



ARTICLE

Forest Regeneration 2021

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By Crystal Chen, NCRN I&M Science Communication Intern

What is Forest Regeneration?

Forests make up about three quarters of all landcover in the National Capital Area (NCA) national parks. To ensure that the forests we have today are around for future generations, we have to consider tree regeneration. This is how a forest sustains itself through the growth and survival of seedlings and saplings that replace large forest trees as they die. It's important to all of us who enjoy the forests, and essential for the animals and plants that depend on them.

What's threatening forest regeneration?

In NCA national parks, forests face a variety of stressors: over-abundant white-tailed deer populations, novel pests and pathogens, invasive plant dominance, development of surrounding lands, altered disturbance regimes (lack of fire), increasingly frequent extreme weather events, and changing climate conditions. One of the largest stressors is a large white-tailed deer population (greater than 8/km² or 20/mi² per Horsley et al. 2003) that has significantly reduced forest regeneration through browsing. Deer damage and eat tree seedlings, preventing them from growing taller and becoming saplings. Over time, this can also reduce tree species diversity and density. Therefore, many NCA parks are working to reduce their deer populations and allow forest regeneration capacity to rebuild and recover, including 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.



Healthy forest regeneration in response to fire at Prince William Forest Park, with many oak seedlings on the forest floor.

NPS / Brolis

How do parks monitor forest regeneration?

The NPS National Capital Region Network, Inventory & Monitoring program (NCRN I&M), has monitored forests since 2006, before any deer management began. So, we are well situated to document changes in forest regeneration over time. Our forest monitoring crew collects data on seedlings, saplings, and mature trees in over 400 plots throughout NCA. From this data, we have two views of forest regeneration based on seedling and sapling numbers.

In typical times, NCRN's forest monitoring crew visits over 100 vegetation plots in a year, completing a full round of visits to the area's 400+ plots every 4 years. However, COVID-19 reduced operations starting in 2020 and what would normally take one year took two. The crew visited Catoctin Mountain Park, Monocacy National Battlefield, and Rock Creek Park in 2020, and all other parks in 2021.



Our forest monitoring crew collects vegetation data for over 400 plots in NCA parks.

