



An Introduction to the Water Resources of Richmond National Battlefield Park

Richmond National Battlefield Park (RICH) is located in and around the city of Richmond, Virginia. This battlefield park commemorates the Siege of Richmond, the Confederate capital during the Civil War. Though the park was initially established to protect this historically significant area, it also conserves a number of ecosystems and associated natural resources. This brief provides an introduction to the water resources of RICH.

Landscape Setting and Land Use

It is important to describe the landscape surrounding RICH to better understand the water resources. Land use is particularly important because

it has a large influence on the protection or pollution affecting a stream. Land use is also the feature on the landscape which we control through management, policy, or other human activities.

RICH consists of approximately 3,655 acres in many disjunct units spread out over approximately 135 square miles. Contiguous units range in size from less than 10 acres to over 1,500 acres. The park and city lie along the transition (fall line) between the Coastal Plain and the Piedmont physiographic regions and between the James and York River basins.

All of the major park units are located along the western edge of the Coastal Plain. Soils in this region are composed of loosely consolidated sediments laid down in terraces by streams over the past 100 million years. The James, Chickahominy, and Pamunkey Rivers have cut wide floodplains with terraces and steep valleys throughout this region. The soils are primarily sandy and silt loams which support a variety of land uses including urban development, agriculture, forests, and wetlands.

According to the National Land Cover Dataset, within the park boundaries, forest cover accounts for 42% of the landscape (see Map and Table, page 2). Wetlands cover an additional 28% of the park. This is a far greater propor-

Headwater Streams

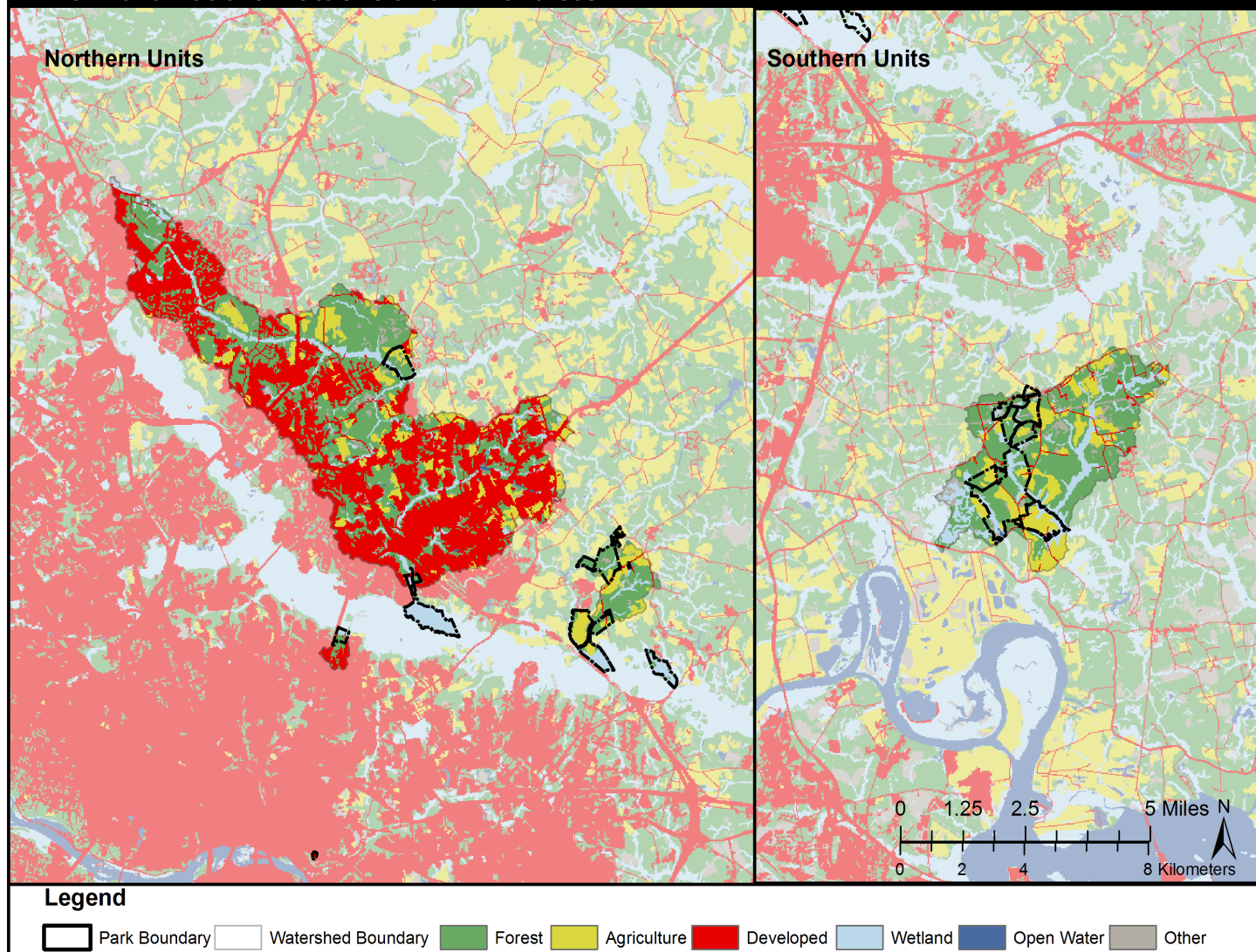
- More than 90% of the streams in RICH are headwater streams (i.e. drain small watersheds).
- Healthy headwater streams are generally well-shaded with fully forested riparian communities.
- In aggregate, headwater streams play a major role in nutrient and sediment delivery downstream.
- Due to their small size, these streams can be easily influenced by riparian disturbance and nearby land use.

