National Capital Region Network
Climate Change Brief

National Park Service
U.S. Department of the Interior

Inventory & Monitoring

NCRN Summary of Climate Change Activities

Forest Health Monitoring

Forest vegetation is a primary resource in the NCRN, the health of which is determined in large part by climatic factors. To monitor forest health, the NCRN gathers data on the species and size class of forest vegetation at 400 plots scattered throughout the region. This effort represents the most comprehensive study of the structure and composition of NCRN forests ever undertaken and a fourth year of monitoring has just been completed. These plots are also monitored for the presence of forest insect pests and pathogens and the abundance and distribution of select exotic invasive plants which may be increasing due to climate changes. High-resolution LiDAR data has also been gathered for PRWI and is being analyzed to assess forest vegetation structure.

I&M Botanist John Parrish measures a forest tree. (Photo: NPS/Thomas Paradis)

Forest Monitoring Collaboration

The NCRN is working with 8 I&M networks (APHN, CUPN, ERMN, GLKN, MIDN, NCBN, NCRN, NETN), three parks (GRSM, SHEN and CACO), and the Appalachian Trail (APPA) to standardize forest monitoring. By using comparable monitoring methods, 4 NPS regions, 18 states, and 64 parks will have comparable data from more than 2,000 plots. The fall 2009 cover story in *Park Science* details this multi-network collaboration.

Vegetation Mapping

In addition to forest health monitoring, the NCRN has completed draft maps of vegetation communities in all the region's parks and funds are currently being sought to examine potential changes in vegetation community composition in response to climate change.

Excerpt from the completed vegetation map for Rock Creek Park. (Image: NPS)

Potomac River flood waters at Great Falls. (Photo: Leon Reed)

Flooding of the Potomac River

Changes in precipitation patterns may lead to more frequent flooding in the non-tidal regions of the Potomac River. In anticipation of this possible change, NPS has collaborated with the Interstate Commission on the Potomac River Basin and the USGS in creating a predictive flood mapping tool for the non-tidal Potomac stretching inland up to Cumberland, Maryland. It is hoped that the tool will help decision makers anticipate the frequency and intensity of flooding in this region under various climatic and water withdrawal scenarios.

Habitat Connectivity & Land Use

The issue of land cover and land use in areas surrounding national park lands is one of the NCRN's vital signs and is of particular significance in climate-induced migration of animal and plant species. Because parks tend to be smaller in the NCRN, connectivity between parks and other natural landscapes may be especially vital for allowing species to shift their habitats upward in latitude and elevation. Connectivity is currently part of the region's draft climate change adaptation strategy. As a result the NCRN has begun to take land cover and land use data and ideas and look at connectivity across the region, focusing initially on Manassas National Battlefield. Study is ongoing.

Stream Discharge & Precipitation

Precipitation (measured over the long-term) is a vital resource in the National Capital Region Network. Timing and amount of precipitation, both seasonally and by individual event, affects stream flow and hence, aquatic ecosystem processes. The NCRN has analyzed long-term, regional precipitation and stream-gauge data and found that seasonal precipitation patterns are flattening out. Streamflow patterns are changing too, but in different ways depending on the degree of human influence on the watershed.

A stream gauge used to collect data on streamflow. (Photo: USGS)

Regional Climate Change Workshops and Planning

The NCRN and the Urban Ecology Research Learning Alliance conducted a one-day climate change training seminar in October 2009 to foster understanding and a multidisciplinary regional discussion of the impacts of climate change to NCRN parks. Attendance was at full capacity. Additional climate change events are slated for 2010. During the same time, the regional Natural Resources Advisory Team (NAT) worked on recommendations and strategies to address adaptation and helped complete a draft regional climate change adaptation strategy. The NAT's contribution will likely to be incorporated into the long-term planning and goals for the National Capital Region.

