USGS
science for a changing world

Prepared in cooperation with the

U.S. Fish and Wildlife Service (Patuxent Research Refuge)

U.S. Department of Agriculture (Henry A. Wallace Beltsville Agricultural Research Center)

National Park Service (Chesapeake and Ohio Historical Park, Prince William Forest Park, Rock Creek Park, Shenandoah National Park)

Water-Quality Data at Amphibian Research Sites in Maryland, Washington, D.C., and Virginia, 2005–2007

Open-File Report 2008–1204

U.S. Department of the Interior
U.S. Geological Survey

Water-Quality Data at Amphibian Research Sites in Maryland, Washington, D.C., and Virginia, 2005–2007

By Karen C. Rice

Prepared in cooperation with the

U.S. Fish and Wildlife Service (Patuxent Research Refuge)

U.S. Department of Agriculture (Henry A. Wallace Beltsville Agricultural Research Center)

National Park Service (Chesapeake and Ohio Historical Park, Prince William Forest Park, Rock Creek Park, Shenandoah National Park)

Open-File Report 2008–1204

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2008

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS--the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested citation:
Rice, K.C., 2008, Water-quality data at amphibian research sites in Maryland, Washington, D.C., and Virginia, 2005–2007: U.S. Geological Survey Open-File Report 2008–1204, 12 p.

Contents

Figures

Tables

Conversion Factors, Vertical Datum, and Abbreviated Water-Quality Units

Multiply	By	To obtain
	Length	
millimeter (mm)	0.039	inch
meter (m)	3.28	foot
kilometer (km)	0.62	mile
	Volume	
liter (L)	0.264	gallon
cubic meter (m^3)	264	gallon

Water temperature is reported in degree Celsius (°C), which can be converted to degree Fahrenheit (°F) by the following equation:

$$°F = 1.8\ (°C) + 32$$

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Abbreviated water-quality units: Chemical concentration is reported in milligrams per liter (mg/L) or microequivalents per liter (µeq/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million. Microequivalents per liter is a unit expressing the concentration of chemical constituents in solution as equivalent charges (equivalents) of solute per unit volume (liter) of water. Specific electrical conductance of water is reported in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Water-Quality Data at Amphibian Research Sites in Maryland, Washington, D.C., and Virginia, 2005–2007

By Karen C. Rice

Abstract

Data on the chemical composition of water were collected at least once from 47 amphibian research sites in Maryland, Washington, D.C., and Virginia, from 2005 through 2007. One hundred twenty-five water samples were collected from vernal pools and streams and analyzed as part of long-term monitoring projects of the U.S. Geological Survey Amphibian Research and Monitoring Initiative in the Northeast Region. Field measurements of water temperature, specific conductance, and pH were made. Laboratory analyses of the water samples included acid-neutralizing capacity, total Kjeldahl nitrogen (ammonium plus organic nitrogen), nitrite plus nitrate, total nitrogen, and total phosphorus concentrations. Field and laboratory analytical results of water samples and quality-assurance data are presented.

Introduction

Water-quality samples at 47 amphibian research sites in Maryland, Washington, D.C., and Virginia were collected and analyzed at least once from 2005 through 2007. The samples were collected as part of the U.S. Geological Survey (USGS) Amphibian Research and Monitoring Initiative (ARMI) in the Northeast Region. ARMI was established in 2000 to (1) identify a network of Department of Interior lands for monitoring the status of and changes in the distribution and abundance of amphibian species and communities in the United States (U.S.); (2) gather information about environmental conditions that may affect amphibians; (3) document the scope of amphibian declines throughout the U.S.; (4) identify possible causes of observed amphibian declines, population changes, malformations, and diseases; and (5) provide scientific information to support management decisions that address declines, malformations, and diseases in amphibian populations.

Water-quality data were collected at vernal pools and streams. Water-quality data collected at both types of sites included field measurements of water temperature, specific conductance, pH, and laboratory analyses of acid-neutralizing capacity (ANC), total Kjeldahl nitrogen (ammonium plus organic nitrogen), nitrite plus nitrate, total nitrogen (N), and total phosphorus (P) concentrations.

Purpose and Scope

This report presents data on the chemical composition of 125 water samples collected from 2005 through 2007. The methods used to collect water samples are described, as are laboratory methods and quality-assurance protocols. Locations of the sampling sites and analytical results for the water-quality samples are presented in tables.

Description of Data-Collection Sites

In Maryland, water samples were collected at the U.S. Fish and Wildlife Service's Patuxent Research Refuge; the U.S. Department of Agriculture's Henry A. Wallace Beltsville Agricultural Research Center (BARC); and the National Park Service's Chesapeake and Ohio Canal National Historical Park (CHOH; fig. 1; tables 1, 2). Patuxent Research Refuge and BARC are in the Coastal Plain Physiographic Province, approximately 17 kilometers (km) northeast of Washington, D.C., and 25 km southwest of Baltimore, MD. The CHOH extends northwest from Washington, D.C., to western Maryland, but samples were collected in an area just north of Washington, D.C. The CHOH research site is located in the Piedmont Physiographic Province.