tion of the landscape with wetland habitats than in either the surrounding watershed (9%) or the greater Chesapeake Bay Watershed (6%). Much of the contributing watershed to RICH streams is found outside the park boundaries and is highly developed. This is important to understand because of the potential negative impacts on water resources in RICH.

Forested watersheds, wetlands, and stream buffers have the ability to improve stream conditions. This is accomplished through nutrient cycling, ground water recharge and protection of physical habitat. In contrast, urban development can degrade water quality and stream habitat. Urban runoff, erosion, and sedimentation can all occur with urban development. In parks like RICH, upstream developments can often overwhelm the benefits associated with park forests.



Richmond National Battlefield Park - Land Use



Land Use Type	Within Park		Within Surrounding Watershed		Within 100 m. Riparian Buffer in Surrounding Watershed		Within Chesapeake Bay Watershed	
	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)
Forest	42.1	5.0	37.0	36.2	44.5	11.1	54.7	91,329
Agriculture	20.5	2.4	12.7	12.5	3.0	0.8	24.6	40,996
Developed	5.9	0.7	37.2	36.4	22.0	5.5	11.0	18,432
Wetland	28.1	3.3	9.0	8.8	26.7	6.6	6.4	10,665
Other	3.7	0.4	4.1	3.9	3.8	0.9	3.3	5,535

Land use map and table. Note that RICH and the surrounding watershed contain a lower percentage of forested lands than the larger Chesapeake Bay Watershed. However, RICH also has a much higher percentage of wetlands.

Aquatic Resources

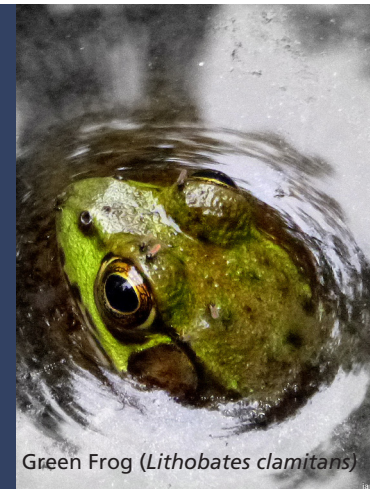
The National Park Service (NPS) manages approximately 28 km (~18 miles) of streams at RICH, primarily in the James River watershed. More than 90% of these streams are small headwater streams. These small streams are important components of the landscape that can be easily impacted by anthropogenic activities (see “Headwater Streams” box, page 1).