Tidal Marsh Elevation Monitoring

To determine if tidal marshes are rising or sinking, the NCRN is monitoring elevations using surface elevation tables (SET) and monitoring accretion using feldspar layer techniques at GWMP's Dyke Marsh and NACE's Anacostia Park. The NCRN will also analyze LiDAR data from Dyke Marsh in conjunction with data from field monitoring. If natural marsh sedimentation rates are not raising elevations enough to balance out land subsidence, compaction, erosion, and rising tidal levels, our marshes and their unique habitat could be submerged and lost.

Surface Elevation Tables (SET) are used to monitor marsh elevations. (Photo: NPS)

Fostering Amphibians with Structured Decision Making

The NCRN, the Chesapeake & Ohio Canal National Historical Park (CHOH), and the USGS Patuxent Wildlife Research Center are developing structured decision making (SDM) models to identify management actions which may foster amphibian populations in CHOH. Park goals are to increase or maintain amphibian diversity and occupancy, and to provide assessments of the state of amphibian populations. The SDM model uses NCRN amphibian monitoring data and will include park-specific and regional stressors which may be mitigated through management actions. Models will be used to evaluate management of vernal pools in the face of climate change. Continued NCRN amphibian monitoring will help to feed an adaptive management cycle at the park level.

North Atlantic Coastal Monitoring

The NCRN is participating with other Atlantic Coastal parks in the NETN, and NCBN I&M networks, in contributing to the Fish & Wildlife Service's North Atlantic Landscape Conservation Cooperative (LCC). The LCCs are regional units set up to look at landscape level issues in the face of climate change. The NCRN is primarily co-located with the Northeast LCC but also overlaps with the Appalachian LCC.

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Monitoring Forest Health in the NCRN

Forest health is a key vital sign for the National Capital Region Network (NCRN). The health of forests is determined in large part by climatic factors from precipitation and temperature to atmospheric composition.

Data suggest that the climate in the NCRN is changing; less precipitation in summer and more in fall. Average temperatures may also be on the rise along with atmospheric levels of carbon dioxide. NCRN monitoring is a primary gauge of how our forests are being affected.

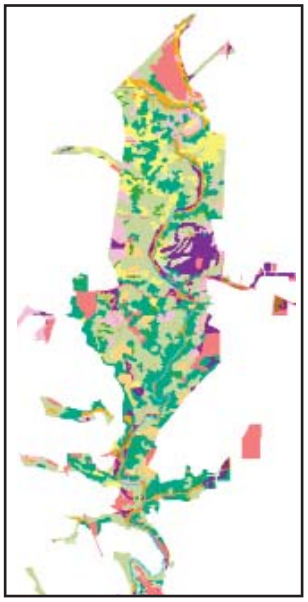
NCRN I&M Botanist John Parrish measures the DBH (diameter at breast height) of a forest tree. (Photo: NPS/Thomas Paradis)

Forests and Climate Change

NCRN forest health monitoring gathers data on the species and size class of forest vegetation at 400 plots scattered throughout the region. This effort represents the most comprehensive study of the structure and composition of NCRN forests ever undertaken and a fourth year of monitoring has just been completed. In these plots we also monitor for the presence of forest insect pests and pathogens, and the abundance and distribution of select exotic, invasive plants. By monitoring these elements, we can learn more about the status and trends of NCRN forest health.

Mapping Vegetation Communities

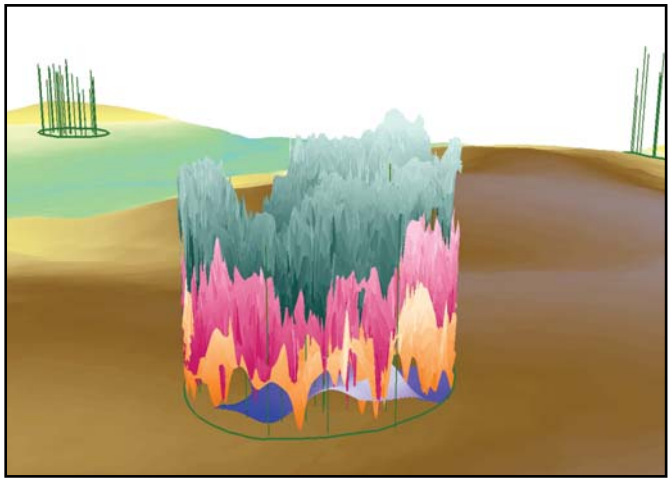
Draft-stage vegetation maps of plant communities, with detailed classifications and descriptions of community types are now complete for all eleven parks in the region. We are currently seeking funds to examine potential changes in community composition in response to climate change.



