



ARTICLE

Forest Regeneration 2022

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/>), Oxon Cove Park & Oxon Hill Farm (<https://www.nps.gov/oxhi/>), Piscataway Park (<https://www.nps.gov/pisc/>), Prince William Forest Park (<https://www.nps.gov/prwi/>), Rock Creek Park (<https://www.nps.gov/rocr/>), Theodore Roosevelt Island (<https://www.nps.gov/this/>), Wolf Trap National Park for the Performing Arts (<https://www.nps.gov/wotr/>)

By Nicholas Tait, NCRN I&M Science Communication Intern

◀▶ A Forest Plot at Catoctin Mountain Park in 2009 and 2022 Showing Seedling and Understory Regrowth



Left image

2009

Credit: NPS



Right image

2022

Credit: NPS

Plot is dominated by maple and birch seedlings.

Forest Regeneration in Our Parks

When a forest tree dies, seedlings and saplings grow to fill the gap in the canopy. This is regeneration, a crucial process that allows forests to sustain themselves for generations.

In National Capital Region (NCR) national parks, forests make up nearly three quarters of all landcover, and the state of their regeneration is concerning. Threatened by large populations of hungry white-tailed deer (>8/km² per Horsley et al. 2003), invasive plant crowding, and other factors, seedlings struggle to grow into saplings that can eventually replace canopy trees. Over time, these stressors can reduce tree species diversity and density, negatively impacting forests and the plants and animals that rely on them.

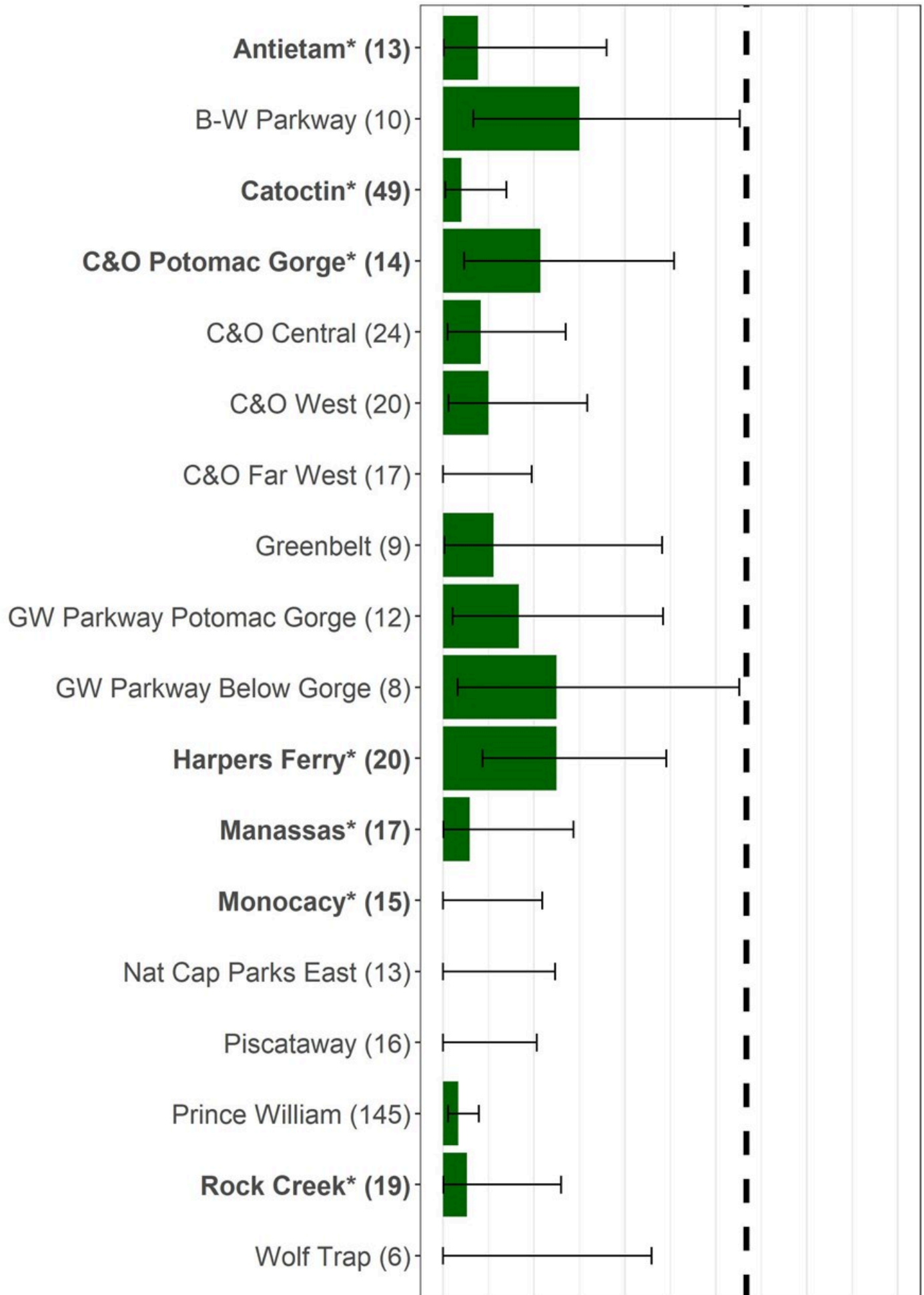
NCR parks that are reducing deer populations to allow their forests to rebuild and recover include Antietam and Monocacy National Battlefields, Catoctin Mountain Park, Chesapeake and Ohio Canal and Harpers Ferry National Historical Parks, Manassas National Battlefield Park, and Rock Creek Park.

