59	6.45	141.20	5.920	67.600	2.307	1	3.9	1	1	3.8
SM-S-019	21MAR87	38 25 35	76 44 31	7.14	384.50	2.980	105.200	4.651	2	2.3	1	1	3.0
SM-S-020	21MAR87	38 12 55	76 32 56	5.48	3.00	2.230	45.900	0.883	1	1.4	1	1	3.7
SM-S-021	21MAR87	38 17 09	76 35 34	5.66	17.80	3.190	45.900	1.362	2	4.5	1	1	8.5
SM-S-022	21MAR87	38 23 02	76 48 35	6.82	148.90	3.680	74.900	2.168	2	8.1	1	1	15.2
SM-S-024	21MAR87	38 19 59	76 48 45	5.57	75.60	4.710	208.000	6.762	3	3.0	1	1	3.2
SM-S-025	21MAR87	38 22 00	76 43 22	7.87	286.20	4.950	89.300	2.994	3	19.5	3	5	24.4
SM-S-026	21MAR87	38 23 31	76 42 37	7.04	314.50	4.620	77.700	3.584	2	5.3	2	2	6.8
SM-S-027	21MAR87	38 16 50	76 27 04	5.78	45.60	5.050	118.900	3.649	0	1.1	1	1	2.8
SM-S-028	21MAR87	38 24 21	76 41 00	6.69	175.30	2.970	113.900	2.833	2	1.5	1	1	1.6
SM-S-029	21MAR87	38 12 42	76 23 24	5.35	17.60	5.340	134.900	2.381	1	0.6	1	1	1.1
SM-S-240	21MAR87	38 20 05	76 37 56	6.76	169.90	3.920	81.600	2.456	2	22.6	2	6	31.5

TABLE E-9. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN WICOMICO COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
WI-S-001	07MAR87	38 22 46	75 45 44	4.28	-64.40	2.480	64.800	2.599	30	3.7	1	1	8.8
WI-S-002	07MAR87	38 19 43	75 41 52	4.74	-1.10	3.380	97.900	3.330	6	1.4	1	1	3.5
WI-S-004	07MAR87	38 23 16	75 33 30	6.44	317.40	3.690	123.400	5.560	0	7.7	1	1	16.3
WI-S-005	07MAR87	38 20 27	75 22 33	5.04	24.20	7.510	180.000	3.088	7	6.4	2	2	12.2
WI-S-006	14MAR87	38 18 14	75 28 55	4.78	-8.40	12.350	62.100	1.545	7	5.5	1	1	13.7

TABLE E-10. DATA FOR STREAMS SAMPLED IN THE SOUTHERN COASTAL PLAIN IN WORCHESTER COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
WO-S-002	07MAR87	38 11 15	75 17 36	5.54	42.80	2.440	102.900	3.378	6	2.1	1	1	10.3
WO-S-004	07MAR87	38 05 36	75 27 55	6.04	111.80	3.760	175.400	2.770	4	8.9	1	1	26.6
WO-S-006	07MAR87	38 19 05	75 09 43	5.72	86.30	4.140	168.800	4.207	4	3.9	1	1	11.9
WO-S-008	14MAR87	38 26 02	75 20 05	4.95	9.50	12.210	128.600	3.778	5	59.0	3	9	88.1
WO-S-009	14MAR87	38 19 17	75 17 11	6.51	298.30	16.170	134.200	5.084	20	6.7	1	1	13.7
WO-S-011	14MAR87	38 12 34	75 17 43	5.68	80.50	14.800	101.100	2.561	13	2.0	1	1	18.6

TABLE E-11. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN ANNE ARUNDEL COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
AA-N-001	28MAR87	38 52 05	76 39 35	6.91	131.30	3.720	193.600	1.725	1	5.6	1	1	7.9
AA-N-002	04APR87	39 05 21	76 47 41	6.50	84.10	4.940	89.400	1.381	1	2.1	1	1	2.2
AA-N-008	04APR87	39 12 21	76 36 43	6.88	1058.20	12.680	575.000	14.160	6	8.3	2	2	11.3
AA-N-009	04APR87	39 10 29	76 37 19	7.02	570.90	13.690	181.000	7.174	5	22.5	3	9	19.2
AA-N-011	28MAR87	39 00 08	76 32 25	6.77	853.50	19.300	205.000	12.850	4	0.6	1	1	2.1
AA-N-012	28MAR87	38 52 11	76 35 12	5.66	34.80	3.990	125.100	1.929	2	5.5	1	1	8.1
AA-N-017	04APR87	38 57 07	76 36 49	6.60	173.00	3.560	119.000	2.877	2	3.1	1	1	4.5
AA-N-019	28MAR87	39 06 17	76 30 38	5.93	75.50	4.340	106.000	2.805	1	0.5	1	1	1.6
AA-N-020	28MAR87	39 08 58	76 33 51	4.58	-23.90	5.570	125.500	2.324	1	1.2	1	1	2.6
AA-N-022	04APR87	39 06 44	76 42 17	6.71	362.70	8.220	167.800	5.227	4	8.4	2	3	8.5
AA-N-025	28MAR87	39 05 22	76 39 04	4.32	-55.60	5.220	71.500	3.078	1	3.2	1	1	3.3
AA-N-026	28MAR87	39 09 46	76 43 17	6.62	226.20	8.840	243.000	3.733	2	1.5	1	1	1.7
AA-N-027	04APR87	39 06 28	76 33 15	7.33	805.90	17.410	141.600	9.067	8	1.1	1	1	1.8
AA-N-028	04APR87	39 10 26	76 37 55	7.36	769.60	11.960	219.000	8.460	5	4.5	2	2	3.0
AA-N-029	28MAR87	38 52 29	76 40 14	6.90	157.50	3.880	80.100	2.215	1	2.1	1	1	1.9
AA-N-030	04APR87	39 10 25	76 44 56	6.76	289.60	7.310	144.400	3.796	3	5.3	2	2	8.2
AA-N-031	28MAR87	38 56 30	76 30 01	7.07	1416.00	9.970	171.700	17.990	2	0.9	1	1	1.4
AA-N-034	28MAR87	39 01 06	76 28 44	6.71	189.00	4.260	114.000	2.762	2	5.9	2	3	5.6
AA-N-035	04APR87	39 08 31	76 29 53	7.03	1465.20	57.590	393.000	13.800	40	0.8	1	1	1.8
AA-N-036	04APR87	39 06 45	76 41 20	7.31	185.30	8.190	147.700	3.659	2	4.6	1	1	5.6
AA-N-037	04APR87	39 07 14	76 48 01	7.35	826.50	17.290	290.000	10.050	6	0.8	1	1	1.2
AA-N-038	28MAR87	39 00 07	76 28 10	6.07	182.80	3.420	58.200	4.835	0	0.5	1	1	0.8
AA-N-039	04APR87	39 08 30	76 36 33	6.87	457.30	7.570	176.400	6.257	5	11.6	2	5	10.3
* AA-N-064	04APR87	38 53 10	76 40 16	7.20	240.00	4.510	150.400	2.835	1	10.9	2	2	14.8
* AA-N-126	04APR87	39 11 00	76 36 53	6.94	590.00	11.950	188.200	8.067	6	28.2	3	12	24.4
* AA-N-132	04APR87	39 10 15	76 37 48	6.22	111.40	7.480	163.200	2.486	4	16.8	3	7	15.6
* AA-N-137	04APR87	39 05 04	76 37 59	6.77	218.40	3.590	123.500	3.293	1	46.1	3	15	46.3
* AA-N-160	28MAR87	39 06 55	76 33 09	7.15	618.10	8.040	643.000	8.133	2	22.1	2	6	13.6
* AA-N-161	04APR87	39 08 46	76 36 22	7.08	576.80	11.320	212.000	7.263	5	14.5	2	6	14.2
* AA-N-165	28MAR87	38 59 39	76 36 46	6.71	253.10	4.110	131.200	3.832	1	17.5	2	5	25.8
* AA-N-192	28MAR87	38 52 50	76 33 54	6.66	212.10	3.380	142.900	2.880	1	8.9	2	2	12.8
* AA-N-282	04APR87	38 57 32	76 41 47	7.23	720.10	6.010	214.000	8.292	2	861.4	5	252	909.8
* AA-N-314	28MAR87	39 00 12	76 37 00	6.46	217.50	4.080	144.200	3.812	1	16.1	2	4	21.6
* AA-N-327	28MAR87	38 59 08	76 37 28	6.02	44.30	2.820	107.300	1.897	1	16.8	3	4	24.1

TABLE E-12. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN BALTIMORE COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
BA-N-001	04APR87	39 20 35	76 29 30	7.85	1045.50	13.420	362.000	11.050	4	11.5	2	4	13.2
BA-N-002	11APR87	39 20 19	76 29 43	8.87	1597.20	3.120	413.000	17.570	2	1.6	1	1	2.2
BA-N-003	04APR87	39 23 35	76 29 24	7.63	1015.50	13.920	217.000	11.260	3	1.3	1	1	6.2
BA-N-006	04APR87	39 22 16	76 31 40	7.51	1022.10	8.870	220.000	11.950	2	2.8	1	1	3.8
* BA-N-008	11APR87	39 21 57	76 26 28	8.06	1422.30	3.080	286.000	16.180	2	14.7	2	3	16.4
BA-N-009	11APR87	39 25 17	76 23 55	7.26	453.80	2.460	145.700	5.894	2	2.7	1	1	3.9
BA-N-011	11APR87	39 13 32	76 41 32	8.12	1728.30	2.050	511.000	20.360	2	15.8	3	5	21.0
BA-N-012	11APR87	39 22 32	76 25 39	7.66	1517.60	2.920	307.000	14.440	2	23.9	2	5	30.7
* BA-N-018	11APR87	39 19 56	76 28 50	7.42	1205.60	3.790	178.700	15.330	3	14.5	2	5	17.4
* BA-N-021	11APR87	39 14 59	76 41 39	8.83	1429.20	2.170	462.000	15.990	1	4.2	1	1	6.2
* BA-N-042	11APR87	39 26 09	76 25 31	7.80	581.20	1.420	137.300	6.897	2	5.2	1	1	8.7

TABLE E-13. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN THE CITY OF BALTIMORE.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
BC-N-001	04APR87	39 16 36	76 40 06	7.71	962.70	8.970	220.000	10.400	2	5.0	2	3	8.0
BC-N-003	04APR87	39 16 42	76 41 16	7.88	1025.40	9.250	240.000	10.890	3	0.9	1	1	2.4

TABLE E-14. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN CECIL COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
** CE-N-001	04APR87	39 36 24	75 57 39	7.13	232.80	9.260	124.700	2.315	4	16.2	2	3	24.2
CE-N-002	04APR87	39 36 53	75 51 47	7.13	379.00	8.470	139.600	4.264	4	39.9	2	3	86.2
CE-N-003	21MAR87	39 24 26	75 57 56	6.45	148.80	3.590	85.900	3.417	2	2.3	1	1	7.6
* CE-N-004	28MAR87	39 27 52	75 46 41	8.30	811.30	5.690	186.400	8.241	1	3.3	1	1	11.7
CE-N-006	28MAR87	39 27 04	75 45 58	7.11	546.00	5.430	176.500	6.310	1	3.6	1	1	7.1
* CE-N-018	04APR87	39 33 24	75 46 37	6.46	190.10	12.240	102.200	2.966	5	7.2	1	1	16.0
* CE-N-033	11APR87	39 37 48	75 49 30	7.67	388.40	1.380	133.700	4.821	1	67.4	3	5	150.0

TABLE E-15. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN CAROLINE COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
CN-N-002	21MAR87	39 05 36	75 45 04	6.79	352.00	6.500	168.500	5.401	1	30.2	3	5	75.4
CN-N-003	07MAR87	38 52 54	75 55 29	6.41	155.90	4.530	131.600	3.042	1	12.3	2	2	24.2
CN-N-004	21MAR87	39 04 48	75 45 02	6.81	298.70	4.120	161.900	4.620	2	39.0	2	2	88.9
CN-N-005	07MAR87	38 55 59	75 51 33	6.57	283.60	3.040	199.800	4.216	1	6.3	1	1	13.4
CN-N-006	07MAR87	38 54 23	75 54 33	6.35	197.00	4.900	143.200	4.002	1	5.5	1	1	9.5
CN-N-007	14MAR87	38 53 58	75 44 22	5.86	103.90	4.700	160.200	3.990	3	2.8	1	1	6.3
CN-N-008	14MAR87	38 53 41	75 53 52	6.38	136.20	3.580	128.400	3.063	2	5.0	1	1	10.3
* CN-N-047	21MAR87	39 00 12	75 46 52	6.89	224.90	4.410	127.900	3.194	2	137.3	4	19	290.0

TABLE E-16. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN HARFORD COUNTY.

	SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
	HA-N-001	04APR87	39 26 11	76 19 18	6.67	307.00	9.650	177.700	4.471	6	2.7	1	1	2.9
	HA-N-002	04APR87	39 27 11	76 17 44	5.78	67.00	10.670	133.200	1.194	4	4.4	1	1	8.0
	HA-N-003	11APR87	39 27 23	76 10 04	6.76	483.70	9.670	177.200	8.540	6	6.7	2	2	8.0
	HA-N-004	04APR87	39 32 07	76 15 25	7.37	420.30	11.440	134.800	4.154	2	3.1	1	1	4.2
	HA-N-005	11APR87	39 29 14	76 20 10	7.73	595.40	0.720	143.400	7.570	1	2.2	1	1	3.2
	HA-N-006	04APR87	39 33 19	76 08 07	6.79	208.40	7.610	111.700	2.848	2	4.4	1	1	4.8
	HA-N-007	11APR87	39 27 22	76 20 15	7.31	571.60	2.320	127.800	7.074	1	3.3	1	1	4.3
	HA-N-008	11APR87	39 26 58	76 10 18	6.54	411.10	11.030	154.300	7.541	6	15.0	2	3	24.9
*	HA-N-046	04APR87	39 29 01	76 12 57	7.50	461.00	6.660	143.600	4.953	2	13.1	2	3	15.2

TABLE E-17. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN HOWARD COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
HO-N-001	28MAR87	39 11 26	76 43 21	7.50	911.50	14.350	294.000	11.520	2	16.1	2	6	14.5
HO-N-002	28MAR87	39 11 50	76 45 40	7.18	414.50	7.330	332.000	5.011	2	2.0	1	1	1.3
HO-N-004	28MAR87	39 11 31	76 46 04	7.17	1001.00	17.110	515.000	12.360	3	1.4	1	1	1.3
* HO-N-023	04APR87	39 09 20	76 49 58	7.42	1263.30	7.820	195.800	8.570	4	85.7	4	23	102.8

TABLE E-18. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN KENT COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
KE-N-001	21MAR87	39 11 05	76 15 18	5.57	83.60	18.840	49.500	3.814	9	2.8	1	1	3.2
KE-N-003	21MAR87	39 16 11	76 06 56	6.36	109.60	4.510	100.300	2.297	3	3.0	1	1	5.3
KE-N-004	21MAR87	39 21 18	76 04 45	7.22	435.00	11.740	95.400	5.244	8	2.8	1	1	5.8
KE-N-005	21MAR87	39 16 40	76 07 02	6.36	107.10	3.250	99.900	2.385	2	2.3	1	1	2.6
KE-N-006	28MAR87	39 13 01	76 11 53	6.05	296.90	30.220	155.200	8.474	27	2.1	1	1	3.3
KE-N-008	28MAR87	39 18 34	76 05 04	6.59	243.60	5.210	128.900	3.954	1	1.9	1	1	2.3
KE-N-010	28MAR87	39 15 46	76 04 50	9.31	13641.3	33.580	1344.000	126.500	7	2.3	1	1	3.5
KE-N-012	28MAR87	39 16 13	76 04 52	5.98	124.20	6.950	139.100	3.901	3	2.1	1	1	2.4
KE-N-013	28MAR87	39 18 33	76 04 31	6.79	210.10	5.360	140.600	2.941	2	2.8	1	1	2.9
* KE-N-034	28MAR87	39 16 50	76 00 53	7.05	1117.60	14.970	208.000	14.900	4	12.6	2	3	34.9
* KE-N-069	28MAR87	39 15 25	75 49 59	6.68	253.60	8.570	131.500	3.815	4	45.4	2	6	101.6
* KE-N-109	28MAR87	39 21 47	75 47 27	7.27	486.40	6.490	123.500	5.682	4	6.0	1	1	17.7

TABLE E-19. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN PRINCE GEORGES COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
PG-N-003	28MAR87	38 53 58	76 48 07	7.06	447.20	7.820	214.000	6.020	1	26.9	2	4	49.3
PG-N-005	28MAR87	39 05 49	76 51 45	6.89	555.50	16.360	503.000	8.855	4	3.7	1	1	3.6
PG-N-006	28MAR87	38 49 45	76 54 22	6.65	329.80	6.710	602.000	5.386	1	2.2	1	1	3.1
PG-N-007	28MAR87	39 06 46	76 53 02	7.07	395.50	9.350	149.300	4.638	2	3.0	1	1	3.6
PG-N-008	28MAR87	38 52 32	76 48 19	7.75	1001.30	12.460	340.000	11.510	1	30.5	3	7	47.6
PG-N-009	28MAR87	39 03 49	76 50 55	7.17	1041.80	16.960	258.000	13.790	4	1.2	1	1	2.8
PG-N-010	04APR87	38 41 33	76 58 34	6.18	64.70	7.040	99.000	1.228	4	6.2	2	2	8.5
PG-N-011	28MAR87	38 54 17	76 49 23	7.12	1098.60	11.370	287.000	13.000	1	1.3	1	1	2.5
PG-N-012	28MAR87	38 45 27	77 00 04	7.78	762.60	10.610	315.000	8.432	1	37.2	3	7	63.4
PG-N-013	28MAR87	39 02 17	76 54 38	7.17	2512.90	17.560	432.000	32.870	2	2.0	1	1	2.7
PG-N-014	28MAR87	39 01 33	76 57 03	7.48	578.30	8.530	197.200	6.536	1	34.2	2	11	43.5
PG-N-015	28MAR87	39 02 36	76 53 49	7.59	1889.70	19.810	1310.000	19.400	2	11.8	3	5	11.8
PG-N-018	04APR87	38 53 05	76 40 51	7.34	697.40	8.330	200.000	7.103	4	9.0	2	2	12.2
PG-N-019	14MAR87	38 44 23	76 57 55	6.93	274.60	10.030	225.000	3.450	1	19.7	2	2	40.9
PG-N-020	04APR87	39 01 52	76 57 40	6.82	250.40	8.470	63.300	2.425	5	30.6	2	10	36.7
PG-N-021	28MAR87	38 43 24	76 57 44	7.08	265.90	4.120	188.300	3.199	0	2.3	1	1	4.8
PG-N-022	14MAR87	38 40 57	77 02 24	6.95	248.80	2.530	113.900	3.276	1	2.0	1	1	2.4
PG-N-023	04APR87	38 47 17	77 00 04	7.28	514.50	9.990	205.000	5.360	5	4.5	1	1	6.4
PG-N-024	04APR87	38 45 49	76 59 02	7.23	563.90	8.000	163.600	6.251	3	4.2	1	1	10.5
* PG-N-094	04APR87	38 57 04	76 56 01	6.90	427.90	7.410	122.400	3.935	6	143.1	4	44	197.1
* PG-N-171	04APR87	38 57 13	76 57 51	7.44	540.50	7.740	99.700	5.015	5	91.4	3	20	130.1
PG-N-175	28MAR87	38 41 39	76 57 38	6.64	87.70	3.020	90.700	1.423	1	2.7	1	1	4.0
* PG-N-232	04APR87	38 42 29	76 57 36	6.54	171.30	6.770	124.400	2.372	4	62.2	3	11	103.0

TABLE E-20. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN QUEEN ANNE COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
QA-N-002	21MAR87	39 11 13	75 46 53	6.77	552.10	8.990	177.100	8.619	3	3.7	1	1	6.4
QA-N-003	21MAR87	39 10 45	75 53 43	6.73	364.30	5.910	176.200	5.928	1	9.2	2	2	21.2
QA-N-005	21MAR87	39 01 57	75 56 43	7.05	538.30	8.260	168.700	7.461	2	13.3	1	1	43.5
QA-N-006	21MAR87	39 08 36	76 02 13	6.67	160.50	4.070	244.000	2.531	2	1.5	1	1	2.6
QA-N-007	21MAR87	39 13 30	75 51 12	6.68	232.20	4.920	142.600	4.127	2	23.2	2	3	53.8
QA-N-008	28MAR87	39 07 00	75 57 15	7.30	647.00	7.050	217.000	7.976	2	8.4	1	1	22.8
QA-N-009	28MAR87	39 04 39	76 00 52	6.96	1023.90	11.400	194.000	13.540	4	1.7	1	1	2.4
QA-N-010	28MAR87	39 03 30	76 02 37	7.52	949.10	8.860	223.000	11.520	3	1.6	1	1	2.4
QA-N-011	28MAR87	39 05 33	76 02 34	7.26	1055.30	6.420	210.000	13.180	3	3.4	1	1	5.1
QA-N-012	28MAR87	39 09 47	75 53 21	6.91	416.70	6.220	171.400	2.278	20	3.6	1	1	6.8
* QA-N-034	28MAR87	39 14 54	75 51 45	7.52	318.00	4.840	144.900	3.298	3	23.6	2	3	59.5
* QA-N-067	28MAR87	39 06 30	76 02 04	7.14	687.70	11.670	180.100	8.634	4	10.3	2	2	23.9

TABLE E-21. DATA FOR STREAMS SAMPLED IN THE NORTHERN COASTAL PLAIN IN TALBOT COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
TA-N-001	07MAR87	38 47 30	75 59 47	6.99	332.60	3.470	160.900	5.586	4	17.1	2	4	27.8
TA-N-002	14MAR87	38 48 40	76 02 00	6.63	260.50	11.650	113.600	4.141	8	5.6	1	1	11.4
TA-N-003	14MAR87	38 46 45	76 04 12	7.18	983.40	13.220	299.000	13.680	7	2.2	1	1	6.0
TA-N-004	07MAR87	38 41 21	76 05 14	6.66	179.10	3.380	124.000	2.315	4	0.6	1	1	2.6
TA-N-005	14MAR87	38 47 37	75 59 49	7.28	647.60	3.750	206.000	7.690	1	0.5	1	1	2.4
TA-N-007	14MAR87	38 53 25	75 57 25	7.05	445.00	5.690	220.000	6.040	3	17.0	2	4	30.8