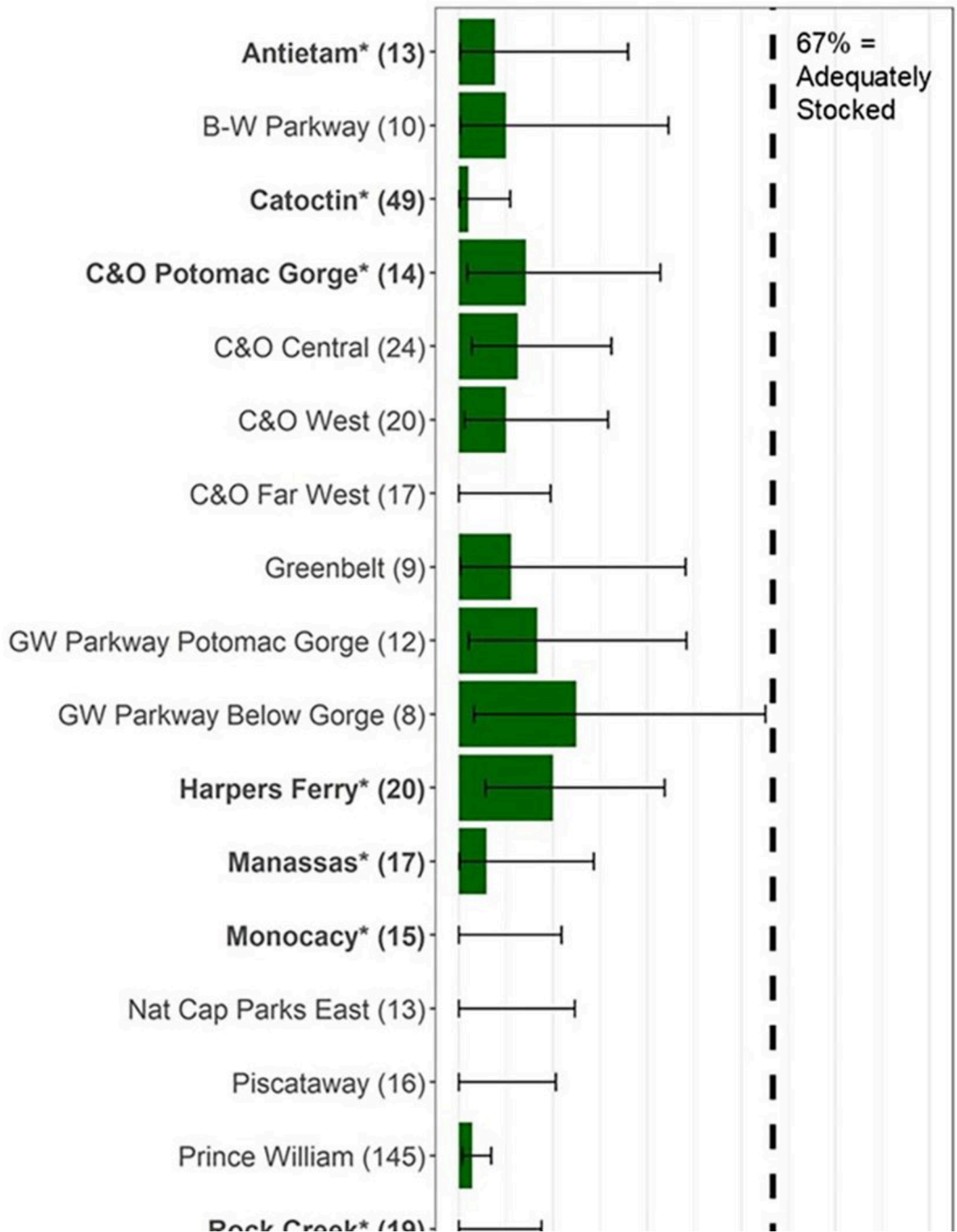
NPS / Brolis

Stocking Index

The [Stocking Index \(https://irma.nps.gov/DataStore/Reference/Profile/2191678\)](https://irma.nps.gov/DataStore/Reference/Profile/2191678) (Figure 1) calculates forest 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 are scored higher, 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 forest monitoring began in 2006, no NCA park has ever had more than 30% of their plots adequately stocked.

Stocking Index 2017-2021



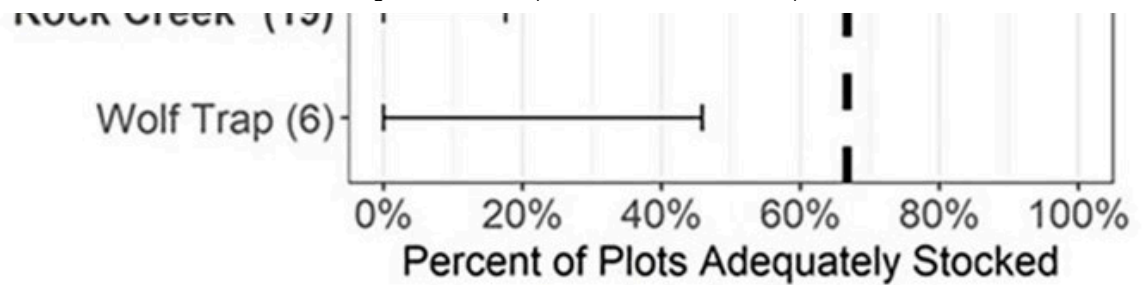


Figure 1. Stocking Index 2017-2021. For a park or smaller distinct park area to have healthy regenerative capacity, 67% of plots must be adequately stocked (dashed line). The number of NCRN forest monitoring plots is listed in parenthesis after each park name. Asterisks show parks managing deer. T-shaped error bars indicate 95% confidence intervals.