In Washington, D.C., samples were collected in the National Park Service's Rock Creek Park (ROCR; fig. 1; tables 1, 3). ROCR is in the Piedmont Physiographic Province and extends from the northern corner of the District of Columbia southward approximately 11 km to the Potomac River.

In Virginia, samples were collected in the National Park Service's Prince William Forest Park (PRWI) and Shenandoah National Park (SHEN; fig. 1; tables 1, 4). PRWI is in the Piedmont Physiographic Province in northeastern Virginia, approximately 56 km south of Washington, D.C., SHEN is in the Blue Ridge Physiographic Province in north-central Virginia.

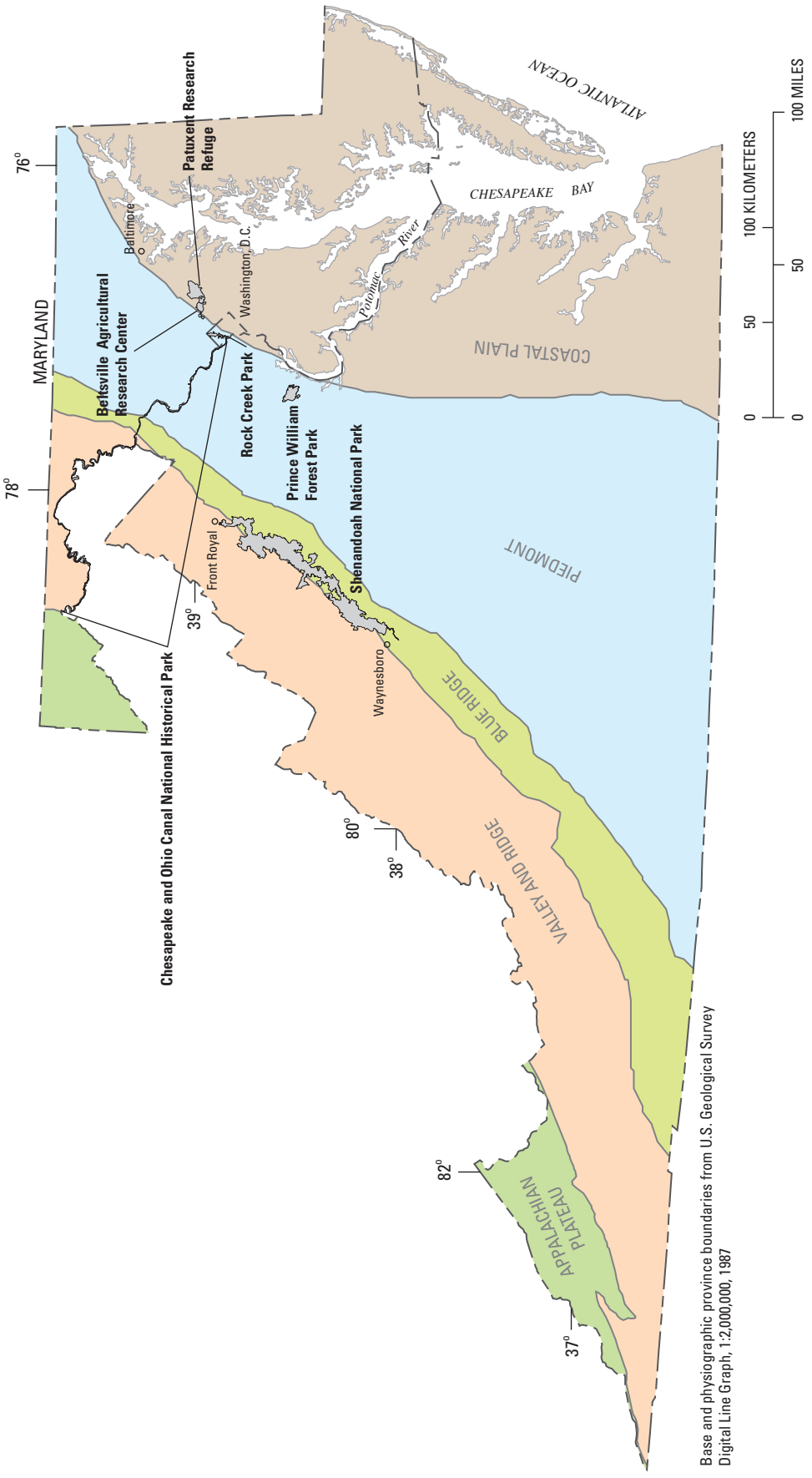

Figure 1. Location of data-collection sites in Maryland, Washington, D.C., and Virginia.

Collection and Analysis of Water-Quality Samples

Water temperature, specific conductance, and pH were measured in the field. Water samples were collected and sent to laboratories to be analyzed for ANC, total Kjeldahl nitrogen, nitrite plus nitrate, total N, and total P concentrations.