An excerpt from the completed vegetation map for Rock Creek Park. (Image: NPS)

Vegetation Assessment Using LiDAR

We are also analyzing high-resolution LiDAR data gathered at Prince William Forest Park in conjunction with our forest monitoring data. We hope to eventually use LiDAR as a way to monitor forest growth, track forest gaps, and understand light penetration to the forest floor. In the long-term, LiDAR data on the spatial distribution of the understory may help us to understand rates of forest regeneration.



The vivid colors in this 3-D rendering of LiDAR data represent the layers of vegetation in a circular forest monitoring plot in Prince William Forest Park. The brown and green backdrop show elevation and the green lines on the left and right represent individual trees in nearby forest monitoring plots. (Image: NPS/Mark Lehman)

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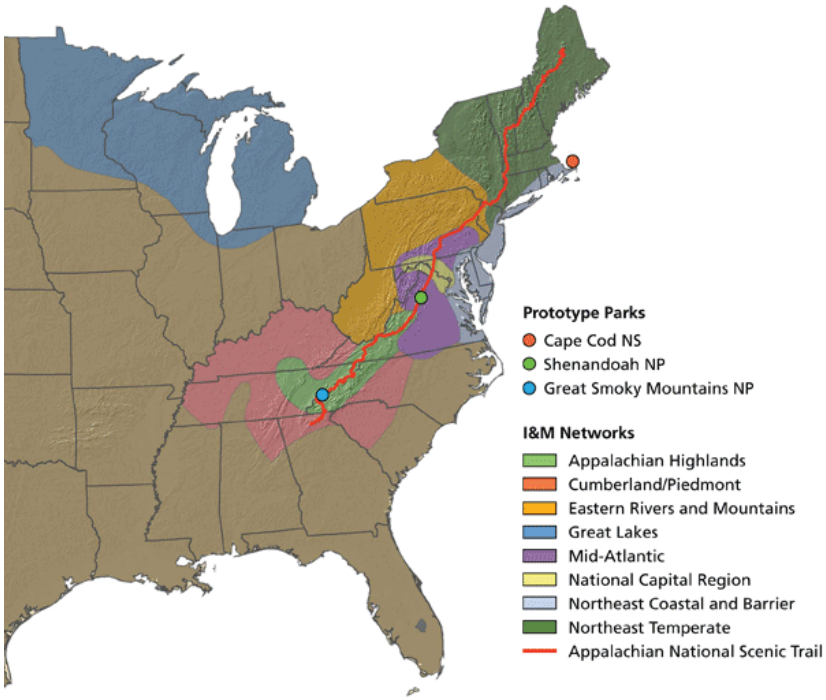
Collaboration in Monitoring

The NCRN is working with 8 I&M networks (APHN, CUPN, ERMN, GLKN, MIDN, NCBN, NCRN, NETN), three parks (GRSM, SHEN, and CACO), and the Appalachian Trail (APPA) to standardize forest monitoring. By using comparable monitoring methods 4 NPS regions, 18 states, and 64 parks will have comparable data from more than 2,000 plots. The fall 2009 cover story in *Park Science* details this multi-network collaboration.



Parks and I&M networks collaborating on forest vegetation monitoring activities. (Image: NPS/Jim Comiskey, John Paul Schmit, Suzanne Sanders, Patrick Campbell, and Brian Mitchell)

A few possible impacts of climate change on forest health:

• **Pollination problems.** Warming temperatures could affect the timing of flowering of plants, which could alter the period of overlap they have with important pollinators.