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Seedlings

A more sensitive measure is a simple look at change in seedlings over time (Figure 2). Seedlings are affected by boom and bust cycles of seed production, browsing by deer, weather, disease, and other natural phenomena. The number of seedlings per hectare (about 2.47 acres) naturally varies year to year. While increases in seedlings are a positive change, they don't guarantee future regeneration. It takes many years for small vulnerable seedlings to grow into large resilient saplings, and they face many threats to their survival along the way.

Seedlings 2009-2021

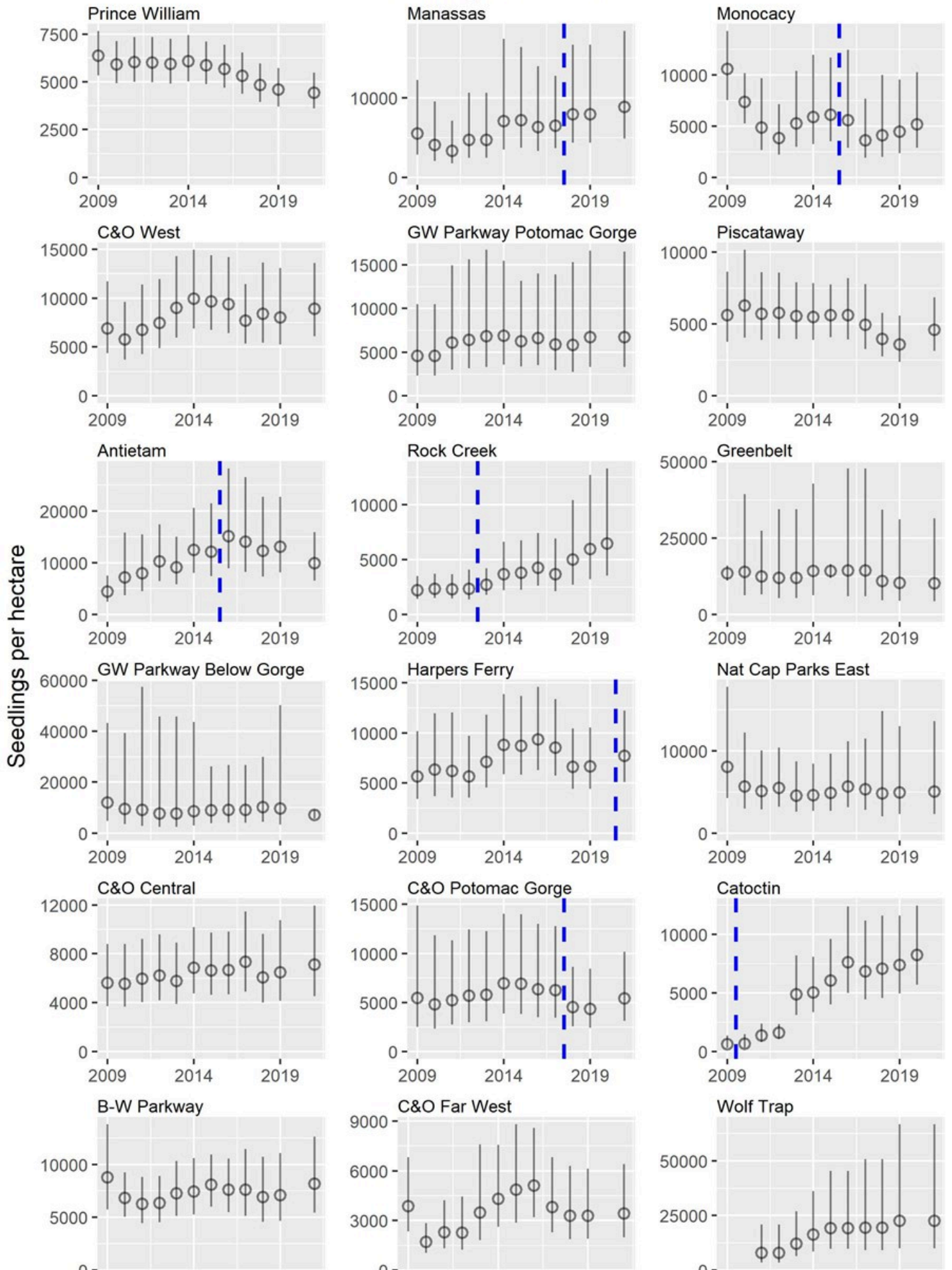




Figure 2. Change in seedlings per hectare 2009-2021. Parks and smaller distinct park areas appear in order of lowest seedling densities at upper left, to highest in lower right. Each circle represents an average of the last 4 years of seedling data (a complete sample of all plots at the park). Vertical 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.

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Up Close: Stocking Index and Seedling Density

It is worth noting that both the Stocking Index and measures of seedling density do not consider which tree species are regenerating and how that will affect the composition of future forests. These measures only show the presence or absence of regeneration. Native canopy species like oaks, maples, and hickories are counted equally with non-natives (tree of heaven), non-canopy species (pawpaw), and species that face certain demise due to forest pests (ash trees due to emerald ash borer). If the Stocking Index only included canopy species likeliest to survive, fewer plots would be stocked.

While some areas have high enough densities of seedlings and small saplings to meet the criteria of “adequately stocked” in terms of the Stocking Index, they are the exception. This is the case not only in NCA, but throughout national parks in the Northeast.

Suppressed [forest regeneration \(https://www.nps.gov/im/netn/managing-resilient-forests-initiative.htm\)](https://www.nps.gov/im/netn/managing-resilient-forests-initiative.htm), together with changes in the mix of species that are regenerating, suggests the future of these forests may be imperiled.

Sites around the Potomac Gorge on both sides of the Potomac River have some of the highest Stocking Index scores in the NCA (GW Parkway Below Gorge, GW Parkway Potomac Gorge, C&O Potomac Gorge, and C&O Central). C&O Potomac Gorge has ongoing deer management and seedling levels show a slight increase since it began.

