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Natural Resource Stewardship and Science

Chesapeake and Ohio Canal National Historical Park Natural Resource Condition Assessment—SUMMARY

National Capital Region

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Jane E. Thomas, Simon D. Costanzo, R. Heath Kelsey, Catherine N. Bentsen, William C. Dennison
Integration & Application Network
University of Maryland Center for Environmental Science
PO Box 775
Cambridge, MD 21613

Patrick Campbell, Mark Lehman, Megan Nortup
National Capital Region Inventory & Monitoring
National Park Service
4598 MacArthur Blvd NW, Washington, DC 20007

Chris Stubbs, Michelle Carter, Brian Carlstrom, John Hitchcock
Chesapeake & Ohio Canal National Historical Park
National Park Service
1850 Dual Highway, Suite 100
Hagerstown, MD 21740-6620

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The full 224-page report can be accessed via *https://irma.nps.gov/App/Reference/Profile/2206698* and *http://www.ian.umces.edu/press*.

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ON THE COVER

C&O Canal and towpath in Maryland, just west of Harpers Ferry, West Virginia.
Photo by Kevin Smith.

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BACKGROUND AND CONTEXT

The 297-km (184.5-mile) Chesapeake and Ohio Canal National Historical Park was established in 1971 to "preserve and interpret the historic and scenic features of the Chesapeake and Ohio Canal, and to develop the potential of the canal for public recreation." The long and linear shape of the park makes it particularly vulnerable to changes in adjacent land use and also more susceptible to the introduction of exotic plants and animals. Other threats to the park include deer overpopulation, adverse recreational use, sedimentation, flooding, and nutrient pollution and contamination.

Due to its location spanning four physiographic provinces, Chesapeake and Ohio Canal National Historical Park provides a wealth of natural resource values. The range of geology and soils, combined with the Potomac River, has resulted in diverse habitats including caves, wetlands, and forests which support a variety of rare, threatened, and endangered plants and animals.

Chesapeake and Ohio Canal National Historical Park's natural resources are challenged by multiple regional and local stressors. Air pollution from power plants, industry, and vehicle emissions result in reduced air quality through large regions of the central eastern seaboard of North America. The park is therefore subjected to high ozone and atmospheric deposition, potentially impacting flora, fauna, and park visitors. Watershed-wide urbanization and development result in challenges to water quality. Increased nutrients, pollutants, and flashiness of river flow can result in impacts to wetland flora and fauna as well as streambank erosion.

Lock 7 at Glen Echo. Photo by Tom Paradis/ NPS.

APPROACH

The Vital Signs framework was used to assess natural resource condition within Chesapeake and Ohio Canal National Historical Park. Within each Vital Sign, indicators were identified that would inform the assessment and data was sourced for these indicators. Reference conditions were established for each indicator, and the percentage attainment of reference condition was calculated. Once attainment was calculated for each indicator, an unweighted mean was calculated to determine the condition for each Vital Sign category and then similarly to combine Vital Sign categories to calculate an overall park assessment. Based on these key findings, management recommendations and data gaps were developed.

Vital Signs framework used in this assessment.

Vital Signs framework

—Air Quality—
Wet sulfur deposition
Wet nitrogen deposition
Ozone
Visibility
Particulate matter

—Water Resources—
pH
Dissolved oxygen
Water temperature
Acid neutralizing capacity
Specific conductance
Nitrate
Total phosphorus
Macroinvertebrates
Physical habitat

—Biological Integrity—
Exotic herbaceous species
Exotic trees & saplings
Forest pest species
Native seedlings
Stream fishes
Birds
Deer density
White-nose syndrome

—Landscape Dynamics—
Forest interior area
Forest cover
Impervious surface
Road density

FEATURES OF CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Spanning the Coastal Plain, Piedmont Plateau, Blue Ridge, and Ridge and Valley physiographic provinces, Chesapeake and Ohio Canal National Historical Park is home to several populations of state and nationally rare, threatened, or endangered species of plants and animals and outstanding examples of unusual and imperiled natural communities. This wide geological range also results in many different geologic formations, including caves and fossil-bearing formations.