TABLE E-22. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN BALTIMORE COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
BA-P-003	04APR87	39 42 25	76 34 55	7.40	389.80	5.060	147.900	4.507	1	63.1	4	17	69.1
BA-P-005	04APR87	39 28 32	76 46 26	7.41	411.60	3.890	112.100	4.355	2	2.5	1	1	3.0
BA-P-006	04APR87	39 33 47	76 33 08	7.12	361.00	5.650	115.900	4.281	2	3.6	1	1	4.8
BA-P-008	25APR87	39 29 47	76 51 17	7.31	477.20	2.310	199.200	6.293	1	2.6	1	1	3.1
BA-P-010	11APR87	39 39 40	76 38 29	7.08	294.30	0.700	141.600	4.167	1	3.4	1	1	3.9
BA-P-012	04APR87	39 27 11	76 38 57	7.83	795.60	6.690	224.000	8.338	10	2.4	1	1	4.3
BA-P-013	04APR87	39 18 49	76 43 35	7.80	956.00	10.150	216.000	9.983	2	12.4	3	5	13.1
BA-P-014	25APR87	39 37 10	76 48 26	7.76	506.60	1.530	216.000	6.677	1	13.0	2	3	15.7
BA-P-015	04APR87	39 28 39	76 41 15	7.17	167.50	3.490	95.900	1.926	2	2.7	1	1	4.1
BA-P-018	11APR87	39 36 27	76 44 27	7.42	363.20	1.460	155.800	5.356	1	2.8	1	1	3.0
BA-P-019	11APR87	39 28 30	76 34 08	7.26	222.30	0.720	117.400	4.120	1	4.2	1	1	4.5
BA-P-021	11APR87	39 34 32	76 38 39	7.29	518.50	1.110	100.600	6.977	1	1.6	1	1	1.9
BA-P-022	04APR87	39 41 57	76 35 59	7.19	321.10	3.740	130.700	3.870	2	3.2	1	1	3.7
BA-P-023	11APR87	39 21 28	76 50 35	7.06	330.10	1.430	128.100	4.458	1	3.3	1	1	4.6
BA-P-024	04APR87	39 24 27	76 43 32	7.78	1319.70	9.460	229.000	14.150	2	4.2	2	2	7.0
BA-P-025	04APR87	39 28 28	76 43 25	6.65	174.80	6.130	69.700	2.763	3	1.6	1	1	2.8
BA-P-026	04APR87	39 20 16	76 49 12	7.38	1107.60	10.910	177.500	8.691	3	15.3	3	4	17.8
BA-P-027	04APR87	39 28 48	76 32 14	7.20	438.80	4.930	129.800	4.267	3	3.8	1	1	4.6
BA-P-028	04APR87	39 32 19	76 44 40	7.81	1626.80	13.820	209.000	17.960	2	1.6	1	1	2.8
BA-P-029	11APR87	39 39 40	76 47 11	7.28	247.30	0.720	77.800	3.109	1	3.5	1	1	3.7
BA-P-031	04APR87	39 32 29	76 33 11	7.12	387.30	6.410	94.600	4.386	2	1.7	1	1	1.6
BA-P-032	04APR87	39 35 45	76 42 05	7.13	269.30	2.690	130.400	3.158	1	1.4	1	1	2.0
* BA-P-331	11APR87	39 20 06	76 43 31	9.02	1270.50	1.520	257.000	14.110	1	67.3	3	15	90.7

TABLE E-23. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN THE CITY OF BALTIMORE.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
BC-P-003	04APR87	39 21 51	76 34 24	7.79	1004.20	11.600	260.000	10.670	4	9.1	2	2	12.0

TABLE E-24. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN CECIL COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
CE-P-001	04APR87	39 37 51	76 03 13	7.13	374.20	5.750	126.500	4.261	2	2.1	1	1	2.3
CE-P-002	04APR87	39 38 27	75 53 10	6.66	181.60	13.880	88.000	2.404	8	4.2	1	1	5.1
CE-P-003	11APR87	39 42 29	76 04 14	8.64	937.60	2.720	161.000	11.370	3	11.0	3	4	12.1
CE-P-005	11APR87	39 41 56	76 00 19	7.66	879.10	2.400	150.500	10.670	2	19.5	2	6	31.3
* CE-P-050	04APR87	39 37 10	76 02 25	7.31	546.80	15.260	153.400	5.688	7	17.2	2	4	27.3

TABLE E-25. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN CARROL COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
CR-P-001	11APR87	39 41 24	77 12 07	6.99	323.80	2.070	141.600	4.743	1	2.2	1	1	2.1
CR-P-003	11APR87	39 22 32	77 00 46	7.47	334.90	0.950	121.100	4.298	1	15.4	3	4	14.9
CR-P-006	11APR87	39 34 56	77 11 43	7.58	913.50	2.720	272.000	12.050	2	1.8	1	1	2.5
CR-P-008	04APR87	39 33 31	77 00 17	7.74	1661.00	12.630	275.000	16.850	2	2.5	1	1	6.0
CR-P-009	04APR87	39 25 45	76 57 26	7.35	546.20	7.320	139.300	5.404	2	17.2	2	4	20.2
CR-P-010	11APR87	39 40 03	76 55 57	7.96	800.00	1.070	159.200	9.067	1	7.5	2	2	8.7
CR-P-011	11APR87	39 36 48	77 05 54	8.02	1618.80	1.290	321.000	19.340	1	2.8	1	1	2.7
CR-P-013	11APR87	39 42 44	77 05 05	7.30	249.30	0.920	117.900	3.168	1	2.1	1	1	2.9
CR-P-015	25APR87	39 30 35	76 51 24	7.42	354.80	0.820	159.300	4.474	1	1.8	1	1	2.3
CR-P-016	11APR87	39 32 35	77 01 00	8.95	1227.20	0.870	212.000	13.530	1	3.2	1	1	3.2
CR-P-017	11APR87	39 30 37	77 01 30	7.11	339.80	0.880	119.400	4.301	1	8.5	2	3	8.2
CR-P-018	04APR87	39 42 03	76 53 33	7.07	370.60	5.380	97.500	4.533	3	2.3	1	1	1.7
CR-P-019	25APR87	39 38 05	77 03 08	7.63	927.50	4.100	174.900	10.870	2	13.1	2	5	16.7
CR-P-020	25APR87	39 24 28	76 55 04	7.49	599.70	1.690	130.100	6.652	1	5.7	2	2	7.3
CR-P-021	11APR87	39 33 15	77 10 05	8.07	1531.80	1.200	261.000	18.250	1	33.9	3	8	43.1
CR-P-022	04APR87	39 39 39	76 51 31	6.88	357.90	7.790	123.400	4.526	4	2.2	1	1	3.2
CR-P-025	25APR87	39 29 28	77 01 18	7.43	478.30	1.460	128.200	5.861	1	32.8	3	10	38.7
CR-P-027	04APR87	39 32 38	76 58 16	7.18	405.80	8.230	166.500	4.929	3	1.6	1	1	1.8
CR-P-028	25APR87	39 24 17	77 07 18	6.88	226.00	2.110	64.200	3.474	1	3.2	1	1	4.5
CR-P-029	04APR87	39 39 19	76 55 41	7.61	1884.50	12.070	252.000	11.960	5	7.1	2	2	9.0
* CR-P-200	11APR87	39 36 47	77 14 05	7.66	802.00	1.300	183.300	9.869	1	228.6	4	61	263.2
* CR-P-229	11APR87	39 35 27	76 58 17	8.42	1492.00	1.150	338.000	16.830	1	3.8	1	1	8.4

TABLE E-26. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN FREDERICK COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
FR-P-001	11APR87	39 22 07	77 29 39	8.06	648.20	2.000	230.000	7.214	1	2.2	1	1	2.5
FR-P-002	11APR87	39 18 28	77 17 47	7.15	303.10	0.730	99.800	3.835	1	31.6	2	9	32.3
FR-P-003	11APR87	39 32 13	77 23 46	6.16	180.60	1.270	41.600	1.159	1	25.6	2	7	40.1
FR-P-005	11APR87	39 25 39	77 29 01	7.39	527.00	1.260	306.000	6.564	1	7.1	1	1	6.5
FR-P-006	11APR87	39 14 32	77 26 03	7.43	302.40	1.480	83.600	3.852	1	12.5	2	4	12.0
FR-P-007	11APR87	39 34 18	77 12 44	8.01	1598.60	1.460	271.000	20.160	1	17.4	2	5	20.5
FR-P-009	11APR87	39 41 59	77 18 56	9.16	1201.00	3.280	205.000	12.450	2	25.9	3	7	29.7
FR-P-013	11APR87	39 32 48	77 23 24	7.58	538.70	3.140	156.800	6.607	3	1.7	1	1	1.8
FR-P-014	11APR87	39 31 56	77 14 24	7.60	1005.00	2.640	195.300	12.700	2	1.8	1	1	2.2
FR-P-015	25APR87	39 18 57	77 20 05	7.33	468.80	4.930	128.300	6.485	1	61.6	3	14	68.6
FR-P-016	25APR87	39 23 31	77 13 20	7.17	315.70	1.300	83.100	4.097	1	6.7	1	1	15.9
FR-P-020	25APR87	39 40 16	77 21 30	5.58	9.60	0.960	19.400	0.618	1	2.3	1	1	2.9
FR-P-021	25APR87	39 20 07	77 18 06	7.51	453.60	2.010	127.800	5.723	2	15.2	2	2	18.1
FR-P-022	11APR87	39 30 16	77 16 44	7.15	211.60	1.530	61.500	3.024	2	1.4	1	1	1.5
FR-P-023	11APR87	39 41 30	77 20 35	7.70	515.00	1.300	122.200	6.442	1	2.1	1	1	3.0
FR-P-026	11APR87	39 35 28	77 23 37	7.53	406.50	1.650	111.500	4.856	1	36.9	3	8	48.1
FR-P-028	11APR87	39 22 07	77 22 58	7.76	1079.50	1.530	250.000	13.280	1	60.8	3	19	78.6
FR-P-029	11APR87	39 33 31	77 22 32	7.27	637.40	3.220	260.000	8.332	2	1.8	1	1	2.6
FR-P-030	25APR87	39 41 25	77 16 11	7.58	924.10	5.750	279.000	11.210	3	2.1	1	1	3.1
FR-P-031	25APR87	39 27 13	77 15 47	7.84	674.60	2.770	164.300	8.341	2	4.8	2	2	4.2
FR-P-033	25APR87	39 34 36	77 14 36	7.75	992.80	4.380	266.000	11.840	3	3.6	1	1	5.3
FR-P-034	11APR87	39 34 56	77 26 00	7.06	113.10	0.940	42.400	1.593	1	14.5	2	2	21.0
FR-P-035	25APR87	39 21 15	77 23 53	7.56	456.00	2.010	166.400	5.566	1	5.0	1	1	5.2
* FR-P-039	11APR87	39 35 37	77 23 47	7.47	397.20	1.600	110.900	4.840	2	33.4	3	7	43.8
* FR-P-131	11APR87	39 18 02	77 24 49	7.46	472.70	1.080	127.200	5.993	1	152.9	4	39	164.9
* FR-P-213	11APR87	39 41 05	77 14 05	7.63	771.40	2.380	182.300	9.479	1	399.2	5	99	447.7

TABLE E-27. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN HARFORD COUNTY.

	SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
	HA-P-001	04APR87	39 34 53	76 26 24	7.33	372.60	5.680	110.200	4.302	3	17.0	2	3	22.9
	HA-P-003	04APR87	39 34 49	76 15 06	7.03	419.90	3.580	192.100	4.022	1	0.7	1	1	1.4
	HA-P-004	04APR87	39 30 11	76 26 08	7.42	436.60	4.450	118.700	4.966	10	86.3	3	24	94.9
	HA-P-005	04APR87	39 42 19	76 28 50	7.20	219.10	3.520	102.100	2.620	2	9.0	2	3	11.7
	HA-P-006	11APR87	39 40 08	76 19 14	7.53	304.90	0.990	138.500	3.706	1	35.5	3	10	43.8
*	HA-P-007	11APR87	39 36 59	76 12 12	7.54	428.90	1.130	130.200	5.486	1	336.2	4	78	416.4
	HA-P-008	04APR87	39 42 00	76 16 10	7.06	235.50	1.740	91.800	2.675	2	14.0	2	4	18.7
	HA-P-010	04APR87	39 35 39	76 24 38	7.09	305.00	2.380	96.600	3.931	1	2.5	1	1	5.3
	HA-P-012	04APR87	39 38 38	76 21 25	7.19	384.70	5.030	175.100	4.444	2	7.7	2	2	9.4
	HA-P-013	11APR87	39 35 22	76 08 20	7.38	450.20	0.940	146.500	5.837	1	3.3	1	1	4.3
	HA-P-014	11APR87	39 33 42	76 20 58	7.94	710.40	1.670	135.500	8.562	2	2.8	1	1	3.7
	HA-P-016	11APR87	39 36 22	76 12 21	7.47	458.50	1.260	147.700	5.560	1	4.2	1	1	5.5
	HA-P-018	11APR87	39 34 54	76 18 05	7.80	807.50	1.290	163.800	9.977	1	6.2	2	2	9.9
	HA-P-019	11APR87	39 35 16	76 18 24	7.68	827.70	0.870	137.600	10.420	1	2.2	1	1	2.8
*	HA-P-069	04APR87	39 31 20	76 22 46	7.64	350.90	4.810	117.900	3.941	3	64.7	3	13	89.4
*	HA-P-140	04APR87	39 37 59	76 24 36	7.40	394.10	3.250	116.600	3.499	1	199.8	4	47	242.6

TABLE E-28. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN HOWARD COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
HO-P-001	04APR87	39 14 20	76 57 22	7.13	634.20	9.520	114.000	5.299	7	6.4	2	2	7.4
HO-P-002	04APR87	39 15 15	76 50 53	7.34	784.20	9.470	189.000	8.891	4	22.2	3	5	26.8
HO-P-003	11APR87	39 19 33	77 04 57	7.14	330.50	0.960	155.700	4.496	1	2.2	1	1	1.9
HO-P-007	11APR87	39 17 02	77 03 48	7.40	316.70	0.980	144.800	3.855	1	37.8	3	10	42.1
HO-P-008	11APR87	39 18 13	77 05 01	6.82	216.70	0.870	95.700	3.475	1	6.0	1	1	3.2
HO-P-009	04APR87	39 14 10	76 56 28	7.47	851.30	7.770	241.000	8.884	4	9.8	2	3	11.3
HO-P-011	04APR87	39 11 47	76 50 49	7.00	507.30	11.410	101.900	6.746	7	2.2	1	1	3.3
HO-P-013	11APR87	39 12 10	76 54 36	7.78	474.80	1.270	141.700	5.779	1	14.6	3	5	17.4
HO-P-014	04APR87	39 14 53	76 49 53	7.24	774.60	8.560	203.000	8.772	3	5.8	2	2	6.3
HO-P-015	11APR87	39 16 27	76 55 45	7.70	456.00	1.280	175.100	5.613	1	30.0	3	8	45.3
HO-P-016	04APR87	39 14 24	76 58 29	6.98	461.90	11.530	101.900	4.516	5	1.5	1	1	2.7
HO-P-020	04APR87	39 11 54	76 49 20	7.35	838.20	6.340	163.900	8.278	3	4.9	1	1	6.9
HO-P-021	04APR87	39 18 32	76 49 01	7.49	385.20	5.800	157.000	4.201	2	1.6	1	1	2.8

TABLE E-29. DATA FOR STREAMS SAMPLED IN THE PIEDMONT IN MONTGOMERY COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
MO-P-001	11APR87	39 05 30	77 10 16	7.63	808.40	1.220	236.000	9.958	2	5.1	2	2	7.1
MO-P-003	11APR87	39 14 16	77 03 11	7.11	235.30	1.030	94.000	3.373	1	77.5	3	19	90.0
MO-P-004	11APR87	39 06 40	77 22 06	7.51	491.00	2.420	179.200	6.254	2	35.6	3	7	40.1
MO-P-005	11APR87	39 08 00	77 05 59	7.25	640.90	1.690	101.900	5.914	2	13.6	3	4	17.2
MO-P-006	11APR87	39 12 32	77 11 00	7.52	928.70	1.010	204.000	11.480	1	8.3	2	2	9.0
MO-P-007	11APR87	39 09 06	77 22 33	7.54	600.80	2.230	172.800	7.490	2	7.8	2	2	9.1
MO-P-009	11APR87	39 17 49	77 15 41	7.08	335.00	1.110	115.100	4.698	1	3.3	1	1	3.9
MO-P-010	25APR87	39 04 55	76 55 55	7.08	589.40	2.860	142.700	7.755	2	1.3	1	1	1.5
MO-P-012	11APR87	39 09 03	77 05 17	7.33	716.00	1.070	151.500	10.030	1	2.3	1	1	2.6
MO-P-013	11APR87	39 13 36	77 18 12	6.92	175.60	0.720	106.800	2.596	1	1.7	1	1	1.3
MO-P-014	11APR87	39 09 16	77 30 27	7.29	354.30	1.190	86.200	4.129	2	3.1	1	1	2.3
MO-P-015	11APR87	39 14 19	77 14 25	7.13	1567.20	0.750	340.000	19.620	1	2.0	1	1	2.5
MO-P-016	11APR87	39 09 11	77 26 14	7.21	495.90	2.690	188.100	5.785	2	4.7	2	2	6.7
MO-P-017	11APR87	39 07 08	77 26 51	6.95	238.00	2.930	143.200	3.643	2	2.9	1	1	3.6
MO-P-018	11APR87	39 08 29	77 17 38	6.85	1593.90	22.790	264.000	18.170	4	1.6	1	1	1.6
MO-P-020	25APR87	39 16 34	77 18 02	7.39	539.60	2.180	117.800	6.572	1	22.3	3	6	25.5
MO-P-021	11APR87	39 19 02	77 11 10	7.12	359.00	1.840	129.500	5.001	1	2.5	1	1	3.8
MO-P-022	25APR87	39 06 57	77 20 25	7.36	676.40	3.190	177.200	7.771	2	2.9	1	1	3.4
MO-P-024	25APR87	39 12 20	77 16 19	7.61	448.10	2.180	114.400	5.836	1	19.4	3	7	18.7
MO-P-025	25APR87	39 08 37	77 13 25	7.44	1406.60	4.480	532.000	18.720	2	3.3	1	1	4.2
MO-P-027	25APR87	39 12 17	77 03 23	7.27	279.80	2.880	83.700	3.386	3	22.9	2	6	30.4
MO-P-028	25APR87	39 08 02	77 18 47	7.38	644.40	3.310	180.700	7.861	2	2.2	1	1	2.3
MO-P-030	25APR87	39 05 31	77 14 11	7.68	1374.20	5.790	224.000	17.260	4	3.0	1	1	3.6
MO-P-032	25APR87	39 05 23	77 17 13	7.43	758.30	3.010	151.700	9.285	2	2.3	1	1	3.3
MO-P-033	25APR87	39 07 56	77 17 23	7.29	593.50	3.510	178.300	7.686	2	5.5	2	2	4.6
MO-P-034	25APR87	39 07 16	77 12 37	7.35	421.90	3.360	210.000	10.840	2	4.9	1	1	8.9
MO-P-035	25APR87	39 11 15	77 02 28	7.18	365.10	4.300	97.200	4.734	3	34.5	2	8	44.1
MO-P-036	25APR87	39 06 36	77 06 27	7.51	571.40	4.530	130.800	7.127	4	21.8	3	6	29.6
MO-P-037	26APR87	39 10 03	77 19 18	7.71	695.40	4.530	125.200	8.150	3	5.4	2	2	5.0
* MO-P-296	11APR87	39 04 43	77 10 52	7.51	828.80	1.170	263.000	10.510	1	9.2	2	3	11.7
* MO-P-457	11APR87	39 07 09	77 22 20	7.62	583.70	2.010	175.800	7.219	1	29.5	3	6	33.7