• **Range changes.** Warming may lead some species to shift their range northward and upward in elevation. This would lead to changes in community composition. If habitat connectivity is impaired, some species may find it challenging to migrate.

• **More pests for longer periods.** Warming could also cause improved survival rates of forest pathogens and pests that would otherwise be reduced by cold winter temperatures. Warming could also extend their period of activity and expand their ranges.

• **Spread of exotics.** Warming temperatures may also encourage the spread and range expansion of exotic, invasive plant species.

• **Accelerated growth.** Warming, along with rising atmospheric CO_2 levels could boost tree growth at high elevations .

• **Changes in plant community makeup.** Lower rainfall in summer, could cause earlier summer droughts that could increase disease and mortality rates for certain plant and tree species resulting in changed forest structure and dynamics affecting everything from large mammals to tiny soil organisms.

Sometimes collecting forest health data isn't easy. On the left: a welcoming monitoring plot in Prince William Forest Park with a relatively open understory. And on the right: a forest monitoring plot with dense understory in National Capital Parks - East. I&M Vegetation Field Tech Eric Johnson can barely be seen ducking under prickly greenbrier while marking out a plot transect. (Photos: NPS)

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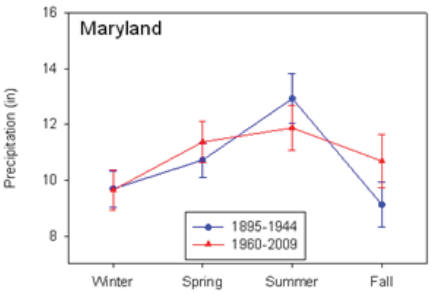
Changing Precipitation and Streamflow in the NCRN

Precipitation (measured over the long-term) is a vital resource in the National Capital Region Network (NCRN). Timing and amount of precipitation, both seasonally and by individual event, affects stream flow and aquatic ecosystem processes. To find out if stream flows and precipitation (and hence climate) are changing in meaningful ways the NCRN has been analyzing long-term, regional precipitation and stream-gauge data.

The amount of precipitation and its timing are changing

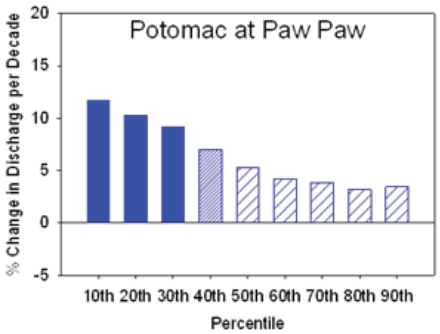
Based on analysis of long-term precipitation data gathered by the National Oceanic and Atmospheric Administration, there is a a historic, seasonal pattern to precipitation in the NCRN. It is lowest in the fall, increases gradually through the winter and spring, and peaks in summer before dropping again in the fall. This trend has been flattening out in recent decades as precipitation is decreasing in the summer months and increasing in the fall. The line graph below shows the changes in seasonal precipitation in the state of Maryland. Changes are similar in Virginia and the District of Columbia.



This line graph of seasonal precipitation rates in Maryland shows the trend toward less precipitation in summer and more in fall. (Image: NPS/John Paul Schmit)

Streamflow changes across the region

Analyzing long-term, U.S. Geological Survey stream gauge data, has shown that streams of the NCRN have a seasonal flow pattern that is similar to the seasonal pattern of precipitation. Flows are lowest in fall, rise through the winter, peak in early spring and then fall during the late spring and summer eventually dropping again to their lowest levels in fall. However, the contours of flow profiles have been changing in recent decades, and this change is tied strongly to the condition of watersheds. In non-urbanized watersheds the lowest flows (in fall) are getting higher but high flows are staying the same. See bar graph below.