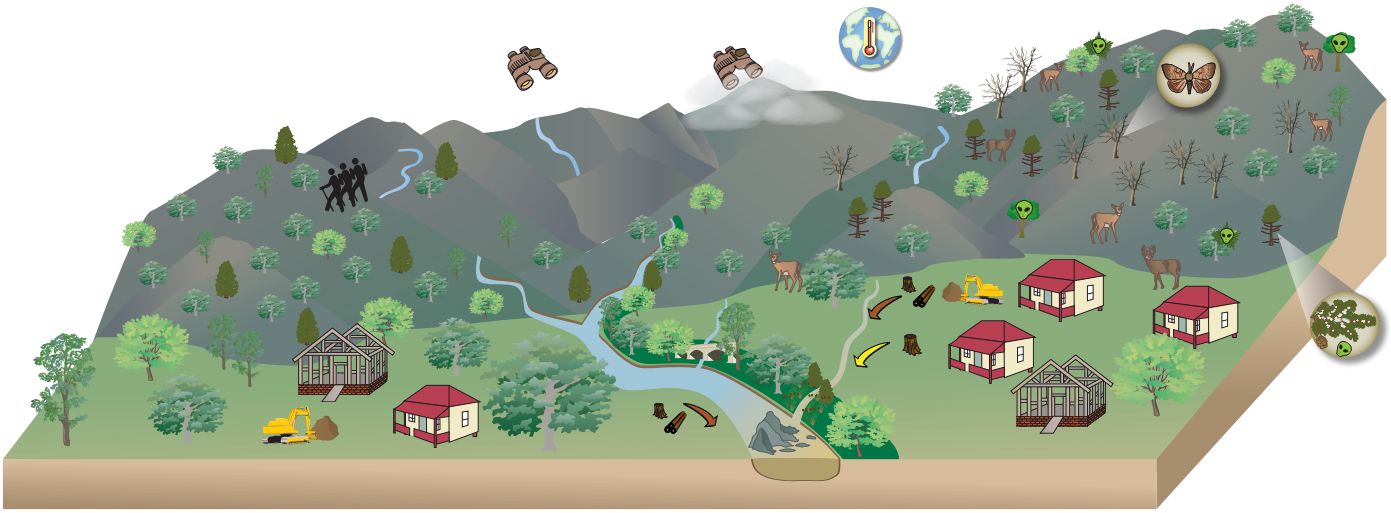
McMahon's Mill Cave #1. Photo by Eckee.

The canal's entire 297 km (184.5 mi) length is built adjacent to the Potomac River, with approximately 261 perennial and hundreds of intermittent streams flowing through or under the park before exiting into the Potomac River. Not surprisingly, the park hosts many wetland areas, especially in the Potomac Gorge region. The caves and tunnels of the park are home to nine bat species, including the federally endangered Indiana bat (*Myotis sodalis*). A diversity of other mammals, birds, fish, herpetofauna, and invertebrates are also found in the park.

THREATS TO CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK

Exotic plants, animals, and diseases are prevalent within the park. Several hundred exotic plants and several dozen exotic animals have been documented within the park. Exotic and invasive plants compete with native species, while insect and other pests cause damage to forest trees. Several pests and diseases threaten forest resources, among them the gypsy moth (*Lymantria dispar*), hemlock woolly adelgid (*Adelges tsugae*), Dutch elm disease, and emerald ash borer (*Agrilus planipennis*). Excessive numbers of white-tailed deer use the park as a refuge, resulting in overgrazing of native flora, particularly tree seedlings. Population and housing densities continue to increase in the areas adjacent to the park, which reduces the habitat available for native flora and fauna. On a regional scale, degraded air quality associated with vehicular traffic affects aquatic habitats and sensitive species.

The canal passes under the Capital Beltway (Route I495). Photo by NPS.



Natural resources

- Scenic views (good air quality)
- Native plant communities
- Historic places and events
- Sustainable visitor use

Threats to park natural resources

- Obstructed scenic views (poor air quality)
- Invasive exotic species (including gypsy moth, hemlock woolly adelgid, and plant species)
- Deer overpopulation
- Exotic diseases and tree death
- Adjacent land use/development
- Sediments and contaminants
- Global climate change (including increasing stream temperature)

Features of and threats to the natural resources of Chesapeake and Ohio Canal National Historical Park.