Field Data-Collection Methods

During each site visit, measurements of water temperature, specific conductance, and pH were made. These properties were measured in 2005 with a Universal Pocket Meter Multiline P4 (manufactured by WTW, Weilheim, Germany) and in 2006–2007 with a Hanna multiparameter meter 991300. Before measuring the physical properties of the water, the pH electrode was calibrated by using pH buffers of 4.0 and 7.0 pH units, and the conductivity probe was calibrated. The probes of the meter were placed directly into the water by reaching over the surface of the water from the bank. At sites where this method was not practical, a grab sample was collected by using a wide-mouth polyethylene bottle, and the probes were placed in the bottle. All field analyses were made using unfiltered (whole) water.

Samples for laboratory analyses of selected constituents were collected as grab samples. At vernal pools, samples were collected approximately 2 meters from the bank and approximately 10 centimeters below the water surface. Care was taken to avoid collecting water that contained sediment stirred up from the pool bottom. At streams, samples were collected from an area of maximum discharge, which generally was near the center of the stream channel. In shallow streams, water was collected by using a 60-cubic centimeter syringe and discharging the sample into a sample bottle.

The polyethylene sampling bottles with caps were rinsed three times with in situ water prior to sampling. At both vernal pools and streams, samples for analysis of ANC, total Kjeldahl nitrogen, and total P concentrations were collected by holding the sample bottle opening below the water surface and allowing the bottle to fill. Water samples for analysis of ANC were collected in a 250-milliliter (mL) clear sample bottle filled to the top. Water samples for analysis of concentrations of total Kjeldahl nitrogen and total P were collected in a 125-mL clear sample bottle filled to the top, and 1.0 mL of Baker 4.5-normal (1:7) sulfuric acid was added as a preservative. Water samples for analysis of concentrations of nitrite plus nitrate and total N were collected by using disposable two-piece Norm-Ject 20-mL syringes (manufactured by Henke Sass Wolf). Each syringe was rinsed three times prior to the sample collection. Sample water was filtered through a Whatman 0.45-micron PES 25-millimeter diameter PP filter into a 125-mL amber sample bottle. Samples were chilled and stored until all field work was completed, typically about 2 weeks. The samples then were shipped on ice in coolers for laboratory analysis.

Laboratory Analytical Methods

Acid-neutralizing capacity was determined in the USGS Water, Energy, and Biogeochemical Budgets (WEBB) Project Laboratory in Lakewood, CO, using the automated Gran titration (U.S. Environmental Protection Agency test method number AERP 05). Because this method is designed to report negative values (that is, net acidity), there is no detection limit.

Concentrations of total Kjeldahl nitrogen, nitrite plus nitrate, total N, and total P were determined in the USGS National Water-Quality Laboratory in Lakewood, CO. Samples for total Kjeldahl nitrogen were analyzed by using a microkjeldahl digestion method, which yields a concentration of ammonium plus organic nitrogen (Patton and Truitt, 2000). The reporting limit for the total Kjeldahl nitrogen method is 0.14 milligram per liter (mg/L) as N. Samples for nitrite plus nitrate concentration were analyzed using a cadmium reduction method with a reporting limit of 0.04 mg/L (Fishman, 1993). Total N and total P concentrations were determined by using an alkaline persulfate digestion method, with reporting limits of 0.06 mg/L as N and 0.02 mg/L as P, respectively (Patton and Kryskalla, 2003).

Quality Assurance and Quality Control

All laboratories providing water-quality data for the USGS must participate in the Standard Reference Water Sample (SRWS) Program, a continuing quality-assurance program. A major-ion constituent, a trace-metal constituent, a nutrient sample, and a precipitation sample are prepared by the USGS Branch of Quality Assurance and distributed to participating laboratories twice a year. Natural waters are used to prepare these samples and may be spiked with certain analytes to increase the range in concentration.

In addition to the SRWS Program, the USGS WEBB project laboratory voluntarily participates in an ongoing laboratory intercomparison study conducted by Environment Canada. Two samples of natural waters are sent to participating laboratories each year by Environment Canada (2006). Samples are analyzed for concentrations of major cations and anions, silica, dissolved-organic carbon, and alkalinity, and for values of pH and specific conductance.

For quality assurance of the data collected, two sequential water-quality samples were collected at random sites during each sampling trip, and the second sample was the replicate sample, which was collected immediately after the first sample was collected. The purpose of replicate samples is to evaluate the variability in sampling and analysis processes. Results of laboratory analyses of replicate samples are reported in tables 2–4.

Acknowledgments

I appreciate the sampling assistance of William Yeaman and Kenneth Ferebee at Rock Creek Park, and the logistical help provided by James Atkinson at Shenandoah National Park and Holliday Obrecht and Marshall Howe at the Patuxent Research Refuge. I thank the following Patuxent Research Refuge ARMI staff for field assistance: Andrew Dietrich, Sara E. Faust, Lindsay D. Funk, Evan H.C. Grant, Sandra Mattfeldt, Priya K. Nanjappa, Clint Otto, Sheera Schneider, and Edward J. Schwartzman. I also appreciate the colleague reviews of the report provided by Evan H.C. Grant, Patuxent Research Refuge, and William A. Battaglin, USGS Colorado Water Science Center; the data review by Amy E. Jensen, USGS Virginia Water Science Center; and graphics support provided by Robert B. Banks, USGS Virginia Water Science Center.