TABLE E-30. DATA FOR STREAMS SAMPLED IN THE BLUE RIDGE IN FREDERICK COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
FR-B-003	11APR87	39 39 14	77 26 57	7.01	193.60	0.980	101.700	2.675	1	1.3	1	1	3.0
FR-B-005	25APR87	39 42 32	77 26 20	7.89	774.70	0.870	167.700	9.097	1	1.6	1	1	2.1
FR-B-006	25APR87	39 20 09	77 33 20	7.77	835.00	1.560	231.000	10.350	1	7.1	2	2	8.5
FR-B-007	25APR87	39 23 19	77 36 27	7.59	580.80	2.480	163.300	7.327	2	10.3	2	4	11.5
FR-B-008	11APR87	39 40 12	77 27 52	7.24	187.50	0.940	63.200	2.437	0	2.2	1	1	4.1
** FR-B-009	11APR87	39 37 25	77 27 48	7.25	228.80	0.970	65.500	2.818	0	5.8	2	2	8.2
FR-B-010	25APR87	39 30 15	77 34 15	7.96	558.70	1.160	196.600	6.588	1	8.7	2	2	13.3
FR-B-011	25APR87	39 33 27	77 32 04	7.62	386.90	1.690	104.500	4.531	2	29.8	2	5	46.2
FR-B-013	11APR87	39 35 48	77 28 22	7.15	137.50	0.980	51.200	1.821	0	3.8	1	1	7.0
FR-B-014	11APR87	39 31 08	77 35 54	6.71	79.40	1.360	97.500	1.346	1	1.8	1	1	3.8
FR-B-015	11APR87	39 37 15	77 28 25	7.11	168.70	0.940	56.100	2.282	1	1.5	1	1	2.4
FR-B-017	25APR87	39 19 44	77 39 29	7.43	555.90	1.280	214.000	6.936	1	3.4	1	1	5.7
FR-B-018	25APR87	39 43 10	77 25 52	7.45	472.00	1.230	134.500	6.319	1	2.5	1	1	2.8
FR-B-019	25APR87	39 28 16	77 36 11	7.31	437.80	0.870	168.600	5.468	1	2.9	1	1	5.5
FR-B-020	25APR87	39 43 15	77 23 44	7.32	395.40	0.250	93.400	5.136	1	1.2	1	1	1.7
FR-B-024	26APR87	39 26 54	77 36 07	7.02	156.40	1.340	46.500	2.174	2	3.1	1	1	3.6
FR-B-025	25APR87	39 18 23	77 33 04	7.60	870.50	1.430	209.000	10.300	1	2.2	1	1	4.9
FR-B-026	25APR87	39 42 49	77 25 06	7.34	516.70	1.170	96.100	7.032	1	1.7	1	1	1.8
FR-B-027	25APR87	39 40 52	77 29 01	6.95	280.00	1.090	68.100	3.785	1	1.3	1	1	2.4
FR-B-028	11APR87	39 28 47	77 35 20	7.67	614.40	0.920	163.200	7.513	1	3.9	1	1	5.0
FR-B-029	25APR87	39 19 36	77 36 13	7.53	847.70	3.910	236.000	10.560	2	13.4	2	4	18.9
FR-B-031	26APR87	39 23 56	77 36 08	7.67	532.00	1.940	147.300	5.638	2	13.2	2	3	15.6
FR-B-032	11APR87	39 41 59	77 27 04	7.79	675.20	1.160	171.500	7.430	1	5.7	2	2	7.3
FR-B-033	26APR87	39 26 27	77 34 59	7.81	962.70	8.240	247.000	10.730	4	3.2	1	1	3.4
FR-B-036	11APR87	39 28 27	77 31 10	7.29	359.40	1.050	98.700	4.657	1	3.4	2	2	4.5
FR-B-038	25APR87	39 42 12	77 25 54	8.22	593.10	1.170	146.200	6.540	1	11.1	2	3	15.9
FR-B-039	25APR87	39 20 15	77 37 29	7.47	851.20	4.480	226.000	10.260	2	8.4	2	3	12.7
FR-B-040	11APR87	39 28 16	77 31 10	7.30	439.40	0.950	126.800	4.941	1	0.9	1	1	1.4
FR-B-042	25APR87	39 40 29	77 23 09	5.93	11.30	0.970	38.200	0.690	1	1.5	1	1	1.9
FR-B-043	25APR87	39 42 59	77 26 31	7.82	762.30	1.170	188.600	8.157	0	2.7	1	1	2.6
FR-B-044	25APR87	39 29 20	77 28 40	5.51	2.30	0.830	32.800	0.366	1	4.0	2	2	4.9
FR-B-045	25APR87	39 41 03	77 24 25	7.56	348.50	1.010	85.500	4.544	1	1.7	1	1	3.2
FR-B-047	25APR87	39 25 36	77 36 27	7.28	718.20	2.070	177.000	9.204	1	1.4	1	1	2.3
FR-B-048	11APR87	39 29 11	77 29 18	7.19	46.60	0.800	20.700	2.218	1	1.7	1	1	2.4
FR-B-049	25APR87	39 35 05	77 33 44	8.03	300.80	1.630	101.000	3.395	2	8.8	2	2	12.4
FR-B-050	25APR87	39 29 35	77 29 17	5.61	0.10	0.640	28.400	0.463	0	1.3	1	1	1.9
* FR-B-051	11APR87	39 25 29	77 33 33	7.50	440.10	1.320	155.600	5.749	1	122.5	4	26	157.7
FR-B-052	26APR87	39 23 04	77 35 58	7.98	618.70	1.820	186.400	7.056	1	24.7	3	7	28.0
FR-B-053	25APR87	39 26 05	77 35 31	7.31	384.90	1.180	108.600	5.063	1	5.6	2	2	6.7
FR-B-054	25APR87	39 20 39	77 35 00	7.59	617.30	1.650	203.000	7.715	1	1.6	1	1	1.9
FR-B-055	25APR87	39 21 44	77 35 43	7.53	647.20	1.870	296.000	9.912	2	2.6	1	1	2.8
FR-B-057	25APR87	39 27 58	77 32 01	8.03	750.80	1.520	265.000	9.093	1	2.4	1	1	2.2
* FR-B-081	25APR87	39 37 58	77 28 23	7.52	332.50	1.380	94.700	3.949	1	6.5	2	2	9.8
* FR-B-147	25APR87	39 39 10	77 29 16	7.29	336.20	1.000	98.800	4.262	1	1.7	1	1	2.5
* FR-B-161	25APR87	39 39 37	77 29 47	7.36	349.00	0.980	85.400	4.484	1	2.5	1	1	3.2

TABLE E-31. DATA FOR STREAMS SAMPLED IN THE BLUE RIDGE IN WASHINGTON COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
WA-B-001	25APR87	39 22 26	77 43 44	7.36	231.80	1.840	81.900	2.932	1	4.0	1	1	4.2
WA-B-002	25APR87	39 23 23	77 43 28	7.13	177.50	1.660	48.900	1.913	1	6.4	2	2	6.6
WA-B-004	25APR87	39 20 23	77 41 45	7.66	526.80	1.950	130.300	6.447	1	1.8	1	1	3.5
WA-B-005	25APR87	39 23 03	77 39 53	7.50	511.40	1.930	137.200	6.450	2	8.3	2	3	11.8
WA-B-006	25APR87	39 23 15	77 42 20	6.62	52.20	1.110	32.300	1.001	0	1.4	1	1	1.7
WA-B-007	25APR87	39 39 44	77 31 31	6.97	278.30	1.000	84.200	4.228	1	5.2	1	1	8.8
WA-B-008	25APR87	39 23 38	77 42 19	6.96	86.20	1.590	45.000	1.227	0	2.5	1	1	2.5
WA-B-010	25APR87	39 19 48	77 41 05	7.53	521.20	0.380	135.200	6.411	2	22.1	2	7	33.0
WA-B-011	25APR87	39 21 01	77 44 10	7.13	159.50	2.020	61.300	2.055	1	1.8	1	1	4.0

TABLE E-32. DATA FOR STREAMS SAMPLED IN THE VALLEY AND RIDGE IN WASHINGTON COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
WA-V-001	25APR87	39 37 08	77 47 29	7.99	5254.70	0.290	768.000	66.350	1	4.3	1	1	7.0
** WA-V-002	25APR87	39 29 43	77 40 19	8.43	1878.80	1.900	292.000	21.290	1	3.3	1	1	3.0
WA-V-003	25APR87	39 32 58	77 46 12	7.79	5542.40	0.230	624.000	69.050	1	1.3	1	1	2.4
WA-V-006	25APR87	39 26 57	77 40 13	7.72	640.50	0.300	146.600	8.041	1	10.7	2	3	16.1
WA-V-008	25APR87	39 44 53	77 38 57	7.77	5549.50	0.490	625.000	68.310	1	10.2	1	1	34.9
WA-V-009	25APR87	39 36 38	77 45 11	8.24	4318.70	1.160	684.000	56.670	1	2.2	1	1	5.3
WA-V-011	25APR87	39 40 02	77 52 51	7.26	5463.10	0.440	650.000	73.800	0	1.6	1	1	1.5
WA-V-012	25APR87	39 36 24	77 39 30	8.24	4872.50	1.430	612.000	59.080	1	5.7	1	1	15.1
WA-V-016	25APR87	39 40 07	77 45 48	7.89	4738.00	0.820	676.000	57.170	1	7.1	1	1	12.5
WA-V-017	25APR87	39 38 18	77 49 17	8.06	5540.20	0.800	786.000	69.310	1	1.2	1	1	1.1
WA-V-019	25APR87	39 43 37	77 41 06	8.18	5362.70	0.600	653.000	63.130	1	4.1	1	1	13.7
WA-V-020	25APR87	39 24 39	77 43 12	7.00	176.70	3.460	77.400	2.695	1	1.8	1	1	2.6
WA-V-021	25APR87	39 37 18	77 54 17	8.02	1472.20	1.600	210.000	18.210	1	32.6	2	9	32.5
WA-V-023	25APR87	39 42 35	77 52 31	7.70	286.50	1.390	61.900	3.330	1	2.8	1	1	2.2
WA-V-024	25APR87	39 42 56	77 46 59	7.64	1121.00	4.610	238.000	15.720	2	2.2	1	1	5.0
WA-V-025	25APR87	39 32 14	77 45 41	7.94	4646.80	0.750	663.000	68.380	1	8.6	2	2	13.4
WA-V-026	25APR87	39 28 20	77 39 09	6.77	884.40	16.050	149.900	12.060	30	2.7	1	1	2.8
WA-V-027	25APR87	39 30 21	77 46 35	8.03	5780.00	0.930	595.000	61.660	1	38.5	3	11	57.4
WA-V-028	25APR87	39 42 04	77 52 25	8.45	1880.40	2.560	248.000	21.820	2	9.7	2	4	6.4
WA-V-029	25APR87	39 40 30	77 51 53	8.19	5085.30	0.930	653.000	59.260	1	1.4	1	1	2.0
WA-V-030	25APR87	39 28 30	77 40 54	7.96	1842.70	1.260	250.000	21.960	1	14.8	2	4	17.0
WA-V-031	25APR87	39 29 51	77 38 51	7.96	534.20	0.370	195.200	6.475	1	3.5	2	2	3.8
WA-V-032	25APR87	39 34 21	77 45 41	7.44	5382.10	0.380	665.000	69.790	1	1.6	1	1	1.8
WA-V-033	02MAY87	39 41 30	77 36 09	8.08	3149.40	1.110	403.000	37.300	1	2.3	1	1	3.4
WA-V-034	02MAY87	39 39 58	77 35 49	8.22	3867.40	1.500	499.000	44.540	2	6.5	1	1	15.3
WA-V-035	02MAY87	39 31 21	77 47 07	7.77	4808.60	1.150	565.000	55.190	2	3.1	1	1	5.0
WA-V-036	02MAY87	39 40 46	77 53 49	7.92	3973.30	0.440	470.000	45.970	1	3.9	2	2	4.5
WA-V-038	02MAY87	39 32 48	77 37 05	7.29	246.30	0.940	170.300	3.057	1	2.0	1	1	3.1
WA-V-040	02MAY87	39 34 49	77 45 09	8.00	5526.30	1.090	702.000	65.270	1	8.3	2	3	15.2
WA-V-042	02MAY87	39 40 30	77 47 32	8.05	4714.50	1.100	673.000	52.670	0	7.6	2	2	9.7
WA-V-044	02MAY87	39 42 28	77 51 29	7.75	3273.40	1.490	412.000	38.420	1	8.9	2	3	7.6
* WA-V-049	25APR87	39 41 48	77 37 30	8.10	2129.90	1.270	287.000	25.940	1	158.5	4	37	248.4
WA-V-050	02MAY87	39 41 55	77 42 09	8.20	3664.80	1.230	531.000	44.010	1	5.0	1	1	16.7
WA-V-051	02MAY87	39 41 17	77 35 35	8.02	1874.40	1.250	294.000	22.990	2	28.1	3	5	47.4
WA-V-052	02MAY87	39 43 16	77 50 53	7.37	4625.70	0.800	610.000	58.450	1	4.5	1	1	7.3
WA-V-053	02MAY87	39 35 06	77 38 48	8.05	3165.00	0.920	393.000	38.290	1	22.4	2	4	42.0
WA-V-054	02MAY87	39 41 27	77 39 40	7.94	4345.70	0.490	626.000	63.950	2	5.4	1	1	12.5
WA-V-056	25APR87	39 33 33	77 42 32	7.93	4448.40	0.730	614.000	53.990	1	2.2	1	1	3.5
WA-V-058	02MAY87	39 28 56	77 45 57	7.76	5349.00	0.830	667.000	63.790	1	2.3	1	1	4.1
WA-V-059	25APR87	39 38 37	77 49 19	8.00	6040.20	1.000	791.000	70.320	1	1.5	1	1	2.3
WA-V-060	02MAY87	39 37 53	77 42 42	8.04	5046.50	0.990	860.000	58.710	1	0.8	1	1	4.2
WA-V-061	02MAY87	39 26 17	77 39 49	7.73	553.80	1.550	133.500	6.419	1	5.0	2	2	6.9
WA-V-062	02MAY87	39 33 35	77 39 57	8.53	3657.90	0.920	448.000	41.130	1	31.2	2	5	50.9
WA-V-063	02MAY87	39 41 26	77 34 05	7.88	1862.00	0.940	244.000	21.530	2	6.4	2	2	7.6
WA-V-065	02MAY87	39 39 21	77 47 03	8.06	4384.50	0.860	696.000	60.800	1	5.9	2	2	11.5
WA-V-069	02MAY87	39 30 27	77 38 20	7.29	461.80	1.380	98.500	5.703	1	1.6	1	1	3.3
WA-V-070	02MAY87	39 25 28	77 39 17	7.02	275.90	0.940	59.000	3.725	1	2.1	1	1	3.1
WA-V-140	02MAY87	39 35 32	77 45 05	7.95		0.720	735.000	68.980	1	6.0	2	2	11.1