Thirty species of fish have been documented in RICH. The

greatest diversity of fish was found in Beaverdam Creek which included popular sport fish species such as the spotted bass (*Micropterus punctulatus*) and black crappie (*Pomoxis nigromaculatus*) as well as non-game species like the swamp darter (*Etheostoma fusiforme*). Sixty-nine genera of aquatic macroinvertebrates have been observed in RICH streams as well as 15 species of frogs and 12 species of salamanders. In a rapidly urbanizing landscape, these streams and associated fauna are significant regional resources.

Wetlands

Some estimates identify over 800 acres of wetlands in RICH. In general, these wetlands are found along the banks of several small tributaries of the James and Chickahominy Rivers, or within the floodplain of the Chickahominy River. The majority of the forested wetlands in the park are seasonally saturated or flooded forests. These can be found at Chickahominy Bluff, Fort Harrison, Totopotomoy Cr., and Malvern Hill. Several smaller headwater wetlands are located at Cold Harbor, Malvern Hill, and Fort Harrison. These locations support Coastal Plain / Piedmont Acidic Seepage Swamps. The portion in Cold Harbor is considered globally rare. Several uncommon odonates (dragonflies and damselflies) depend on such forested seeps for breeding habitat. Small areas at Beaverdam Cr., Chickahominy Bluff, Malvern Hill, and Watt House were historically identified as Coastal Plain / Piedmont Small-Stream Floodplain Forest. However, many of these areas have been altered by beaver activity and now function as Beaver Wetland Complexes.



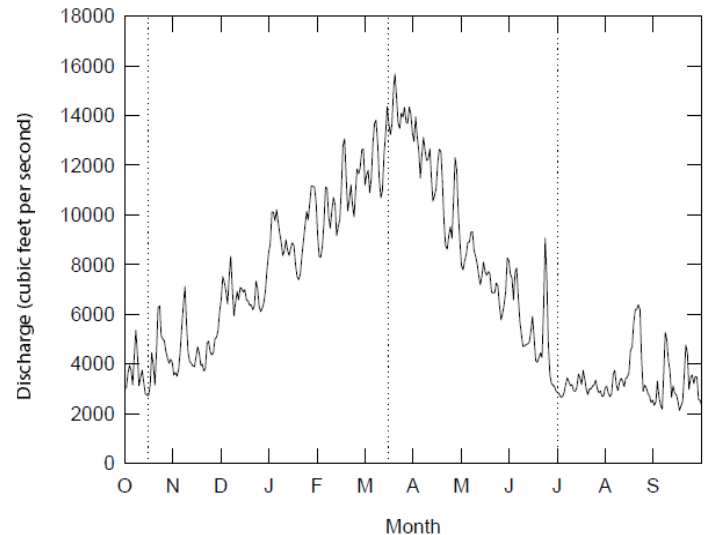
Green Frog (*Lithobates clamitans*)

Water Quality Assessments

Historical water quality data for RICH is limited. Even so, the Commonwealth of Virginia did assess many waters during the 2014 assessment cycle. Both within and around the park, a number of these waters are listed as impaired (see “Water Quality Impairment” box, page 4). The streams failed to meet standards for recreational use due to bacterial contamination. Other streams are impaired due to low pH or low dissolved oxygen (DO) levels.

The Drewry’s Bluff unit has additional concerns. This unit receives stormwater discharge from industrial developments. Also, a decommissioned county landfill discharges hazardous leachate to a park stream in the unit. The park is working with the NPS Contaminated Sites Program to determine how to protect park resources from the landfill.