At Catoctin, the 13-fold increase in seedlings the park has seen since deer management began has finally registered in the Stocking Index and one of their 49 forest plots is now considered adequately stocked. A small but significant step forward.

At Rock Creek Park, tree seedling numbers have almost tripled since deer management began, but the Stocking Index remains unchanged. Not a single plot is considered adequately stocked.

Seedling numbers also show continued improvements at Monocacy and Wolf Trap, but neither park has yet registered on the Stocking Index.

Antietam National Battlefield does register on the Stocking Index score, but seedling numbers are declining. While Antietam is managing deer, it is taking longer there to reduce deer populations to levels that will allow seedlings to regenerate.

At Prince William Forest Park, the forest is showing declines in both the Stocking Index and seedling densities. The park does not manage deer, and recent fires in six forest plots have caused a natural burst in seedling density that will dwindle as seedlings compete for resources. Regeneration at Prince William is further threatened by the recent identification of [Beech Leaf Disease \(https://www.nps.gov/articles/000/beech-trees-in-the-national-capital-area.htm\)](https://www.nps.gov/articles/000/beech-trees-in-the-national-capital-area.htm) that is expected to kill many of the park’s most common tree species, American Beech.

Overall, the lack of forest regeneration throughout the National Capital Area remains a cause for concern and Stocking Index scores have changed very little since 2006-2009. While deer management has made a promising start to sustaining our forests, continued effort is needed for long-term success.

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.
- 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).

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 \(https://www.nps.gov/im/ncrn/index.htm\)](https://www.nps.gov/im/ncrn/index.htm) (NCRN I&M) serves national parks in the greater Washington, DC area. To learn more about NCRN I&M forest monitoring, you can visit [the NCRN forest monitoring webpage \(https://www.nps.gov/im/ncrn/forest.htm\)](https://www.nps.gov/im/ncrn/forest.htm).

[Previous briefs on this topic from 2011 to 2020 \(https://irma.nps.gov/DataStore/Collection/Profile/7658\)](https://irma.nps.gov/DataStore/Collection/Profile/7658) are also available.



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

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