KEY FINDINGS, RECOMMENDATIONS, AND DATA GAPS

Overall, the natural resources of Chesapeake and Ohio Canal National Historical Park were in *moderate condition*.

The Vital Signs framework showed that air quality condition was generally very degraded, water resources condition was variable but generally good, biological integrity condition was variable but moderate overall, and landscape dynamics condition was generally moderate.

Natural resource condition assessment of Chesapeake and Ohio Canal National Historical Park.

Vital Sign	Reference condition attainment	Current condition
Air Quality	12%	Very degraded
Water Resources	60%	Good
Biological Integrity	43%	Moderate
Landscape Dynamics	59%	Moderate
Chesapeake and Ohio Canal National Historical Park	**44%**	**Moderate**

Air quality was in a very degraded condition. Degraded air quality is a problem throughout the eastern United States and while the causes of degraded air quality are out of the park's control, the specific implications to the habitats and species in the park are less well known. Gaining a better understanding of how reduced air quality is impacting sensitive habitats and species within the park would help prioritize management efforts.

The close connection between climate and air quality is reflected in the impacts of climate change on air pollution levels. In particular, the U.S. EPA has concluded that climate change could increase ozone concentrations and change amounts of particle pollution.

Air Quality. Key findings, management implications, and recommended next steps for air quality in Chesapeake and Ohio Canal National Historical Park.

Key findings	Management implications	Recommended next steps
• Air quality is very degraded	• Habitats and species in the park may be affected	• Monitor for local effects by identifying sensitive species and habitats • Identify top sources of air pollution
• Air quality is a regional problem	• Habitats and species in the park may be affected	• Support regional air quality initiatives such as Climate Friendly Parks (*www.nps.gov/climatefriendlyparks*)

Air Quality. Data gaps, justification, and research needs for air quality in Chesapeake and Ohio Canal National Historical Park.

Data gaps	Justification	Research needs
• Ecological thresholds for mercury wet deposition	• Wet deposition is monitored but the only available reference condition is for fish tissue concentration	• Relate fish tissue concentrations to wet deposition
• Park-scale air quality data	• Need to implement park-specific management actions	• Use transport and deposition models • Calibrate with roadside data within the park
• Effects of poor air quality on park habitats and species	• Need to implement park-specific management actions	• Investigate effects of poor air quality on sensitive habitats and species within the park

Water resources were in a good condition overall. No water resources metrics (apart from Benthic Index of Biotic Integrity [BIBI] and Physical Habitat Index [PHI]) were measured inside the park boundary which necessitated the use of data collected upstream of the park. It is recommended to establish regular water quality monitoring within the park boundary. Nutrients, specific conductance, BIBI, and PHI were in moderate to very degraded condition while pH, dissolved oxygen, water temperature and acid neutralizing capacity were very good, similar to results found in parks throughout the region. Specific conductance also showed a significant degrading trend. Several data gaps and research recommendations revolve around water in the park, including wetland delineation, sources of stormwater, contaminants, and sediments, and the karst geology of the park.

Many of the streams flowing through the park into the Potomac River are designated as Natural Trout Waters, Nontidal Cold Water and Public Water Supply or as Recreational Trout Waters and Public Water Supply. These streams are characterized by cold water temperatures. Water temperature increase is one of the most immediate threats from climate change, and this would result in the loss of trout from these streams.

Water Resources. Key findings, management implications, and recommended next steps for water resources in Chesapeake and Ohio Canal National Historical Park.

Key findings	Management implications	Recommended next steps
• Water quality parameters are not measured within the park	• Need to rely on data collected by other agencies outside the park boundaries	• Establish regular water quality monitoring within the park boundary
• Benthic Index of Biotic Integrity (BIBI) and Physical Habitat Index (PHI) data have not been updated since 2004	• Current status of BIBI and PHI are poorly known	• Update and regularly repeat BIBI and PHI monitoring
• Very degraded condition for nitrogen and phosphorus	• Affects stream flora and fauna • Reduces quality of visitor experience	• Reduce non-point source nutrient inputs from watershed (in partnership with agencies) • Continue riparian buffer establishment
• Specific conductance is showing a degrading trend	• Affects stream flora and fauna	• Implement intensive monitoring to identify sources and patterns and then develop management alternatives

Water Resources. Data gaps, justification, and research needs for water resources in Chesapeake and Ohio Canal National Historical Park.