TABLE E-33. DATA FOR STREAMS SAMPLED IN THE APPALACHIAN PLATEAU IN ALLEGHENY COUNTY.

	SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
	AL-A-001	09MAY87	39 35 28	78 39 05	7.73	1079.20	1.170	182.000	12.850	1	1.3	1	1	1.0
	AL-A-002	02MAY87	39 40 40	78 27 27	6.98	161.50	1.060	54.400	2.031	2	60.3	3	23	57.0
	AL-A-003	09MAY87	39 41 20	78 35 28	8.49	3710.40	0.820	423.000	41.540	1	7.3	2	3	7.2
	AL-A-005	09MAY87	39 35 54	78 38 52	4.81	-4.50	1.680	51.100	3.554	1	0.8	1	1	1.2
	AL-A-006	09MAY87	39 31 50	78 55 31	6.69	93.60	1.120	56.000	1.480	1	1.4	1	1	1.2
	AL-A-007	02MAY87	39 42 13	78 50 36	8.61	1451.90	0.970	312.000	8.262	1	28.7	3	12	34.3
	AL-A-009	02MAY87	39 41 27	78 27 29	6.48	71.00	1.180	55.800	1.430	1	1.2	1	1	0.8
	AL-A-013	09MAY87	39 41 43	78 33 30	7.64	471.70	1.300	89.800	4.918	1	62.4	3	15	83.4
	AL-A-016	02MAY87	39 27 59	78 57 48	7.01	115.90	2.060	112.100	2.019	1	1.3	1	1	1.9
	AL-A-017	09MAY87	39 36 58	78 32 03	7.15	133.00	1.530	62.100	1.824	1	0.9	1	1	1.3
	AL-A-018	02MAY87	39 32 31	78 35 18	6.85	102.20	1.980	69.900	1.477	1	1.5	1	1	1.4
	AL-A-019	02MAY87	39 32 27	78 36 12	7.82	1034.80	1.690	167.600	11.550	2	63.5	4	23	51.1
	AL-A-020	09MAY87	39 36 58	78 31 49	6.65	109.90	1.180	47.100	1.654	1	5.4	2	2	5.6
	AL-A-022	02MAY87	39 35 43	78 49 33	7.88	1207.00	1.200	213.000	15.260	1	17.9	3	5	18.9
	AL-A-024	09MAY87	39 42 49	78 43 53	7.16	444.50	1.770	92.700	5.516	1	1.0	1	1	2.2
	AL-A-027	02MAY87	39 40 06	78 26 06	6.97	149.40	1.420	80.000	1.931	2	10.5	2	5	12.3
	AL-A-029	02MAY87	39 38 45	78 43 20	7.87	1951.00	2.270	366.000	25.370	2	0.8	1	1	0.8
	AL-A-030	02MAY87	39 38 30	78 50 01	7.14	256.10	1.730	101.100	3.314	1	1.6	1	1	1.7
	AL-A-031	02MAY87	39 37 25	78 24 34	6.38	160.70	1.620	59.600	3.642	1	1.2	1	1	1.2
	AL-A-033	02MAY87	39 42 39	78 26 58	7.24	154.00	1.110	62.200	1.952	1	35.0	3	12	37.0
	AL-A-034	02MAY87	39 33 16	78 36 02	6.79	208.30	1.820	77.800	3.110	1	1.1	1	1	1.4
	AL-A-035	09MAY87	39 37 17	78 31 04	7.10	122.50	1.170	51.500	1.679	1	10.1	2	4	6.8
	AL-A-036	09MAY87	39 39 44	78 37 20	8.23	4648.40	0.700	464.000	53.420	1	5.3	2	2	4.3
	AL-A-038	02MAY87	39 43 06	78 38 38	7.32	390.10	2.410	77.200	4.543	1	0.9	1	1	1.3
	AL-A-041	09MAY87	39 42 12	78 19 48	6.82	88.30	1.580	46.400	1.408	1	1.1	1	1	1.3
*	AL-A-044	02MAY87	39 39 56	78 47 01	7.53	560.40	0.910	170.100	5.944	1	376.6	5	97	642.5
	AL-A-045	09MAY87	39 33 25	78 58 00	7.32	196.40	0.520	96.400	2.131	1	1.9	1	1	2.9
	AL-A-046	02MAY87	39 39 00	78 44 13	8.06	1214.40	1.840	463.000	13.390	1	1.0	1	1	1.0
	AL-A-048	09MAY87	39 35 45	78 29 26	6.61	78.60	1.170	70.400	1.276	1	0.8	1	1	1.2
	AL-A-049	09MAY87	39 32 47	78 54 41	7.72	556.50	0.810	103.500	6.594	2	1.6	2	2	0.8
	AL-A-050	09MAY87	39 39 48	78 48 59	7.29	157.80	1.220	84.400	2.136	1	3.6	2	2	4.0
	AL-A-052	02MAY87	39 33 19	78 34 20	6.95	172.60	1.590	86.000	2.258	1	8.3	2	3	10.0
	AL-A-053	09MAY87	39 41 17	78 41 19	6.90	799.20	1.360	105.400	5.424	1	0.9	1	1	1.6
	AL-A-056	09MAY87	39 31 38	78 30 49	6.25	78.30	3.660	64.300	2.010	1	2.5	2	2	2.1
	AL-A-057	09MAY87	39 43 05	78 43 54	7.65	678.30	1.490	117.800	8.330	1	0.9	1	1	1.6
	AL-A-058	09MAY87	39 40 53	78 29 10	7.69	292.30	1.030	95.300	3.255	1	9.2	2	3	11.2
	AL-A-060	09MAY87	39 28 00	78 57 27	6.96	294.80	1.820	126.600	3.718	1	2.9	2	2	1.8
	AL-A-061	02MAY87	39 38 26	78 27 53	6.92	108.80	0.780	57.700	1.361	1	0.9	1	1	1.6
	AL-A-062	09MAY87	39 38 14	78 49 53	8.03	1439.80	0.540	727.000	16.090	1	20.7	3	9	28.9
	AL-A-063	02MAY87	39 42 43	78 54 26	3.16	-999.00	1.000	549.000	0.522	1	1.1	1	1	1.5
	AL-A-065	02MAY87	39 34 55	78 51 34	6.88	170.00	1.120	81.500	2.414	2	3.4	1	1	1.6
	AL-A-066	02MAY87	39 38 18	78 22 58	6.76	296.90	1.130	65.000	2.174	1	2.2	1	1	1.7
	AL-A-067	09MAY87	39 33 26	78 54 12	6.07	87.50	1.170	61.500	2.643	1	1.0	1	1	0.9
	AL-A-069	09MAY87	39 38 33	78 30 01	6.47	61.70	1.180	35.800	1.377	1	1.1	1	1	0.8
	AL-A-070	09MAY87	39 33 37	78 51 37	7.08	295.40	1.650	80.900	3.778	1	3.7	1	1	3.2
	AL-A-071	02MAY87	39 41 26	78 48 01	7.57	521.30	0.280	365.000	5.537	1	74.0	4	31	96.9
	AL-A-072	09MAY87	39 42 05	78 34 40	7.81	2585.90	1.650	297.000	31.310	1	2.3	1	1	1.7
	AL-A-073	02MAY87	39 35 48	78 31 26	7.81	1014.80	1.280	144.700	11.470	1	1.1	1	1	0.5
	AL-A-074	09MAY87	39 40 05	78 21 57	6.84	183.40	1.240	67.300	2.639	1	2.2	1	1	2.9
	AL-A-075	09MAY87	39 31 07	79 01 51	7.27	299.50	0.700	273.000	3.339	1	13.0	2	3	19.5
	AL-A-076	09MAY87	39 34 14	78 51 45	7.18	201.30	1.200	66.600	2.252	2	4.4	1	1	2.7
	AL-A-078	02MAY87	39 40 06	78 51 34	6.37	28.50	0.630	35.500	0.718	1	0.6	1	1	1.5
	AL-A-079	09MAY87	39 40 30	78 44 17	8.02	1449.80	2.700	1269.000	16.640	2	0.8	1	1	1.7
	AL-A-080	09MAY87	39 36 50	78 26 56	7.23	245.70	1.510	74.300	3.091	1	1.3	1	1	1.2
	AL-A-081	09MAY87	39 32 25	78 29 40	6.45	44.60	0.640	67.200	0.966	1	10.7	2	3	7.8
	AL-A-083	09MAY87	39 39 25	78 50 14	7.15	203.90	1.350	90.100	2.570	1	0.6	1	1	0.9
	AL-A-084	09MAY87	39 34 11	78 58 02	7.19	286.80	0.610	239.000	3.469	1	4.4	2	2	5.6
	AL-A-085	09MAY87	39 38 58	78 28 47	6.70	77.50	1.060	43.000	1.535	1	0.8	1	1	1.0
	AL-A-086	02MAY87	39 41 53	78 53 02	4.65	0.30	0.730	330.000	0.546	1	10.2	3	6	13.3
	AL-A-087	09MAY87	39 33 54	78 56 02	6.67	75.90	0.810	39.400	1.190	1	1.4	1	1	2.4
	AL-A-088	09MAY87	39 43 08	78 35 16	7.29	242.90	1.180	67.900	2.881	1	44.0	3	9	56.4

TABLE E-33. DATA FOR STREAMS SAMPLED IN THE APPALACHIAN PLATEAU IN ALLEGHENY COUNTY (Concluded).

