



ARTICLE

Forest Soils

Anacostia Park (<https://www.nps.gov/anac/>), Antietam National Battlefield (<https://www.nps.gov/anti/>), Baltimore-Washington Parkway (<https://www.nps.gov/bawa/>), Catoctin Mountain Park (<https://www.nps.gov/cato/>), Chesapeake & Ohio Canal National Historical Park (<https://www.nps.gov/choh/>), Fort Dupont Park (<https://www.nps.gov/fodu/>), Fort Foote Park (<https://www.nps.gov/fofo/>), Fort Washington Park (<https://www.nps.gov/fowa/>), George Washington Memorial Parkway (<https://www.nps.gov/gwmp/>), Glen Echo Park (<https://www.nps.gov/glec/>), Great Falls Park (<https://www.nps.gov/grfa/>), Greenbelt Park (<https://www.nps.gov/gree/>), Harpers Ferry National Historical Park (<https://www.nps.gov/hafe/>), Kenilworth Park & Aquatic Gardens (<https://www.nps.gov/keaq/>), Manassas National Battlefield Park (<https://www.nps.gov/mana/>), Monocacy National Battlefield (<https://www.nps.gov/mono/>), National Capital Parks-East (<https://www.nps.gov/nace/>), Piscataway Park (<https://www.nps.gov/pisc/>), Prince William Forest Park (<https://www.nps.gov/prwi/>), Wolf Trap National Park for the Performing Arts (<https://www.nps.gov/wotr/>)



A range of contrasting soil profiles from NCA parks listing park, soil order, and soil series: 1. GWMP, Ultisol, Brinklow, 2. PRWI, Ultisol, Meadowville, 3. CHOH, Alfisol, Ryder, 4. CHOH, Inceptisol, Lindside, 5. NACE, Ultisol, Fallsington, and 6. NACE, Inceptisol, Hatboro.

NPS

The Importance of Studying Soils

Soils are the foundation of land-based ecosystems. They affect all parts of the environment: water, atmosphere, animals, vegetation, and climate.

The National Capital Region Network Inventory & Monitoring program (NCRN I&M) collected data on soil chemistry and physical characteristics in 426 permanent forest vegetation monitoring plots in 11 parks between 2007 and 2017.

The goal of this study was to better understand soil function and the influence of soil structure and nutrients on vegetation in the forested ecosystems of parks monitored by NCRN I&M.

The Nitty Gritty

NCRN's soil investigation differs from the [earlier Inventory & Monitoring Division \(IMD\) soil inventory for the region](https://irma.nps.gov/DataStore/Collection/Profile/301) (<https://irma.nps.gov/DataStore/Collection/Profile/301>) in that it is based on data collected in the field. It goes beyond broadly mapped units to provide very fine scale information on a large range of physical and chemical soil variables, horizon by horizon, to depths that are not frequently sampled.

Key findings:

Parent materials

Most NCRN park soils are closely related to their parent materials: the underlying rock from which soil forms. Different parent materials yield different soils with different chemical composition.

For example, the limestone parent material at Antietam National Battlefield produces relatively basic (higher pH) soils rich in calcium and magnesium. These soils support calcium-loving plants (calciphiles) like chinkapin oak (*Quercus muehlenbergii*) and white ash (*Fraxinus Americana*). In contrast, plants well-known to flourish in acidic soils (e.g., heath family plants like blueberries), are much less common in areas with limestone-derived soils.

At Prince William Forest Park, 90% of plots fall within the Piedmont physiographic province where the soil parent material is metamorphic rock (primarily gneiss and schist, with scattered quartzite). This produced soils that are highly acidic, which helps explain why the park has fewer invasive plants and more acidic stream waters. Heath family plants like blueberries (*Vaccinium* spp.) and mountain laurel (*Kalmia latifolia*) thrive on Prince William's acidic soils, in part because the acidic soils allow for ample supply of iron to these species, which are well known to be susceptible to iron-deficiency.