Data gaps	Justification	Research needs
• Detailed knowledge of wetland intactness and functionality	• Need to know where to prioritize management actions	• Delineate wetlands and perform feasibility study identifying potential restoration sites
• Sources of stormwater influxes to the canal and river are not well known	• Need to know where to prioritize management actions	• Identify sources of stormwater
• Extent to which contaminants from neighboring lands are reaching the Canal and river	• Need to know where to prioritize management actions	• Identify sources and composition of contaminants entering the park
• Karst features in and around the park are poorly understood	• Karst landscapes influence water flows into and through the park	• Initial inventory of sensitive karst areas has been completed and data analysis currently underway (Tudek and Vesper, in press)
• Upstream sediment sources are not well known	• Need to know where to prioritize management actions	• Identify sources and composition of alluvial sediment being deposited
• Specific conductance is showing a degrading trend	• Affects stream flora and fauna	• Identify conductance-sensitive organisms and locations for management initiatives

Biological integrity was in a moderate condition overall. Deer management should continue to be a top priority. Monitoring recommendations include expanding amphibian monitoring, updating and repeating Fish Index of Biotic Integrity monitoring, and continuing to monitor pests and diseases. Forest pest species were in a very good condition; however, emerald ash borer has been detected in the park but has not yet shown up in the regularly monitored forest plots. White-nose syndrome (WNS) is absent from the tunnels in the park, which highlights their importance to bat populations. However, WNS has been detected elsewhere in the park and due to the high mortality from this disease, management intervention is warranted. Emerald ash borer and WNS are two of the biggest threats facing the park and it is worrisome that both have recently reached the park. Data gaps and research needs include developing a bird index for non-forest species and modeling the effects of climate change and other stressors on the region's forests.

How climate change may affect the park's resources and habitats should be an ongoing research focus, in particular how it might affect the introduction and spread of exotic species and forest pests and diseases.

Biological Integrity. Key findings, management implications, and recommended next steps for biological integrity in Chesapeake and Ohio Canal National Historical Park.

Key findings	Management implications	Recommended next steps
• Deer overpopulation may be impacting forest regeneration and agriculture • Deer are only monitored in the Great Falls area	• Increased herbivory reducing desired plant and bird species, and lowering yields in agricultural areas • More road collisions • Potential for spread of chronic wasting disease • Deer densities outside Great Falls are not well known	• Develop a deer management plan • Implement deer population control measures • Expand deer monitoring beyond Great Falls area • Target deer monitoring in areas with sensitive habitats and where there is a known impact on agricultural operations
• Presence of exotic plants	• Displacement of native species, reducing biodiversity	• Prioritize species and locations/habitats for implementing control measures • Restore and maintain native species and communities
• Amphibian monitoring is limited to the Potomac Gorge area only	• Little knowledge of amphibians beyond the Potomac Gorge, and the geographic limitation prevented amphibians from being included in this assessment	• Expand amphibian monitoring beyond the Potomac Gorge area
• Fish Index of Biotic Integrity (FIBI) data have not been updated since 2004	• Current status of BIBI and PHI are poorly known	• Update and regularly repeat FIBI monitoring
• White-nose syndrome has been detected in the park	• Has the potential to spread throughout the park	• Continue to monitor bat populations within the park and throughout the region
• White-nose syndrome is absent from the three tunnels in the park	• Tunnes are important bat hibernacula	• Continue to protect the tunnels of the park to make every effort to keep them free of WNS
• Emerald ash borer has been detected in the park	• Has the potential to spread throughout the park	• Continue to monitor for emerald ash borer in the park and implement management actions • Plan for the future forest with the absence of hemlock and ash trees • Establish a seed bank of hemlock and ash seeds

Biological Integrity. Data gaps, justification, and research needs for biological integrity in Chesapeake and Ohio Canal National Historical Park.