References Cited

Environment Canada, 2006, Information and quality management/inorganic analysis laboratory/organic analysis laboratory—National Laboratory for Environmental Testing: Environment Canada; accessible online at *http://www.nwri.ca/nletlnee/intro-e.html*

Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93–125, 217 p.

Patton, C.J., and Kryskalla, J.R., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory: Evaluation of alkaline persulfate digestion as an alternative to Kjeldahl digestion for determination of total and dissolved nitrogen and phosphorus in water: U.S. Geological Survey Water-Resources Investigations Report 2003–4174, 33 p.

Patton, C.J., and Truitt, E.P., 2000, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of ammonium plus organic nitrogen by a Kjeldahl digestion method and an automated photometric finish that includes digest cleanup by gas diffusion: U.S. Geological Survey Open-File Report 2000–170, 31 p.

Table 1. Description of water-quality sampling sites in Maryland, Washington, D.C., and Virginia, 2005–2007.

[ID, identification number; VP, vernal pool sites; all other sites are streams; na, not applicable]

Station ID	Site name	Latitude	Longitude	County
Patuxent Research Refuge, Maryland				
390138076522007	Powerline Site 57-68 (VP)	39º 01' 42.0"	76º 52' 22.6"	Prince George's.
390201076512901	Shumate Site (VP)	39º 02' 00.9"	76º 51' 27.9"	Prince George's.
390206076483501	Sam's Pond (VP)	39º 01' 55.2"	76º 48' 34.2"	Prince George's.
390211076521402	Entomology Back Pond 1 (VP)	39º 02' 08.4"	76º 52' 10.0"	Prince George's.
390211076521403	Entomology Back Pond 2 (VP)	39º 02' 08.1"	76º 52' 10.6"	Prince George's.
390211076521405	Entomology Boards 1-19 (VP)	39º 02' 11.6"	76º 52' 13.8"	Prince George's.
390224076520401	Laura's Pond (VP)	39º 02' 26.3"	76º 51' 59.3"	Prince George's.
390429076472001	Blue Road (VP)	39º 04' 27.7"	76º 47' 28.2"	Anne Arundel.
390440076482401	Red Road (VP)	39º 04' 49.7"	76º 48' 22.3"	Anne Arundel.
Henry A. Wallace Beltsville Agricultural Research Center, Maryland				
390230076512201	Beltsville 1 (VP)	39º 02' 31.3"	76º 51' 20.1"	Prince George's.
390230076512202	Beltsville 2 (VP)	39º 02' 31.3"	76º 51' 21.7"	Prince George's.
Chesapeake and Ohio Historical Park, Maryland				
390032077142201	COST 8	39º 00' 32.7"	77º 14' 22.8"	Montgomery.
385939077142801	COST 21	38º 59' 39.9"	77º 14' 28.8"	Montgomery.
385929077142101	COST 22	38º 59' 29.3"	77º 14' 21.8"	Montgomery.
385936077135501	COST 27	38º 59' 36.7"	77º 13' 55.0"	Montgomery.
385929077131501	COST 28	38º 59' 29.8"	77º 13' 15.0"	Montgomery.
385913077134301	COST 31	38º 59' 13.2"	77º 13' 43.0"	Montgomery.
385920077134501	COST 39	38º 59' 20.2"	77º 13' 45.5"	Montgomery.
Rock Creek Park, Washington, D.C.				
385716077031201	West Spring	38º 57' 16.0"	77º 03' 12.0"	na.
385846077021601	16th Street	38º 58' 46.0"	77º 02' 16.0"	na.
385755077023001	Fairway 18	38º 57' 55.8"	77º 02' 30.1"	na.
385838077024301	Riley Spring 2	38º 58' 38.7"	77º 02' 43.5"	na.
385725077023801	Picnic 21	38º 57' 25.5"	77º 02' 38.7"	na.
Prince William Forest Park, Virginia				
383442077252601	PRW 101	38º 34' 42.4"	77º 25' 26.1"	Prince William.
383458077250801	PRW 114	38º 34' 58.9"	77º 25' 08.2"	Prince William.
383512077243601	PRW 127	38º 35' 12.1"	77º 24' 36.7"	Prince William.
383655077251301	PRW 146	38º 36' 55.2"	77º 25' 13.4"	Prince William.
383635077243901	PRW 157	38º 36' 35.6"	77º 24' 39.2"	Prince William.
383712077253401	PRW 172	38º 37' 12.3"	77º 25' 34.1"	Prince William.
383543077241601	PRW 226	38º 35' 43.6"	77º 24' 16.7"	Prince William.
383542077240001	PRW 227	38º 35' 42.4"	77º 24' 00.2"	Prince William.
383456077224901	PRW 247	38º 34' 56.9"	77º 22' 49.1"	Prince William.
383521077221001	PRW 262	38º 35' 21.0"	77º 22' 10.7"	Prince William.
383528077221001	PRW 263	38º 35' 28.5"	77º 22' 10.4"	Prince William.
383614077212401	PRW 301	38º 36' 14.8"	77º 21' 24.4"	Prince William.
383639077222201	PRW 314	38º 36' 39.0"	77º 22' 22.4"	Prince William.