Regeneration Levels Still Low

To assess forest condition and regeneration capacity, we analyzed long-term forest data collected by the National Capital Region, Inventory & Monitoring Network (NCRN I&M) starting in 2006, before NCR deer management began, until 2022.

As with previous years, forest regeneration levels remain low throughout National Capital Region parks (Figure 1). We measure the status of forest regeneration using the Stocking Index, a calculation of regeneration potential on a plot-by-plot basis. It factors in the number of seedlings and small saplings, their size, and their distribution across the park. Larger saplings earn higher scores, as they are more likely to survive. Since the process of seedlings growing into saplings and saplings growing into young trees is slow, it takes many years for changes in forest regeneration to move the Stocking Index score of a particular area.

A park is considered to have healthy regeneration if the Stocking Index shows that 67% of its forest plots are adequately stocked with seedlings and small saplings. Since monitoring began, no NCR park has reached 67%, or even exceeded 30%.



0% 20% 40% 60% 80% 100%
Percent of Plots Adequately Stocked

Figure 1. Stocking Index 2018-2022. For a park or smaller distinct park area to have healthy regenerative capacity, 67% of plots must be adequately stocked (dashed line). The number of NCRN forest monitoring plots is listed in parenthesis after each park name. Asterisks show parks managing deer. T-shaped error bars indicate 95% confidence intervals.

NPS

Effects of Fire at Prince William

At Prince William Forest Park, three of the five plots considered adequately stocked were burned during an accidental fire in 2006. These three have a far denser understory with many more saplings, seedlings, and shrubs than unburned areas of the park (Figure 2). Without these atypical burn plots bursting with growth, its forest is showing significant declines in seedlings and saplings.

Seedlings

Tree seedling density is increasing over time in some parks (Figure 3). Because the Stocking Index includes both seedlings and small saplings, and assigns higher values to larger individuals, the increase in seedlings takes time to nudge up a Stocking Index score. While the increases in seedling density are promising, they don't guarantee future regeneration. It takes many years for small vulnerable seedlings to grow into large resilient saplings, and along the way they face many threats to their survival.