Data gaps	Justification	Research needs
• Bird data is limited to forest species only	• Knowledge about usage of other habitats by birds is needed	• Development of indices related to bird use of other habitats (e.g., wetlands)
• Limited knowledge on how forests might change in light of new and future stressors (climate change, pests, and diseases)	• These stressors are already present or will be present in the near future	• Research and modeling into the effects of these stressors on the region's forests
• Limited knowledge about why the tunnels of the park remain free of white-nose syndrome	• The three tunnels of the park are important bat hibernacula	• Research into the reasons why the tunnels remain free of white-nose syndrome, with application to management of the tunnels

Landscape dynamics were in a moderate condition overall, with 59% attainment of reference conditions. Forest interior area was in a degraded condition both inside and adjacent to the park. This was mostly due to the linear shape of the park which limits the amount of potential forest interior area. Forest cover inside the park was in a very good condition but was in very degraded condition adjacent to the park. This relates to the proximity of the park to the Potomac River which is a non-forest land cover. Management opportunities for the park relating to these two results include maintaining and improving the quality of existing forest habitat within the park.

Impervious surface and road density within the park were both in very good condition. Impervious surface adjacent to the park was also in very good condition; however, road density at the same scale was very degraded. High road density has implications for wildlife mortality and could also result in increased surface runoff and stormwater entering the park. With development increasing near the park, it can be expected that impervious surface and road density will increase in the areas surrounding the park in the future. Management options include maintaining or increasing pervious surfaces within the park and installing stormwater retention basins.

Research needs for the park mostly relate to its function as a habitat corridor in the region (Table 5.13). How climate change may affect the park's resources and habitats should be an ongoing research focus.

Landscape Dynamics. Key findings, management implications, and recommended next steps for landscape dynamics in Chesapeake and Ohio Canal National Historical Park.