Table 1. Description of water-quality sampling sites in Maryland, Washington, D.C., and Virginia, 2005–2007.—Continued

[ID, identification number; VP, vernal pool sites; all other sites are streams; na, not applicable]

Station ID	Site name	Latitude	Longitude	County
Prince William Forest Park, Virginia—Continued				
383638077221201	PRW 315	38º 36' 38.0"	77º 22' 12.8"	Prince William.
383534077210601	PRW 331	38º 35' 34.5"	77º 21' 06.1"	Prince William.
383436077214001	PRW 370	38º 34' 36.6"	77º 21' 40.7"	Prince William.
383436077212901	PRW 371	38º 34' 36.4"	77º 21' 29.1"	Prince William.
383505077242801	PRW 424	38º 35' 05.9"	77º 24' 29.0"	Prince William.
383657077255101	PRW 516	38º 36' 57.1"	77º 25' 52.0"	Prince William.
Shenandoah National Park, Virginia				
0166578010	Big Meadows (VP)	38º 30' 54.0"	78º 26' 05.0"	Madison.
0166578040	Hogcamp Swamp (VP)	38º 31' 25.0"	78º 26' 04.0"	Madison.
0203143670	Pond Ridge (VP)	38º 09' 51.0"	78º 45' 32.0"	Albemarle.
01662358	Piney River Tributary	38º 45' 29.0"	78º 16' 24.0"	Rappahannock.
0163054075	RAC.35	38º 38' 47.0"	78º 19' 38.0"	Page.
0163054107	RAC.36	38º 38' 34.0"	78º 19' 42.0"	Page.
01630154	RAC.39	38º 37' 53.0"	78º 20' 35.0"	Page.
01630171	RAC.40	38º 37' 46.0"	78º 20' 48.0"	Page.
0163054161	RAC.37	38º 38' 20.0"	78º 19' 51.0"	Page.
01630577	RAC.03	38º 42' 18.0"	78º 21' 35.0"	Page.
01630579	RAC.02	38º 42' 18.0"	78º 21' 49.0"	Page.
01630581	RAC.01	38º 42' 15.0"	78º 22' 03.0"	Page.
0166235582	RAC.19	38º 45' 25.0"	78º 16' 45.0"	Rappahannock.

Table 2. Water-quality data collected from sites in Maryland, 2005–2007.

[ºC, degrees Celsius; µS/cm, microsiemens per centimeter at 25 ºC; ANC, acid-neutralizing capacity; TKN, total Kjeldahl nitrogen; $NO_2 + NO_3$, nitrite plus nitrate; N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µeq/L, microequivalents per liter; –, no data; <, less than; E, estimated; *, replicate sample]

Site name	Date	Time	Water temperature (ºC)	Specific conductance (µS/cm)	pH (units)	ANC (µeq/L)	TKN (mg/L as N)	$NO_2 + NO_3$ (mg/L as N)	Total N (mg/L)	Total P (mg/L)
Patuxent Research Refuge										
Powerline Site 57-68	3-15-2005	1210	7.3	50	5.87	207.3	0.822	<0.060	1.051	0.06
Shumate Site	3-14-2005	1715	7.6	124	5.27	22.8	0.624	<0.060	0.71	0.033
Sam's Pond	3-15-2005	1330	9.5	35	4.5	16.9	0.875	<0.060	1.196	0.078
Entomology Site 1-19	3-15-2005	1018	5.6	691	5.99	355.8	0.922	<0.060	1.003	0.084
Entomology Site Backpond 1	3-15-2005	1045	4.8	159	5.36	–	1.034	<0.060	0.982	0.081
Entomology Site Backpond 2	3-15-2005	1045	4.8	159	–	53.5	–	–	–	–
Laura's Pond B, South side	3-15-2005	1215	7.6	103	5.65	37.8	0.317	<0.060	0.332	0.021
Laura's Pond A, North side	3-15-2005	1400	8.4	96	5.61	18.9	0.498	<0.060	0.476	0.039
Blue Road (VP)	3-14-2005	1000	5.8	38	5.5	88.7	0.516	<0.060	0.785	0.041
Red Road (VP)	3-14-2005	1540	11.5	25	4.37	-20.3	0.351	<0.060	0.365	0.022
Henry A. Wallace Beltsville Agricultural Research Center										
Beltsville 1	3-25-2005	1215	8.5	35	5.48	4.4	0.772	0.077	0.982	0.083
	*3-25-2005	1220	–	–	–	3.9	0.589	<0.060	0.638	0.042
Beltsville 2	3-25-2005	1210	8.5	29	4.76	70.4	1.063	<0.060	1.464	0.151
Chesapeake and Ohio Historical Park										
COST 8	7-29-2005	1405	13.4	86	6.87	525.6	0.386	6.752	7.306	0.083
	*7-29-2005	1415	–	–	–	524.9	0.224	6.742	7.245	0.082
	7-14-2006	1428	13.2	194	5.69	–	0.106	6.667	6.742	0.038
COST 21	7-29-2005	1140	17.1	55	6.42	414.7	0.295	0.144	0.451	0.083
	7-17-2006	1259	16.9	62	5.78	–	0.269	0.09	0.354	0.054
COST 22	7-27-2006	1235	14.7	53	6.18	315.9	0.773	<0.060	1.033	0.131
	7-17-2006	1137	16.5	87	5.75	–	0.869	E 0.034	1.081	0.423
COST 27	7-25-2006	1342	16.6	195	5.46	461.1	1.089	E 0.072	1.231	E 0.015
COST 28	7-25-2006	1325	16.7	248	5.90	159.6	E 0.084	1.56	1.735	E 0.017
COST 31	7-26-2006	1058	16.3	108	5.81	445	0.203	0.98	1.349	0.080
	7-14-2006	954	13.5	123	5.98	–	0.711	1.17	1.706	0.125
COST 39	7-26-2006	1348	12.7	243	6.31	287.8	0.5	2.273	2.862	0.072
	7-14-2006	1152	13.5	286	5.79	–	0.427	2.603	2.894	0.040
	*7-14-2006	1153	–	–	–	–	0.257	2.619	2.679	0.024