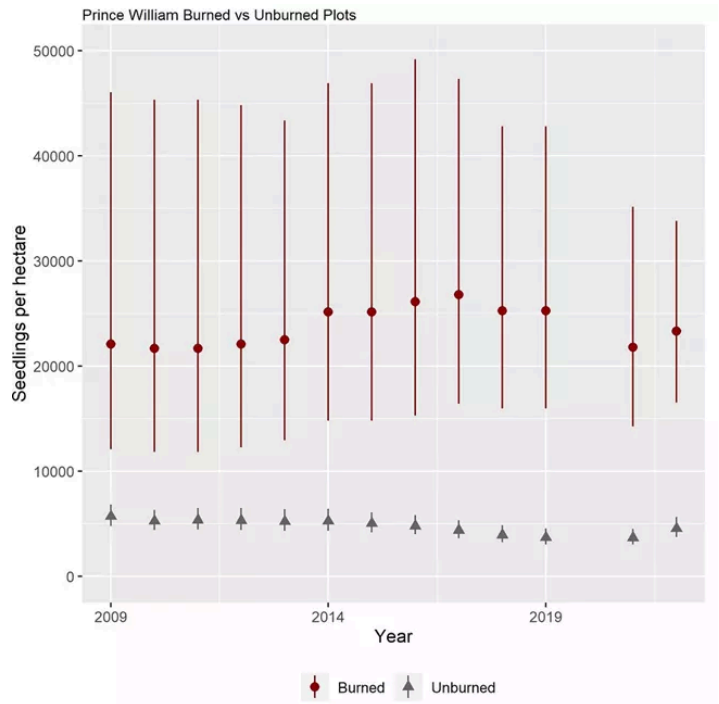


Figure 2. Seedlings per hectare in burned (red circles) vs unburned (gray triangles) plots in Prince William Forest Park. Vertical lines indicate 95% credible intervals.