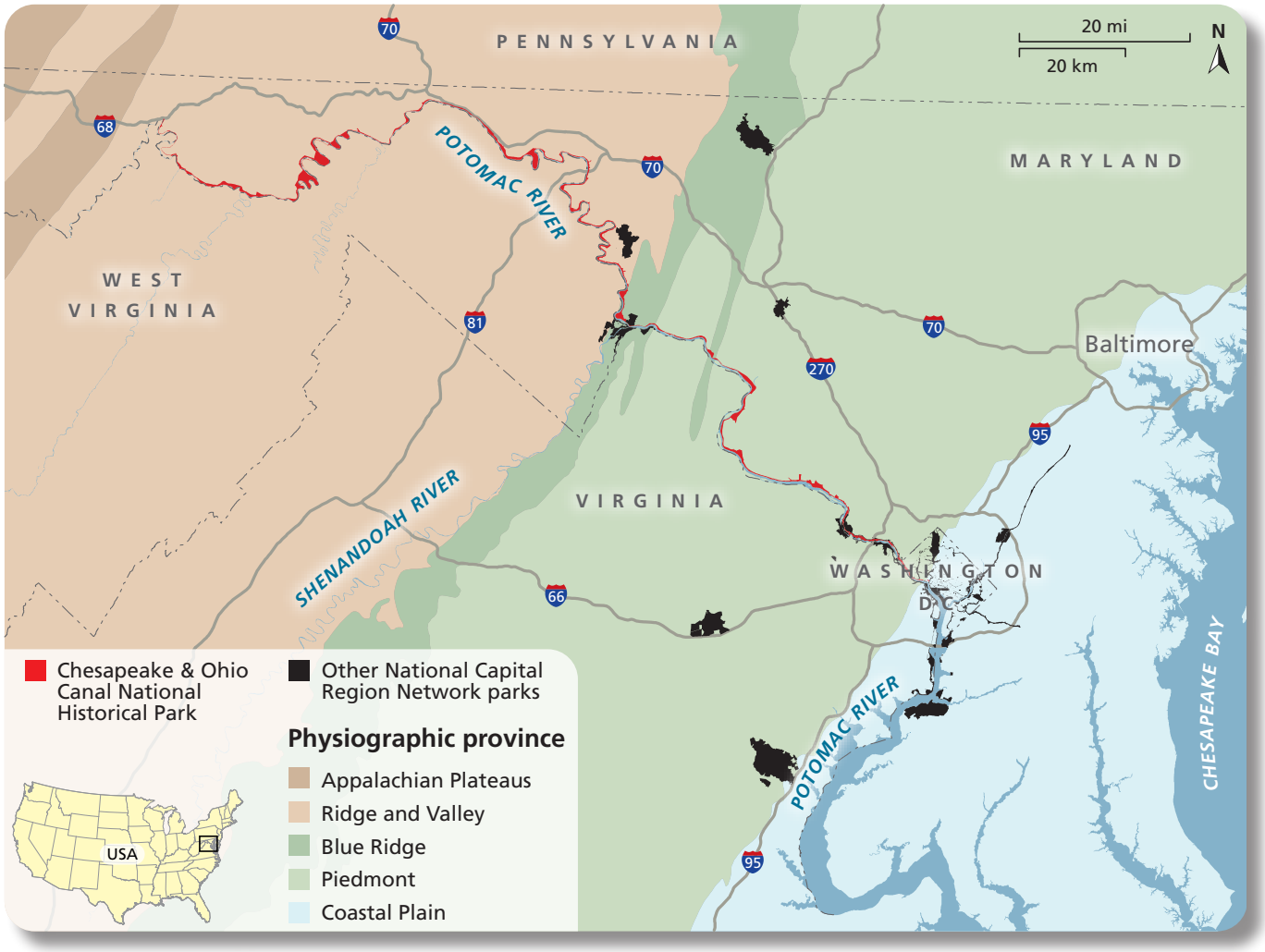
Key findings	Management implications	Recommended next steps
• Forest interior area is degraded	• Degraded forest interior area is a result of the linear shape of the park • Nevertheless, lack of forest interior area reduces habitat available for forest interior dwelling species	• Maintain quality of existing forest habitat by managing for exotic species and forest pests
• Forest cover is good inside the park but very degraded adjacent to the park	• Degraded condition outside the park is due in part to the proximity of the Potomac River—a non-forested land cover • However, lack of forest cover surrounding the park results in fragmented habitat for forest species	• Maintain quality of existing forest habitat by managing for exotic species and forest pests
• Impervious surface is very low	• Slows the flow of surface runoff/stormwater entering park streams	• Continue to maintain pervious surfaces within the park
• Road density is good inside the park but very degraded adjacent to the park	• Road density outside the park may increase surface runoff/stormwater entering the park, and may increase wildlife mortality	• Continue to maintain pervious surfaces within the park and consider installing stormwater retention basins in areas of high stormwater input

Landscape Dynamics. Data gaps, justification, and research needs for landscape dynamics in Chesapeake and Ohio Canal National Historical Park.

Data gaps	Justification	Research needs
• Implications of external land use changes on park resources	• Connectivity of ecological processes from park to watershed	• Landscape analysis at multiple scales
• Wetland corridor function	• Needed for migration and movement of fauna	• Assessment of current and potential use by fauna
• Impacts of climate change on habitat connectivity	• The park acts as a habitat corridor through the region	• Modeling of the potential effects of climate change on habitats within the park and surrounding region

CONCLUSIONS

Natural resoures in Chesapeake and Ohio Canal National Historical Park are in moderate condition overall but are under threat from surrounding land use, regionally poor air quality, overpopulation of deer, and the recent documentation of the presence of emerald ash borer and white-nose syndrome within the park. Climate change is predicted to negatively affect many of the natural resources of the park, including increasing ozone levels and particle pollution, raising the water temperature of cold-water, trout-supporting streams, changing forest composition, and affecting exotic species and forest pests and diseases.


PENNSYLVANIA
MARYLAND
WEST VIRGINIA
VIRGINIA
WASHINGTON D.C.
Baltimore
POTOMAC RIVER
SHENANDOAH RIVER
CHESAPEAKE BAY
20 mi
20 km
N
70
68
81
270
95
66
Chesapeake & Ohio Canal National Historical Park
Other National Capital Region Network parks
Physiographic province
Appalachian Plateaus
Ridge and Valley
Blue Ridge
Piedmont
Coastal Plain
USA