Table 3. Water-quality data collected from sites in Washington, D.C., 2005–2007.

[ºC, degrees Celsius; µS/cm, microsiemens per centimeter at 25 ºC; ANC, acid-neutralizing capacity; TKN, total Kjeldahl nitrogen; NO_2 + NO_3, nitrite plus nitrate; N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µeq/L, microequivalents per liter; –, no data; <, less than; E, estimated; *, replicate sample]

Site name	Date	Time	Water temperature (ºC)	Specific conductance (µS/cm)	pH (units)	ANC (µeq/L)	TKN (mg/L as N)	NO_2 + NO_3 (mg/L as N)	Total N (mg/L)	Total P (mg/L)
Rock Creek Park										
West Spring	7-21-2005	1236	13	497	5.54	417.9	<0.10	0.695	0.714	0.030
	*7-21-2005	1239	–	–	–	430.3	<0.10	0.681	0.747	0.027
	7-24-2006	1011	13	545	5.55	–	<0.10	0.842	0.807	0.022
	*7-24-2006	1012	–	–	–	–	<0.10	0.834	0.809	0.025
16th Street	7-18-2005	1306	20.1	405	6.32	196	0.972	3.019	4.307	0.147
	7-21-2006	1033	17.2	475	7.16	–	0.397	3.824	3.845	0.044
Fairway 18	7-24-2005	1520	19.3	153	6.47	554.9	0.149	6.22	6.656	0.039
	7-21-2006	1330	18.3	131	4.86	–	0.238	4.896	4.727	E 0.015
Riley Spring 2	7-24-2005	1440	18.1	42	7.02	287.6	0.381	0.309	0.634	0.086
	7-24-2006	1437	18.4	56	5.72	–	0.266	<0.060	0.257	0.036
Picnic 21	7-21-2005	1510	12.7	42	5.44	228.8	0.315	0.067	0.466	0.094
	7-21-2006	1330	13.3	42	5.38	–	E 0.050	0.112	0.137	0.032

Table 4. Water-quality data collected from sites in Virginia, 2005–2007.

[ºC, degrees Celsius; µS/cm, microsiemens per centimeter at 25 ºC; ANC, acid-neutralizing capacity; ANC data for Prince William Forest Park are given in mg/L; TKN, total Kjeldahl nitrogen; $NO_2 + NO_3$, nitrite plus nitrate; N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µeq/L, microequivalents per liter; –, no data; <, less than; E, estimated; *, replicate sample; (VP), vernal pool]