Most recently, MIDN in partnership with RICH has been monitoring water quality and benthic macroinvertebrates to assess stream conditions in the park. Several locations show potential problems with low pH and low DO. In contrast, benthic macroinvertebrate monitoring suggests that most evaluated streams are healthy with the exception of a small stream in the Chickahominy Bluff unit. It is possible that some of the water quality issues in RICH are naturally occurring. Some waters may be more ecologically like swamps than is currently recognized. In swamps, decaying vegetation can create natural low pH and low DO conditions. These waters may eventually be reclassified from tidal waters to swamp waters by state regulators. This reclassification would relax the pH and DO standards due to natural



Hydrograph

The figure above shows a representative hydrograph that reveals patterns of stream discharge (cubic feet per second) for waters in RICH. There is a trend of increasing flow from mid-October to mid-March, followed by a trend of decreasing flow from mid-March to July. The lowest flow period is from July to mid-October. These patterns can help interpret stream conditions during the year. For example, during low flow periods, dissolved oxygen readings are generally lower. This occurs due to lower stream flows, higher seasonal air and water temperatures, and other associated ecosystem processes.



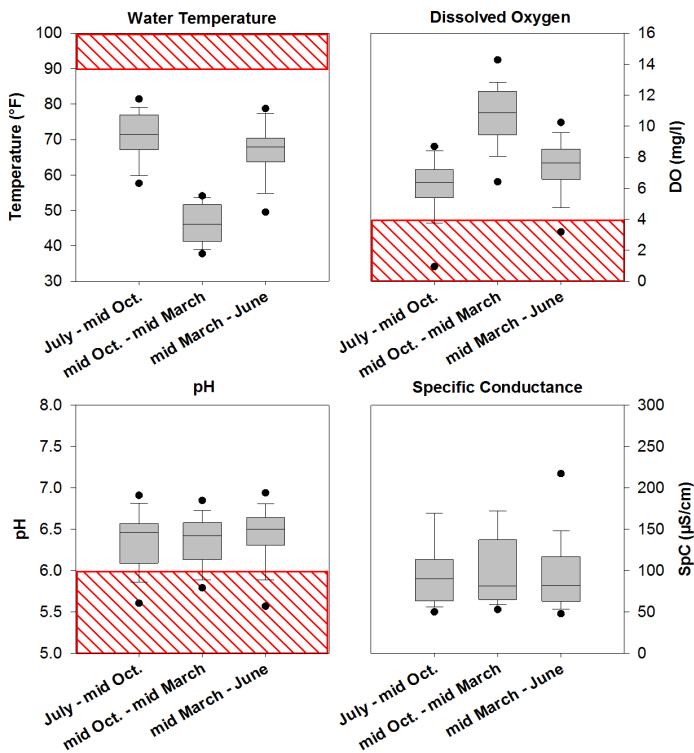
Long-term monitoring of water resources in RICH

In order to better monitor the status and trends of wadeable streams at RICH, the Mid-Atlantic Inventory and Monitoring Program (MIDN) has established several long-term monitoring sites. These sites were placed in streams of significant value as determined by RICH and MIDN staff. Sites are found in the following streams: Beaverdam Cr., Boatswain Cr., Bloody Run, Totopotomoy Cr., Crewes Channel, Western Run, and unnamed tributaries to both the Chickahominy River and the James River. At each site, MIDN staff measure water temperature, specific conductance, pH, and dissolved oxygen. Some sites contain automated equipment that records this information many times a day. Data on weather and discharge stage is also noted. In some sites, data on benthic macroinvertebrates is also collected.