This bar graph shows streamflow changes in a non-urbanized portion of the Potomac River watershed at PawPaw, Maryland. The lowest flows, shown as the 10th, 20th, and 30th percentiles have increased by as much as 12%. (Image: NPS/John Paul Schmit)

A USGS stream gauge measures streamflow on a West Virginia river. (Photo: USGS)

In urbanized watersheds, flows are polarizing, with low flows getting lower and high flows becoming even higher throughout the year. In the non-urbanized watersheds of large rivers that have been dammed, no changes in flow trends were found. The exception to all of these trends, and the lone outlier in the region, is the urbanized northwest branch of the Anacostia, which has shown significantly higher high flows and higher low flows in all seasons.

Possible impacts of precipitation and streamflow change:

• Vernal pools and amphibians.
Changing precipitation and streamflow could affect vernal pools and the amphibians and other biota that are dependent on them. Vernal pools are temporary pools of

water, fed by precipitation and linked to streamflow via ground water, that are important amphibian breeding grounds. Changes in precipitation and streamflow could cause some vernal pools to flood and others to become year-round pools, which could negatively affect amphibian reproduction and survival.

• **Streambank erosion and channelization.** Higher streamflows and more intense storm events could increase destructive stream bank erosion that undercuts streamside trees. It also could promote channelization and quicker flows that carry more sediment and have higher erosive potential.

• **Macroinvertebrates.** Erosion that may occur with higher streamflows could scour or disrupt the habitat of benthic macroinvertebrates. Fewer macroinvertebrates means less food for fish, amphibians, and other creatures.

• **Fish migration.** Changes in streamflow could also affect fish migration.

• **Land and vegetation changes.** As streamflows increase, they may change the acreage of streamside land and affect specially adapted plant and animal communities.

An eroded streambank in Rock Creek Park. (Photo: Integration and Application Network, University of Maryland)

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Tidal Marsh Elevation Monitoring in the NCRN

Tidal wetlands are an important natural resource in the highly urbanized and developed watersheds of the National Capital Region Network (NCRN). However, the few wetlands that remain may be changing due to sea level rise. Global sea levels are rising due to ocean warming and the addition of glacial meltwater, a rise compounded in the NCRN by land subsidence. This accelerated relative sea level rise could cause changes in the plant and animal communities of the region's tidal marshes.

Kenilworth Marsh, a tidal marsh on the Anacostia River, is part of National Capital Parks - East. (Photo: John Beetham)

Monitoring Tidal Marsh Elevations

To determine how natural marsh sediment accretion rates compare to the combination of land subsidence, compaction, erosion, and rising tidal levels, the NCRN monitors marsh elevations. Elevations have been monitored at Dyke Marsh in the George Washington Memorial Parkway on the Potomac River for three years. They have also been monitored at marshes in Anacostia Park on the Anacostia River, part of National Capital Parks – East, for eight years. Marsh elevation is monitored using surface elevation tables (SET) and sediment accretion is monitored using the feldspar marker technique.

Additional data and digital elevation models created using LiDAR (a high-resolution remote sensing technique), will be analyzed along with SET and feldspar marker data to evaluate elevation changes at Dyke Marsh.

Surface Elevation Tables (SET) like this one are used to monitor marsh elevations. (Photo: NPS)

Discussions are now underway to expand monitoring of tidal marshes, in collaboration with both the Northeast Coastal and Barrier and the Northeast Temperate I&M Networks, to include more marshes of the Chesapeake Bay and Atlantic coast.

Possible impacts of climate change on tidal marshes:

• **Vegetation changes.** Rising water levels could increase flooding frequency and inundation causing changes in marsh vegetation creating more low marsh and less high marsh. Increases in low marsh could improve spawning and population levels of fish.

• **Less sediment trapping.** Marsh vegetation changes could reduce the holding and trapping of sediment. This could affect overall sediment accretion rates and water quality.

• **Habitat change.** If sea level rise causes vegetation changes, habitat could shift to favor new species. Species including birds, reptiles, amphibians, and fish could be affected.