Site name	Date	Time	Water temperature (ºC)	Specific conductance (µS/cm)	pH (units)	ANC (µeq/L)	TKN (mg/L as N)	$NO_2 + NO_3$ (mg/L as N)	Total N (mg/L)	Total P (mg/L)
Prince William Forest Park										
PRW101	7-19-2006	1603	19.3	96	5.65	6.96	E 0.091	E 0.052	0.118	<–0.02
	*7-19-2006	1604	–	–	–	6.88	0.501	E 0.050	0.179	<–0.02
PRW 114	7-18-2006	1659	21.4	69	5.97	8.4	0.529	< 0.060	0.479	0.086
PRW 127	7-18-2006	1042	13.5	13	7.12	3.36	0.318	< 0.060	0.275	<–0.02
PRW 146	7-10-2006	1549	19.7	32	5.80	6.86	0.296	< 0.060	0.267	<–0.02
PRW 157	7-19-2006	1333	19.9	90	5.94	27.56	0.247	< 0.060	0.197	0.029
PRW 172	7-10-2006	1146	17.7	27	5.11	4.38	0.143	< 0.060	0.124	<–0.02
PRW 226	7-11-2006	957	19.2	24	7.09	8.38	0.291	< 0.060	0.236	E 0.017
PRW 227	7-11-2006	1235	19.6	22	5.52	2.97	0.261	< 0.060	0.148	<–0.02
	*7-11-2006	1236	–	–	–	2.87	0.222	< 0.060	0.181	<–0.02
PRW 247	7-10-2006	1217	16.1	42	5.42	12.61	0.382	< 0.060	0.251	0.055
PRW 262	7-10-2006	1455	19.4	28	7.34	3.11	0.119	< 0.060	0.096	<–0.02
PRW 263	7-19-2006	1036	18.7	44	5.42	6.89	0.167	< 0.060	0.106	0.028
PRW 301	7-19-2006	1120	19	126	5.68	52.33	0.123	0.062	0.134	E 0.010
PRW 314	7-11-2006	1408	16.3	37	5.48	11.01	1.829	E 0.057	1.427	0.435
PRW 315	7-11-2006	1127	17.4	92	7.23	29.28	0.566	< 0.060	0.549	0.117
PRW 331	7-19-2006	1414	19.2	64	5.3	12.28	0.113	< 0.060	0.085	<–0.02
	*7-19-2006	1418	–	–	–	12.51	0.117	< 0.060	0.084	<–0.02
PRW 370	7-18-2006	1405	19.7	23	7.33	4.62	0.167	E 0.057	0.238	0.023
PRW 371	7-18-2006	1620	18.7	26	4.85	3	0.29	E 0.030	0.192	E 0.015
PRW 424	7-18-2006	1504	18.2	32	5.12	7.36	0.32	0.108	0.45	0.1
PRW 516	7-10-2006	1724	19.4	130	6.36	57.99	0.371	< 0.060	0.321	0.049
Shenandoah National Park										
Big Meadows (VP)	4-4-2005	1240	12.4	–	5.53	11.4	0.118	<0.060	0.125	<0.02
Hogcamp Swamp (VP)	4-4-2005	1358	13.7	–	6.18	93	0.127	0.355	0.485	<0.02
Pond Ridge (VP)	3-17-2005	1125	3.3	15	5.26	22	0.64	<0.060	0.639	0.075
	3-17-2005	1128				24.7	0.701	<0.060	0.649	0.067
Piney River Tributary	7-17-2007	1033	15.9	8	7.14	65.0	–	–	–	–
RAC.35	6-28-2007	1000	13.9	27	6.10	92.1	–	–	–	–
RAC.36	6-26-2007	1126	12.6	17	5.80	70.8	–	–	–	–

Table 4. Water-quality data collected from sites in Virginia, 2005–2007.—Continued

[ºC, degrees Celsius; µS/cm, microsiemens per centimeter at 25 ºC; ANC, acid-neutralizing capacity; ANC data for Prince William Forest Park are given in mg/L; TKN, total Kjeldahl nitrogen; $NO_2 + NO_3$, nitrite plus nitrate; N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µeq/L, microequivalents per liter; –, no data; <, less than; E, estimated; *, replicate sample; (VP), vernal pool]