NPS

Seedlings 2009-2021

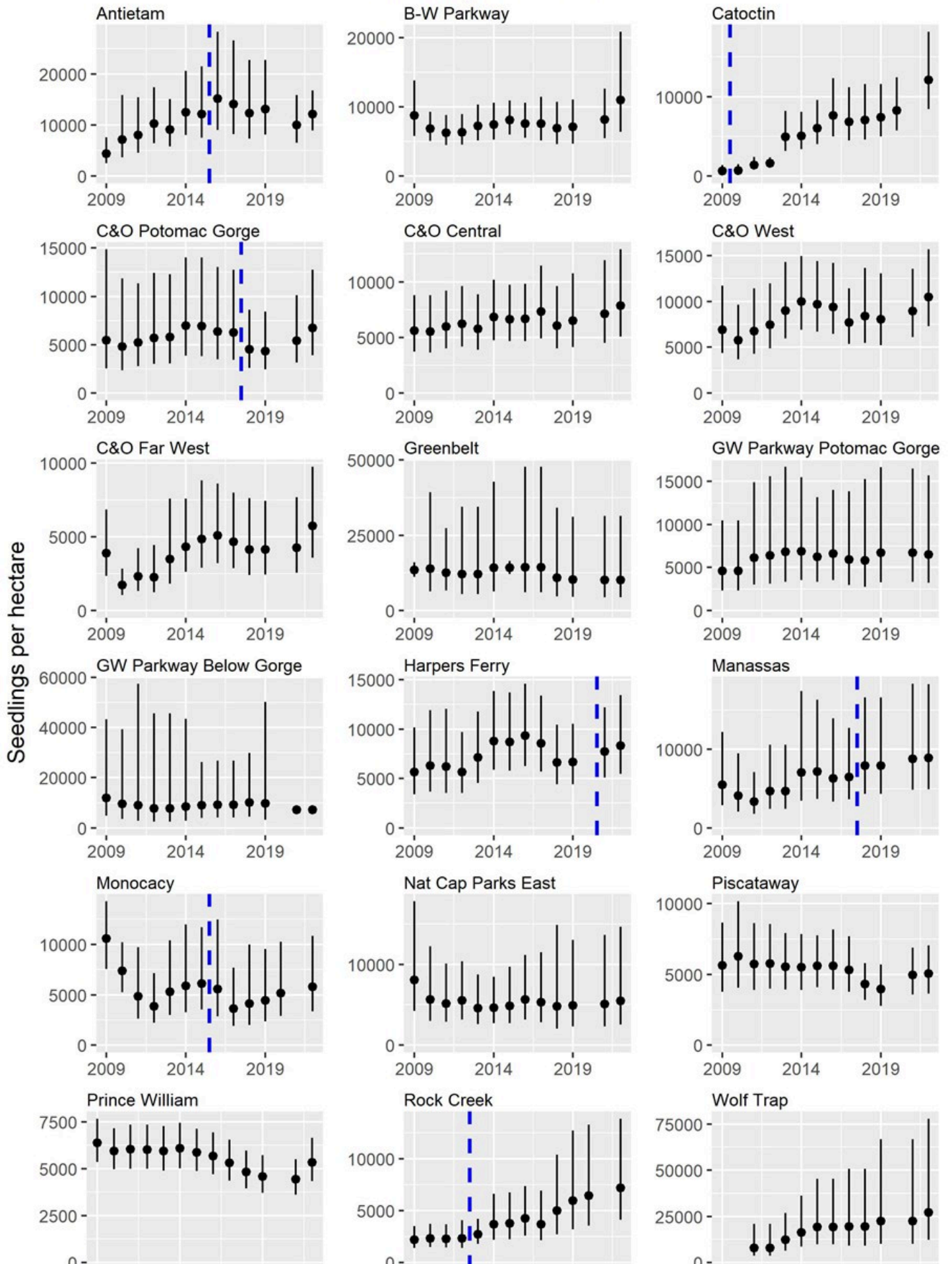




Figure 3. Change in seedlings per hectare 2009-2021. Parks and smaller distinct park areas appear in order of lowest seedling densities at upper left, to highest in lower right. Each circle represents an average of the last 4 years of seedling data (a complete sample of all plots at the park). Vertical lines are 95% confidence intervals. Dashed blue vertical lines indicate the year a park began deer management. The y-axis varies from park to park due to a large variance in number of seedlings.

NPS

Discussion of Stocking Index & Seedlings

Neither the Stocking Index nor the seedling densities consider which tree species are regenerating and how that will affect the composition of future forests. These figures show only the presence or absence of regeneration. Native canopy species like oaks, maples, and hickories are counted equally with non-natives (e.g., tree of heaven), non-canopy species (e.g., pawpaw), and species that face certain demise due to forest pests (e.g., ash trees due to emerald ash borer). If the Stocking Index only included canopy species likeliest to survive, even fewer plots would be stocked.

Early Signs of Progress

Though the results continue to show low regeneration levels across the region, there are some improvements in parks with ongoing deer management.

Catoctin Mountain Park has seen a 19-fold increase in seedlings since deer management began, and now two of their 49 forest plots are considered adequately stocked on the Stocking Index.

In Rock Creek Park, tree seedling numbers have tripled since the start of deer management, and we can finally see one of their 19 forest plots as adequately stocked on the Stocking Index. This regeneration is promising, however, the “stocked” plot is heavily populated by seedlings of box elder (*Acer negundo*), an understory tree that will not create mature canopy cover.

Catoctin and Rock Creek are showing small but significant steps forward on the long road to sustaining our forests. That said, the continued lack of forest regeneration throughout the National Capital Region remains a cause for concern. Despite deer management’s promising start, Stocking Index scores have hardly changed since [2008-2011](https://irma.nps.gov/DataStore/DownloadFile/460861) (<https://irma.nps.gov/DataStore/DownloadFile/460861>).