Unlike many NCRN parks, soils at Manassas National Battlefield are largely derived from sedimentary rocks (shales and siltstones) that formed in an ancient lowland basin. This parent material strongly influences the physical and chemical properties of the park's soils. Most notably, MANA's soils have the highest clay content in the region, which yields very dense soils with high levels of magnesium and manganese.

Human influence – O Horizon and Pollutants

A wide variety of things can affect soil characteristics, and in NCA parks human activity is a major influence. This influence shows up most strongly in missing or minimal **soil organic layers (O horizons)**. Typically, O horizons develop gradually from the decay of plant and other organic material that a forest builds up over time. Yet only a quarter of soil plots in NCA parks have any O horizon at all!

[Recent research at the Smithsonian Environmental Research Center](https://doi.org/10.1016/j.foreco.2016.03.046) (<https://doi.org/10.1016/j.foreco.2016.03.046>) (SERC) in Maryland showed that the biggest difference between soils under undisturbed forests vs. forests regenerated on post-agricultural lands was the presence or absence of a well-developed O horizon. The uncut forests had a thick O horizon, whereas 120-150 year old forests had a small or nonexistent O horizon and the 50-70 year old forests had absolutely no O horizons.

Almost all NCA park forests are second or third-growth forests on land that was previously cleared for agriculture or logged for lumber or charcoal. It may look like a mature forest, but soil inventory data clearly shows the legacy of human disturbance in the soil.

The human influence on soils also shows up in the form of **soil pollutants**. Despite being an urban region, NCA soils have relatively few heavy metal contaminants like cadmium, chromium, and lead.

Among NCRN-monitored parks, National Capital Parks – East and Rock Creek Park show the greatest effects from pollutants—primarily lead. Burning of leaded gasoline from the 1920s until it was banned for use by personal vehicles in the 1990s, left elevated lead levels in soils near roads. The highest lead levels were found in the surface soil layers, suggesting that lead isn't leaching down throughout the soil profile.

Since heavy metal contaminant levels were assessed using standard soil science techniques (i.e., the amount extractable by a weak

acid), other methods would be needed to determine if soil contaminants exceed the EPA's recommended limit for safe residential use. Further study of contaminated soils could also help determine lead's long-term fate in the soil.

Future work

Soil sampling and analysis showed that across NCRN-monitored parks, that nutrient levels change very rapidly in the top layers of the soil surface (30 cm, the typical maximum depth of cumulative A horizons) but are overall fairly consistent below that. This indicates that future sampling activities relating vegetation growth and soil properties should focus on the surface horizons.

Reference/Citation

Bright MB and Others. 2020. [Physical and chemical properties of forest soils in the National Capital Region Network](https://irma.nps.gov/DataStore/Reference/Profile/2277991). (<https://irma.nps.gov/DataStore/Reference/Profile/2277991>) Natural Resource Report. NPS/NCRN/NRR—2020/2151. National Park Service. Fort Collins, Colorado.

Learn More about the National Park Service's Inventory & Monitoring Efforts

To help protect natural resources ranging from bird populations to forest health to water quality, National Park Service scientists perform ecological Inventory & Monitoring (I&M) work in parks across the country. The National Capital Region Network, Inventory & Monitoring program (NCRN I&M) serves national parks in the greater Washington, DC area. [Learn more about NCRN I&M monitoring](https://www.nps.gov/im/ncrn/monitoring.htm). (<https://www.nps.gov/im/ncrn/monitoring.htm>)



anacostia park

antietam national battlefield

baltimore-washington parkway

catoctin mountain park

chesapeake & ohio canal national historical park

fort dupont park

fort foote park

fort washington park

george washington memorial parkway

glen echo park

great falls park

greenbelt park

harpers ferry national historical park

kenilworth park & aquatic gardens

manassas national battlefield park

monocacy national battlefield

national capital parks-east

piscataway park

prince william forest park

wolf trap national park for the performing arts

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