Site name	Date	Time	Water temperature (ºC)	Specific conductance (µS/cm)	pH (units)	ANC (µeq/L)	TKN (mg/L as N)	$NO_2 + NO_3$ (mg/L as N)	Total N (mg/L)	Total P (mg/L)
Shenandoah National Park—Continued										
RAC.39	6-19-2007	953	12.1	22	6.30		< 0.1	0.194	–	–
	6-19-2007	954	12.1	22	6.30	89.6	< 0.1	0.196	–	–
	6-19-2007	1015	12.1	22	6.30	–	E 0.075	0.183	–	–
	6-19-2007	1017	12.1	22	6.30	–	< 0.1	0.185	–	–
	7-25-2007	848	13	26	5.68	–	E 0.056	0.149	–	–
	7-25-2007	849	13	26	5.68	–	< 0.10	0.148	–	–
	7-25-2007	850	13	26	5.68	–	E 0.072	0.155	–	–
	7-25-2007	913	13	26	5.68	–	E 0.052	0.112	–	–
	7-25-2007	914	13	26	5.68	–	0.473	0.108	–	–
	7-25-2007	915	13	26	5.68	–	< 0.10	0.108	–	–
	9-12-2007	856	15.3	61	6.22	–	0.108	–	–	–
	9-12-2007	857	15.3	61	6.22	–	E 0.082	–	–	–
	9-12-2007	858	15.3	61	6.22	–	0.272	–	–	–
	9-12-2007	900	15.3	61	6.22	–	0.132	–	–	–
	9-12-2007	901	15.3	61	6.22	–	E 0.087	–	–	–
	9-12-2007	902	15.3	61	6.22	–	E 0.071	–	–	–
RAC.40	6-22-2007	951	11.1	20	5.40	–	< 0.10	0.212	–	–
	6-22-2007	952	11.1	20	5.40	–	< 0.10	0.217	–	–
	6-22-2007	953	11.1	20	5.40	79.9	E 0.059	–	–	–
	6-22-2007	1021	11.1	20	5.40	–	0.153	0.202	–	–
	6-22-2007	1022	11.1	20	5.40	–	0.197	0.205	–	–
	6-22-2007	1023	11.1	20	5.40	–	0.243	–	–	–
	7-27-2007	940	14.3	32	5.89	–	0.149	0.232	–	–
	7-27-2007	941	14.3	32	5.89	–	0.112	0.231	–	–
	7-27-2007	942	14.3	32	5.89	–	0.128	0.232	–	–
	7-27-2007	946	14.3	32	5.89	–	< 0.10	0.138	–	–
	7-27-2007	947	14.3	32	5.89	–	E 0.052	0.144	–	–
	7-27-2007	948	14.3	32	5.89	–	E 0.079	0.140	–	–
	9-14-2007	901	15.8	31	6.07	–	< 0.10	–	–	–
	9-14-2007	902	15.8	31	6.07	–	E 0.070	–	–	–
	9-14-2007	903	15.8	31	6.07	–	< 0.10	–	–	–
	9-14-2007	911	15.8	31	6.07	–	0.312	–	–	–
	9-14-2007	912	15.8	31	6.07	–	0.140	–	–	–
	9-14-2007	913	15.8	31	6.07	–	0.381	–	–	–

Table 4. Water-quality data collected from sites in Virginia, 2005–2007.—Continued

[ºC, degrees Celsius; µS/cm, microsiemens per centimeter at 25 ºC; ANC, acid-neutralizing capacity; ANC data for Prince William Forest Park are given in mg/L; TKN, total Kjeldahl nitrogen; $NO_2 + NO_3$, nitrite plus nitrate; N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µeq/L, microequivalents per liter; –, no data; <, less than; E, estimated; *, replicate sample; (VP), vernal pool]

Site name	Date	Time	Water temperature (ºC)	Specific conductance (µS/cm)	pH (units)	ANC (µeq/L)	TKN (mg/L as N)	$NO_2 + NO_3$ (mg/L as N)	Total N (mg/L)	Total P (mg/L)
Shenandoah National Park—Continued										
RAC.37	6-21-2007	946	10.8	29	6.11	76.1	< 0.10	0.366	–	–
	6-21-2007	947	10.8	29	6.11	–	< 0.10	0.369	–	–
	6-21-2007	948	10.8	29	6.11	–	< 0.10	–	–	–
	6-21-2007	1015	10.8	29	6.11	–	< 0.10	0.34	–	–
	6-21-2007	1016	10.8	29	6.11	–	< 0.10	0.347	–	–
	6-21-2007	1017	10.8	29	6.11	–	0.105	–	–	–
	7-26-2007	902	13.4	21	6.04	–	< 0.10	0.314	–	–
	7-26-2007	903	13.4	21	6.04	–	E 0.077	0.308	–	–
	7-26-2007	904	13.4	21	6.04	–	E 0.063	0.318	–	–
	7-26-2007	921	13.4	21	6.04	–	0.167	0.330	–	–
	7-26-2007	922	13.4	21	6.04	–	0.193	0.331	–	–
	7-26-2007	923	13.4	21	6.04	–	0.106	0.337	–	–
	9-13-2007	930	14.3	25	5.62	–	E 0.068	–	–	–
	9-13-2007	931	14.3	25	5.62	–	E 0.070	–	–	–
	9-13-2007	932	14.3	25	5.62	–	E 0.090	–	–	–
	9-13-2007	945	14.3	25	5.62	–	0.427	–	–	–
	9-13-2007	946	14.3	25	5.62	–	E 0.099	–	–	–
	9-13-2007	947	14.3	25	5.62	–	E 0.088	–	–	–
RAC.03	7-20-2007	1122	16.2	18	7.14	48.2	–	–	–	–
RAC.02	7-18-2007	1439	19.1	20	7.00	36.8	–	–	–	–
RAC.01	7-18-2007	1006	15.5	17	5.49	56.7	–	–	–	–
RAC.19	6-18-2007	1608	11.4	36	5.75	34.5	–	–	–	–
	6-29-2007	1007	11	14	6.01	42.6	–	–	–	–

Prepared by:

USGS Enterprise Publishing Network
Raleigh Publishing Service Center
3916 Sunset Ridge Road
Raleigh, NC 27607

For additional infomation regarding this publication, contact:

Karen C. Rice
USGS Virginia Water Science Center
Watershed Studies Section
900 Natural Resources Drive, Suite 500
Charlottesville, VA 22903
Phone: 434-297-0106
email: kcrice@usgs.gov

Or visit the Virginia Water Science Center website at:

http://va.water.usgs.gov