Forest Resilience in Eastern Parks

A new study (<https://doi.org/10.1002/eap.2837>) by Miller et al. of national park forests in the eastern United States found that while deer management is a vital tool for supporting forest regeneration, it can’t do the job alone. The study authors analyzed 12 years of forest data across 39 different parks (including those in NCR), and found that 70 percent of forests have insufficient tree regeneration to replace canopy trees as they die or fall. They describe this condition “imminent or probable failure,” and identify overabundant deer populations and invasive plants as the leading causes of regeneration failure.

Integrated forest management, including deer management and strategic invasive plant removal, is critical to promoting abundant and diverse forest regeneration with reducing deer populations as the most effective first step. Parks that have committed to long-term (10+ years) deer management are seeing the future forest of seedlings re-establish in the understory. Additional steps in integrated forest management include controlling invasive plants and pests, restoring targeted species, and in some cases using prescribed fire or canopy thinning.

The study's "imminent and probable failure" labels sound dire, but even forests in this category can be improved with focused, integrated forest management planning and actions. By acting now, there is still time to reverse the damage done in eastern forests.

Forest Plans for NCR Parks

Some NCR parks are already exploring novel approaches to improve forest regeneration beyond deer management. George Washington Memorial Parkway for example, is working with researchers at Virginia Tech University to design an Urban Forest Management Plan for the park.

Rock Creek Park is working with its partner group, Rock Creek Conservancy, to develop a Forest Resilience Framework by the end of 2023. The framework will help the park manage and restore its forest resources and will support the RCC's long-term goal of fundraising for a "forest endowment" that will financially support management activities in the park.

Further Reading

- Horsley, S.B., S.L. Stout, and D.S. DeCalesta. 2003. [White-tailed deer impact on the vegetation dynamics of a northern hardwood forest \(https://www.jstor.org/stable/3099953\)](https://www.jstor.org/stable/3099953). Ecological Applications 13:98-118.
- Miller K., Perles S., Schmit J.P., Matthews E., Weed A., Comiskey J., Marshall M., Nelson P., Fisichelli N. 2023. [Overabundant deer and invasive plants drive widespread regeneration debt in eastern national parks. \(https://doi.org/10.1002/eap.2837\)](https://doi.org/10.1002/eap.2837) Ecological Applications.
- Schmit JP, Matthews ER, Brolis A. 2020. [Effects of culling white-tailed deer on tree regeneration and Microstegium vimineum, an invasive grass \(https://irma.nps.gov/DataStore/Reference/Profile/2273890\)](https://irma.nps.gov/DataStore/Reference/Profile/2273890). Forest Ecology and Management. 463(118015).
- Schmit, JP. and M. Nortrup. 2013. [NCRN Resource Brief: Forest Regeneration 2013 \(https://irma.nps.gov/DataStore/Reference/Profile/2205449\)](https://irma.nps.gov/DataStore/Reference/Profile/2205449).
- Schmit, JP and M. Nortrup. 2020. [Stiltgrass and Tree Seedling Recovery \(https://www.nps.gov/articles/000/stiltgrass-and-tree-seedling-recovery.htm\)](https://www.nps.gov/articles/000/stiltgrass-and-tree-seedling-recovery.htm)
- Schmit JP, Matthews E, Brolis A. 2023. [Trends in woody forest vegetation in Prince William Forest Park, 2006–2017 \(https://doi.org/10.36967/2296913\)](https://doi.org/10.36967/2296913). Natural Resource Report. NPS/NCRN/NRR—2023/2495. National Park Service. Fort Collins, Colorado.



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

oxon cove park & oxon hill farm

piscataway park

prince william forest park

rock creek park

theodore roosevelt island

wolf trap national park for the performing arts

prescribed fire

resilient forest management

resilient forests

forest regeneration

ncrn

ncrn im

i&m

tree

saplings

seedlings

stocking index

eastern deciduous forest

forest

deer management

Last updated: March 17, 2023

Was this page helpful?

☐ Yes☐ No

An official form of the United States government. Provided by [Touchpoints](https://touchpoints.app.cloud.gov/)
(<https://touchpoints.app.cloud.gov/>)