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
AL-A-089	09MAY87	39 35 32	78 36 45	7.15	553.30	2.110	120.100	7.040	1	1.8	1	1	2.1
AL-A-090	02MAY87	39 41 58	78 52 11	7.12	278.80	0.750	514.000	3.249	1	21.8	3	9	36.3
AL-A-091	09MAY87	39 40 16	78 42 34	8.20	4057.90	1.280	446.000	46.620	2	1.1	1	1	1.0
AL-A-093	09MAY87	39 37 45	78 30 43	6.86	110.00	1.050	45.600	1.633	1	2.3	2	2	1.6
AL-A-094	09MAY87	39 38 50	78 56 27	7.12	144.10	0.770	215.000	1.627	1	1.2	1	1	1.5
AL-A-095	09MAY87	39 40 34	78 30 29	7.11	160.40	1.030	56.600	2.107	1	3.1	1	1	4.1
AL-A-097	09MAY87	39 41 25	78 39 28	7.91	4525.70	0.550	698.000	52.880	1	0.8	1	1	1.0
AL-A-098	09MAY87	39 34 47	78 30 32	6.59	67.70	1.520	55.500	1.205	1	2.3	2	2	2.5
AL-A-099	02MAY87	39 39 29	78 27 13	7.36	173.60	2.080	67.600	2.166	1	111.0	4	42	97.7
*AL-A-437	02MAY87	39 38 58	78 20 39	7.52	207.50	1.330	78.900	2.397	2	205.9	4	68	266.7
*AL-A-572	02MAY87	39 29 28	79 02 33	6.90	332.50	0.700	789.000	4.181	1	135.6	3	38	191.6

TABLE E-34. DATA FOR STREAMS SAMPLED IN THE APPALACHIAN PLATEAU IN GARRETT COUNTY.

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
GA-A-001	02MAY87	39 24 28	79 18 09	6.93	136.60	1.470	69.300	1.786	1	0.9	1	1	1.9
GA-A-002	09MAY87	39 36 28	79 02 37	7.37	154.20	1.340	78.800	1.732	2	36.8	3	10	46.6
GA-A-007	09MAY87	39 40 25	78 59 33	6.96	84.60	0.900	43.600	1.277	1	1.1	1	1	1.6
GA-A-008	02MAY87	39 37 47	79 03 32	7.10	98.50	0.710	58.700	1.381	1	7.1	2	2	9.8
GA-A-009	02MAY87	39 28 15	79 19 39	7.01	216.60	1.250	82.400	2.842	1	3.9	2	2	5.8
GA-A-011	09MAY87	39 32 38	79 18 45	4.69	-7.80	1.430	123.200	0.304	1	18.3	3	6	30.4
GA-A-012	02MAY87	39 30 19	79 05 38	4.96	31.50	1.140	852.000	0.311	0	5.8	1	1	10.2
GA-A-013	09MAY87	39 23 25	79 15 22	4.95	-10.70	0.760	51.700	0.510	1	5.6	2	2	9.9
GA-A-014	02MAY87	39 19 20	79 20 53	6.60	173.00	0.990	105.200	2.838	1	0.8	1	1	1.1
GA-A-015	09MAY87	39 43 01	79 08 33	7.84	601.80	1.490	151.700	7.421	1	0.8	1	1	2.7
GA-A-016	09MAY87	39 41 28	79 25 50	7.18	243.30	0.750	92.800	2.788	1	39.4	3	13	45.8
GA-A-017	02MAY87	39 21 41	79 17 22	7.10	226.20	1.250	82.500	2.699	1	6.1	2	2	10.9
GA-A-018	02MAY87	39 33 34	79 21 39	7.24	361.80	1.640	138.200	1.900	1	0.9	1	1	1.4
GA-A-021	09MAY87	39 32 16	79 17 57	4.32	-65.20	1.470	42.300	0.609	1	1.3	1	1	3.0
GA-A-022	09MAY87	39 39 30	79 01 40	7.11	196.40	1.100	99.500	2.371	1	5.6	2	2	7.1
GA-A-024	09MAY87	39 21 15	79 25 42	7.21	298.30	1.770	107.100	4.032	1	2.4	1	1	3.8
GA-A-025	09MAY87	39 34 45	79 15 49	7.14	217.70	2.760	65.200	2.641	2	2.1	1	1	4.2
GA-A-026	02MAY87	39 38 02	79 04 23	6.98	106.70	0.660	56.700	1.427	1	3.2	1	1	6.1
GA-A-027	09MAY87	39 32 57	79 17 28	5.16	6.20	1.630	138.000	1.279	1	8.3	2	3	14.1
GA-A-028	02MAY87	39 23 57	79 24 48	6.90	248.90	1.860	75.400	2.987	2	2.6	1	1	4.3
GA-A-029	02MAY87	39 39 23	79 15 35	6.94	128.10	0.730	55.500	1.158	1	4.9	2	2	10.2
GA-A-031	09MAY87	39 40 00	79 01 24	6.39	40.40	0.810	31.200	0.930	1	1.2	1	1	1.3
GA-A-033	09MAY87	39 28 16	79 25 59	5.78	7.50	0.760	24.900	0.373	1	1.9	1	1	4.6
GA-A-038	09MAY87	39 34 30	79 01 50	7.14	156.40	0.740	80.100	1.925	1	3.4	1	1	7.0
GA-A-040	09MAY87	39 28 01	79 28 20	4.52	-37.00	0.900	38.800	0.327	1	2.9	1	1	4.4
GA-A-041	09MAY87	39 23 21	79 21 22	6.96	205.10	0.930	142.000	2.722	1	2.2	1	1	2.0
GA-A-044	09MAY87	39 19 58	79 21 45	4.53	-28.80	0.750	133.200	0.534	1	1.2	1	1	0.9
GA-A-045	02MAY87	39 35 05	79 07 37	6.63	98.80	0.770	61.200	1.429	1	1.5	1	1	1.5
GA-A-047	02MAY87	39 36 44	79 24 30	4.60	-24.10	0.740	64.300	0.454	1	1.4	1	1	2.4
GA-A-049	02MAY87	39 36 19	79 08 16	6.98	142.80	0.860	49.300	1.627	1	10.1	2	2	14.1
GA-A-050	02MAY87	39 23 09	79 23 34	7.08	241.40	1.440	84.800	3.072	2	5.5	2	2	13.5
GA-A-051	09MAY87	39 31 27	79 27 11	6.65	55.00	1.370	34.500	1.185	1	26.1	3	7	39.1
GA-A-052	09MAY87	39 40 47	79 11 45	6.25	35.20	0.780	83.500	0.668	1	3.4	1	1	5.3
GA-A-053	09MAY87	39 35 43	79 07 01	7.20	125.80	0.740	53.400	1.558	0	13.9	2	3	[illegible]
GA-A-054	09MAY87	39 17 18	79 21 10	7.15	305.40	0.650	78.000	3.399	1	1.4	1	1	1.7
GA-A-056	02MAY87	39 40 05	79 18 59	7.32	245.30	0.920	91.300	2.884	1	2.4	1	1	3.6
GA-A-057	09MAY87	39 35 22	79 10 09	6.77	71.50	0.580	52.000	0.984	1	2.4	1	1	3.8
GA-A-058	09MAY87	39 25 49	79 22 28	7.04	179.10	1.030	65.300	2.250	1	0.7	1	1	1.3
GA-A-059	09MAY87	39 36 30	79 11 50	6.76	69.00	0.950	101.500	1.055	1	7.6	2	3	13.7
GA-A-060	09MAY87	39 23 32	79 12 01	6.64	41.70	0.570	69.000	0.704	1	8.5	2	2	12.9
GA-A-062	09MAY87	39 43 09	79 19 45	7.04	298.50	0.590	119.000	1.886	1	12.6	2	2	21.9
GA-A-064	02MAY87	39 34 58	79 21 35	6.64	108.20	1.160	45.400	1.581	1	0.4	1	1	0.7
GA-A-065	02MAY87	39 32 25	79 20 34	7.06	288.40	0.990	69.800	3.625	2	1.4	1	1	2.5
GA-A-066	02MAY87	39 19 50	79 19 45	7.31	762.80	1.930	112.900	9.172	2	2.8	1	1	4.8
GA-A-067	09MAY87	39 18 57	79 22 05	7.26	209.40	0.930	76.200	2.496	1	1.5	1	1	2.2
GA-A-068	09MAY87	39 43 12	78 59 30	6.76	105.80	0.960	81.200	1.519	1	11.6	2	4	16.9
GA-A-069	02MAY87	39 24 03	79 18 36	7.05	164.80	1.390	48.400	2.157	1	2.1	1	1	5.3
GA-A-072	09MAY87	39 23 36	79 14 06	5.29	-5.50	0.630	23.400	0.433	1	1.7	1	1	2.8
GA-A-073	09MAY87	39 22 15	79 23 46	7.07	179.10	1.420	72.700	2.254	1	2.3	1	1	11.4
GA-A-074	09MAY87	39 36 50	79 01 37	4.75	-21.50	3.920	35.900	0.915	4	7.9	1	1	9.4
GA-A-075	09MAY87	39 37 24	79 12 02	7.25	287.70	0.810	81.400	3.370	1	2.1	1	1	4.1
** GA-A-076	02MAY87	39 36 38	79 04 05	7.10	101.80	0.760	59.500	1.282	1	13.0	2	3	19.8
GA-A-077	09MAY87	39 39 26	79 13 07	4.38	-39.80	1.350	46.700	0.482	1	2.4	1	1	4.2
GA-A-078	02MAY87	39 35 20	79 22 26	6.94	493.10	2.620	175.700	6.199	2	1.0	1	1	1.0
GA-A-079	02MAY87	39 36 43	79 14 59	6.54	95.80	1.560	81.000	0.878	1	6.8	2	2	13.4
* GA-A-080	02MAY87	39 41 53	79 08 39	7.17	211.20	1.330	109.800	2.461	1	101.3	4	24	169.5
GA-A-081	02MAY87	39 31 27	79 10 31	6.94	100.00	0.800	60.600	1.299	1	15.7	2	6	20.0
GA-A-082	09MAY87	39 20 25	79 25 36	7.07	203.00	1.030	76.800	2.595	1	15.3	3	4	24.4
* GA-A-093	02MAY87	39 39 45	79 23 56	7.20	213.20	0.940	78.400	2.472	1	95.7	4	27	127.6
* GA-A-107	02MAY87	39 39 25	79 17 00	6.89	148.40	0.670	61.300	1.403	1	9.8	2	3	[illegible]
* GA-A-135	02MAY87	39 25 46	79 24 49	6.51	85.80	0.840	75.800	1.663	1	244.2	5	68	350.7

TABLE E-34. DATA FOR STREAMS SAMPLED IN THE APPALACHIAN PLATEAU IN GARRETT COUNTY (Concluded).

SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
* GA-A-165	02MAY87	39 15 26	79 25 26	6.95	267.80	0.830	1195.000	2.549	1	3.3	1	1	4.8
* GA-A-184	02MAY87	39 34 13	79 06 06	7.23	147.30	1.210	93.200	1.683	1	95.9	3	21	129.1
* GA-A-269	02MAY87	39 16 03	79 25 02	6.50	39.20	0.750	302.000	1.672	1	3.3	1	1	5.2
* GA-A-411	02MAY87	39 30 06	79 07 09	7.10	126.90	1.080	75.100	1.634	1	326.1	4	104	279.8
* GA-A-439	09MAY87	39 35 57	79 12 24	5.04	-6.90	1.200	156.400	0.849	0	4.8	2	2	9.6
* GA-A-525	02MAY87	39 33 51	79 06 47	7.06	120.20	0.730	59.700	1.497	1	10.4	2	5	9.8

TABLE E-35. DATA FOR STREAMS SAMPLED IN THE APPALACHIAN PLATEAU IN WASHINGTON COUNTY.

	SAMPLE ID	SAMPLING DATE	LATITUDE	LONGITUDE	pH	ANC	DOC	COND	DIC	COLOR	DRAINAGE LENGTH	STRAHLER ORDER	SHREVE ORDER	WATERSHED AREA
	WA-A-002	02MAY87	39 40 56	77 57 50	7.26	263.50	1.300	435.000	3.186	2	2.2	1	1	2.4
	WA-A-006	02MAY87	39 42 22	77 56 47	7.54	741.60	2.080	106.400	8.728	1	1.1	1	1	1.3
	WA-A-007	02MAY87	39 41 13	78 00 50	6.80	345.60	2.130	70.600	5.314	2	2.5	1	1	2.0
	WA-A-008	02MAY87	39 42 14	77 56 30	7.38	445.70	1.920	57.800	5.316	2	9.4	2	4	8.3
	WA-A-009	02MAY87	39 42 30	78 10 39	6.97	775.50	1.340	152.100	11.020	2	3.6	1	1	3.8
	WA-A-012	02MAY87	39 39 46	78 16 35	6.67	152.80	1.400	57.300	2.393	2	0.8	1	1	1.2
	WA-A-013	02MAY87	39 38 58	78 15 27	8.35	3494.90	1.100	374.000	39.180	2	1.6	1	1	1.1
	WA-A-016	02MAY87	39 41 55	78 01 30	7.91	2299.30	2.980	233.000	26.790	1	1.7	1	1	1.1
	WA-A-018	02MAY87	39 40 39	77 58 54	7.49	391.40	1.360	60.900	3.445	2	9.7	2	2	9.6
	WA-A-021	02MAY87	39 42 59	77 56 37	7.34	616.70	2.160	87.600	7.581	2	0.9	1	1	1.1
	WA-A-022	02MAY87	39 42 03	78 04 38	7.16	357.30	1.290	98.400	4.651	3	1.2	1	1	2.8
	WA-A-023	02MAY87	39 39 29	78 15 13	8.21	4730.50	0.950	448.000	47.510	1	1.0	1	1	0.8
	WA-A-070	02MAY87	39 42 39	78 13 27	7.01	215.70	2.170	180.400	2.886	1	45.7	4	19	44.5
*	WA-A-121	02MAY87	39 41 37	78 08 02	7.38	309.90	1.650	137.600	3.628	2	14.8	2	5	12.4

APPENDIX F

S P E C I A L   I N T E R E S T   S T R E A M   L O C A T I O N S   A N D   C H E M I C A L   D A T A

Table F-1 presents water chemistry data for all streams sampled as special interest streams during the survey. Some of the streams shown were selected during random sampling and the data were used in development of population estimates. The majority of the data presented in Table F-1 were not used in population estimates, but are provided solely to allow comparison of data from the MSSCS with data from other sources.

TABLE F-1. LOCATION AND WATER CHEMISTRY DATA FOR SPECIAL INTEREST REACHES

STREAM NAME	LATITUDE	LONGITUDE	pH	ANC	DOC	DIC	COND	COLOR
Antietam Creek	39 41 48	77 37 30	8.10	2129.90	1.270	25.940	287.000	1
Bacon Ridge Branch	39 00 12	76 37 00	6.46	217.50	4.080	3.812	144.200	1
Bacon Ridge Branch	38 59 39	76 36 46	6.71	253.10	4.110	3.832	131.200	1
Bear Creek	39 39 45	79 23 56	7.20	213.20	0.940	2.472	78.400	1
Bear Pen Run	39 33 51	79 06 47	7.06	120.20	0.730	1.497	59.700	1
Bennett Creek	39 18 02	77 24 49	7.46	472.70	1.080	5.993	127.200	1
Big Elk Creek	39 37 48	75 49 30	7.67	388.40	1.380	4.821	133.700	1
Big Pipe Creek	39 36 47	77 14 05	7.66	802.00	1.300	9.869	183.300	1
Bluelick Run	39 36 38	79 04 05	7.10	101.80	0.760	1.282	59.500	1
Broad Run	39 21 57	76 26 28	8.06	1422.30	3.080	16.180	286.000	2
Broad Run	39 26 09	76 25 31	7.80	581.20	1.420	6.897	137.300	2
Casselman River	39 41 53	79 08 39	7.17	211.20	1.330	2.461	109.800	1
Catoctin Creek	39 25 29	77 33 33	7.50	440.10	1.320	5.749	155.600	1
Choptank River	39 00 12	75 46 52	6.89	224.90	4.410	3.194	127.900	2
Cranberry Branch	39 35 27	76 58 17	8.42	1492.00	1.150	16.830	338.000	1
Cypress Branch	39 15 25	75 49 59	6.68	253.60	8.570	3.815	131.500	4
Deer Creek	39 36 59	76 12 12	7.54	428.90	1.130	5.486	130.200	1
Deer Creek	39 37 59	76 24 36	7.40	394.10	3.250	3.499	116.600	1
East Br Herbert Run	39 14 59	76 41 39	8.83	1429.20	2.170	15.990	462.000	1
Faulkner Branch	38 42 41	75 48 16	6.04	86.60	2.210	3.604	140.200	1
Georges Creek	39 29 28	79 02 33	6.90	332.50	0.700	4.181	789.000	1
Granny Finley Branch	39 06 30	76 02 04	7.14	687.70	11.670	8.634	180.100	4
Grays Run	39 29 01	76 12 57	7.50	461.00	6.660	4.953	143.600	2
Great Bohemia Creek	39 27 52	75 46 41	8.30	811.30	5.690	8.241	186.400	1
Gwynns Falls	39 20 06	76 43 31	9.02	1270.50	1.520	14.110	257.000	1
Hauver Branch	39 37 25	77 27 48	7.25	228.80	0.970	2.818	65.500	0
Herring Branch	39 21 47	75 47 27	7.27	486.40	6.490	5.682	123.500	4
Hunting Creek	39 35 37	77 23 47	7.47	397.20	1.600	4.840	110.900	2
Little Bear Creek	39 39 25	79 17 00	6.89	148.40	0.670	1.403	61.300	1
Little Patuxent R	39 09 20	76 49 58	7.42	1263.30	7.820	8.570	195.800	4
Little Tonoloway Cr	39 42 39	78 13 27	7.01	215.70	2.170	2.886	180.400	1
Long Branch	39 33 24	75 46 37	6.46	190.10	12.240	2.966	102.200	5
Magothy Run	39 06 55	76 33 09	7.15	618.10	8.040	8.133	643.000	2
Marley Creek	39 08 46	76 36 22	7.08	576.80	11.320	7.263	212.000	5
Mattawoman Creek	38 34 45	77 04 46	6.35	53.50	4.680	1.179	126.800	2
Mattawoman Creek	38 37 01	77 02 53	6.31	47.80	5.010	1.147	134.400	2
Monocacy River	39 41 05	77 14 05	7.63	771.40	2.380	9.479	182.300	1
Morgan Creek	39 16 50	76 00 53	7.05	1117.60	14.970	14.900	208.000	4
Muddy Creek	38 52 50	76 33 54	6.66	212.10	3.380	2.880	142.900	1
NE Br Anacostia R	38 57 04	76 56 01	6.90	427.90	7.410	3.935	122.400	6
NW Br Anacostia R	38 57 13	76 57 51	7.44	540.50	7.740	5.015	99.700	5
Nanjemoy Creek	38 25 12	77 11 52	6.42	107.60	6.930	2.011	63.700	3
North Fork Sand Run	39 16 03	79 25 02	6.50	39.20	0.750	1.672	302.000	1
North River	38 59 08	76 37 28	6.02	44.30	2.820	1.897	107.300	1
Owens Creek	39 39 10	77 29 16	7.29	336.20	1.000	4.262	98.800	1
Patuxent River	38 57 32	76 41 47	7.23	720.10	6.010	8.292	214.000	2
Piscataway Creek	38 42 29	76 57 36	6.54	171.30	6.770	2.372	124.400	4
Plum Point Creek	38 36 29	76 31 25	6.88	360.90	8.890	5.229	143.600	1
Principio Creek	39 37 10	76 02 25	7.31	546.80	15.260	5.688	153.400	7
S Br Casselman River	39 35 57	79 12 24	5.04	-6.90	1.200	0.849	156.400	0
Savage River	39 34 13	79 06 06	7.23	147.30	1.210	1.683	93.200	1
Savage River	39 30 06	79 07 09	7.10	126.90	1.080	1.634	75.100	1
Sawmill Creek	39 10 15	76 37 48	6.22	111.40	7.480	2.486	163.200	4
Sawmill Creek	39 11 00	76 36 53	6.94	590.00	11.950	8.067	188.200	6
Seneca Creek	39 07 09	77 22 20	7.62	583.70	2.010	7.219	175.800	1
Severn Run	39 05 04	76 37 59	6.77	218.40	3.590	3.293	123.500	1
Sideling Hill Creek	39 38 58	78 20 39	7.52	207.50	1.330	2.397	78.900	2
South Fork Sand Run	39 15 26	79 25 26	6.95	267.80	0.830	2.549	1195.000	1
Stemmers Run	39 19 56	76 28 50	7.42	1205.60	3.790	15.330	178.700	3
Stocketts Run	38 53 10	76 40 16	7.20	240.00	4.510	2.835	150.400	1
Stony Run	39 36 24	75 57 39	7.13	232.80	9.260	2.315	124.700	4
Tull Branch	38 44 12	75 47 38	6.67	127.90	3.430	2.168	166.500	1

TABLE F-1. LOCATION AND WATER CHEMISTRY DATA FOR SPECIAL INTEREST REACHES (CONCLUDED)

STREAM NAME	LATITUDE	LONGITUDE	pH	ANC	DOC	DIC	COND	COLOR
UNT[1] to Antietam Cr	39 29 43	77 40 19	8.43	1878.80	1.900	21.290	292.000	1
UNT to Hunting Creek	39 37 58	77 28 23	7.52	332.50	1.380	3.949	94.700	1
UNT to Owens Creek	39 39 37	77 29 47	7.36	349.00	0.980	4.484	85.400	1
Unicorn Branch	39 14 54	75 51 45	7.52	318.00	4.840	3.298	144.900	3
Watts Branch	39 04 43	77 10 52	7.51	828.80	1.170	10.510	263.000	1
Wheatley Run	38 28 46	76 51 14	6.67	82.20	4.010	1.344	81.600	2
Wills Creek	39 39 56	78 47 01	7.53	560.40	0.910	5.944	170.100	1
Winters Run	39 31 20	76 22 46	7.64	350.90	4.810	3.941	117.900	3
Youghiogheny River	39 25 46	79 24 49	6.51	85.80	0.840	1.663	75.800	1

[1]Unnamed tributary