Water Quality Assessments continued...

conditions. The major issue facing RICH streams is surrounding urban development. This development has negatively impacted many streams. It is likely that additional

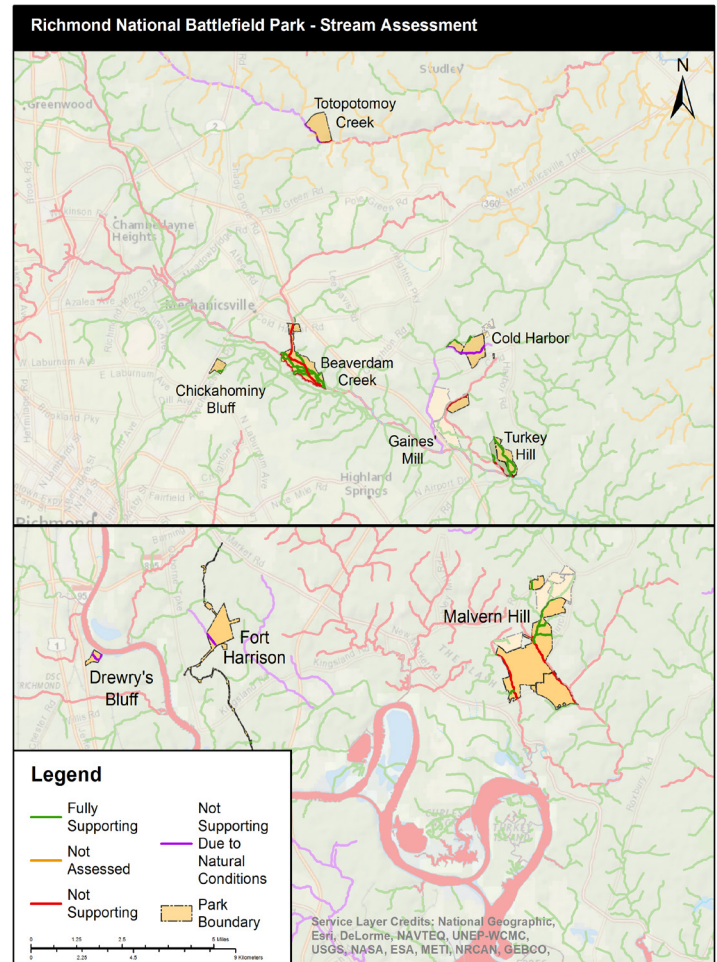
development will further threaten local water resources in the future. For more information, see https://science.nature.nps.gov/im/units/midn/monitor/water_quality.cfm.



Boxplots of water quality parameters in RICH (above). See "Water Quality Impairment" box below for details.

Water Quality Impairment

Generally speaking, when discussing water quality, the term "impairment" refers to the failure to meet standards as required by the Clean Water Act. The figures above show boxplots for "core" water quality parameters measured in RICH by MIDN (2010-2013). The data are grouped by hydrologic season (see "Hydrograph", page 3). Red hatched areas show where impairment occurs as determined by the Commonwealth of Virginia. (At present, there is no impairment threshold for specific conductance). Based on MIDN data, several sites show potential impairment for dissolved oxygen and pH. The Commonwealth of Virginia also assessed several streams in RICH in 2014 (see map, right). Many streams are impaired. Impairments occur due to bacterial contamination, low pH, or low dissolved oxygen values. Fish consumption advisories are also in effect in for parts of the Chickahominy River due to mercury levels. It is possible that the low pH and dissolved oxygen values are natural occurring in some locations. Further investigation is required.



RICH stream assessment map (above). See "Water Quality Impairment" box to left for details.



Photos by James Kaval (green frog, page 3) and the National Park Service.

Lead Scientist
Nathan Dammeyer
Nathan.Dammeyer@nps.gov
Aquatic Ecologist

Mid-Atlantic Network
120 Chatham Lane
Fredericksburg, VA 22405
<https://science.nature.nps.gov/im/units/midn/>

Parks monitored: Appomattox Court House NHP • Booker T. Washington NM
• Eisenhower NHS • Fredericksburg & Spotsylvania NMP • Gettysburg NMP •
Hopewell Furnace • NHS Petersburg NB • Richmond NBP • Valley Forge NHP