Fall 2009 • Volume 26 • Number 2 www.nature.nps.gov/ParkScience

# PARK Science

Integrating Research and Resource Management in the National Parks

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Office of Education and Outreach

## COLLABORATIVE FOREST MONITORING

**Improvements in data compatibility and reporting enable resource managers to track conditions and changes in forest health over wide regions**

# ON THE COVER

Eastern deciduous and northern hardwood forests are the focus of resource managers who are developing a forest vegetation monitoring and reporting framework that facilitates data compatibility and sharing. Discussed on pages 76–80, this collaboration enables managers to observe forest conditions and long-term change in forest health over a broad region of the Northeast. Photo: Fredericksburg and Spotsylvania National Military Park.

NPS/JIM COMISKEY

# Forest vegetation monitoring in eastern parks

By Jim Comiskey, John Paul Schmit, Suzanne Sanders, Patrick Campbell, and Brian Mitchell

**Figure 1.** (Left to right). Forests form an important natural and cultural component within national parks. The Inventory and Monitoring Program is establishing long-term vegetation monitoring plots across the Northeast and Midwest (Acadia National Park, Maine). Standardized protocols (investigator measuring tree, Prince William Forest Park, Virginia) are allowing networks to share information and field crews from Acadia National Park in Maine to Booker T. Washington National Monument in Virginia.

**FORESTS ARE THE DOMINANT ECOSYSTEM** in many eastern and midwestern national parks. As such, activities to assess and promote forest health are a principal focus of park managers. A wide variety of ecosystem stressors affect forests, including, at the regional scale, atmospheric deposition and deer browse, while other stressors, such as introduced disease and climate change, are occurring globally. Numerous state, federal, and nongovernmental organizations currently monitor forests throughout the region, but most programs lack coordination that would facilitate information sharing and comparison. Within the National Park Service (NPS), such coordination is essential for effective management.

Under the guidance of the Inventory and Monitoring (I&M) Program, eastern and midwestern national parks and networks are collaborating to ensure that protocols for tracking forest health allow compatibility with one another and with the USDA Forest Service's Forest Inventory Analysis (FIA) and Forest Health Monitoring programs (fig. 1). Participants include eight I&M networks and three prototype parks. Natural resource staff at these prototype parks have established protocols and legacy data for long-term vegetation monitoring. In total, 61 national park units (23% of the parks in the I&M Program) are participating in this collaborative effort. They belong to the Appalachian Highlands, Cumberland Piedmont, Eastern Rivers and Mountains, Great Lakes, Mid-Atlantic, National Capital Region, Northeast Coastal and Barrier, and Northeast Temperate networks. Cape Cod National Seashore (Massachusetts), Great Smoky Mountains National Park (Tennessee and North Carolina), and Shenandoah National Park (Virginia) are also participating as prototypes (fig. 2, page 78).

The overarching goal of the vegetation monitoring programs is to provide a framework for monitoring long-term change over broad spatial scales of the eastern deciduous and northern hardwood forests. Within this context, field staff (1) monitor status and trends in forest structure, composition, and dynamics of canopy and understory; (2) track changes in the regeneration potential of the forest; (3) detect and monitor presence of invasive exotic plants, exotic plant diseases and pathogens, and forest pests; and (4) monitor trends in forest coarse woody debris and availability of snags.

LEFT TO RIGHT: NPS/THERESA MOORE, NPS/THOMAS PARADIS, NPS/JIM COMISKEY, NPS/CAROLYN DAVIS

## History of monitoring and collaboration

Eleven parks were designated in the 1990s as models on which to base the network monitoring programs. Three of these prototypes, Cape Cod, Great Smoky Mountains, and Shenandoah, are located in the eastern United States, and have long-standing vegetation monitoring programs. The accomplishments of the prototype parks provided a model of how to monitor park natural resources. The Natural Resource Challenge funding initiative in 1998 designated 32 I&M networks, creating a framework for coordinated collection of data needed to understand and manage park ecosystems in 270 parks with significant natural resources. The first networks received funding in 2001 and initiated the process of identifying vital signs, a subset of physical, chemical, and biological elements and processes that are indicators of park ecosystem health. By 2006, seven eastern and midwestern networks had identified vital signs related to forest vegetation as being high-priority.

As the first networks began developing protocols for forest vegetation, an important objective was to have methodologies compatible with approaches used by other agencies and institutions. The Forest Service's FIA Program provided a potential model to be followed by the individual networks, though modifications would be required to meet NPS objectives. The first networks, National Capital Region and Northeast Temperate networks, adapted the FIA approach and conducted initial pilot testing in 2005. As more networks identified their vital signs, investigators appreciated the need for collaboration and for learning from the experience of the prototype parks, which had modified their protocols over time.

Over the past four years, the forest vegetation monitoring working group has expanded to include participation of eight networks and three prototype parks. It has made significant headway in standardizing metrics and field methods so that data sharing is possible. In addition, as the working group has developed protocols and conducted pilot testing, it has provided an ideal forum for the review of protocols and results. Thus, networks identifying forest monitoring as a priority later in the process were easily able to adopt these protocols.

*By 2010, the regional forest monitoring program will be largely implemented, including eight networks in four national park regions covering 18 states. Sixty-one parks and three prototypes will have comparable data from more than 2,000 plots.*

## Monitoring methods

The I&M Program provides general guidance but individual networks have the freedom to develop their monitoring programs based on their own specific need, presenting a challenge to protocol standardization at a regional scale. Though plots may vary in size and shape, the collaborative effort has ensured a standardized approach to what is measured within the plots and how. Generally, plots are composed of a main plot area, with embedded microplots, quadrats, and transects (fig. 3, page 79). For the most part, all networks measure trees with a diameter at breast height (dbh) ≥ 4 inches (10 cm) in the main plot, smaller trees and shrubs in microplots, woody regeneration and herbs in the quadrats, and coarse woody debris along transects. Field staff assesses the condition of trees in the main plot, and notes infestation by native and exotic pests. At some parks, staff also collects soil samples outside each plot to evaluate long-term changes in soil chemistry caused by acid deposition. For the vast majority of the metrics collected, the working group has ensured a consistent approach.

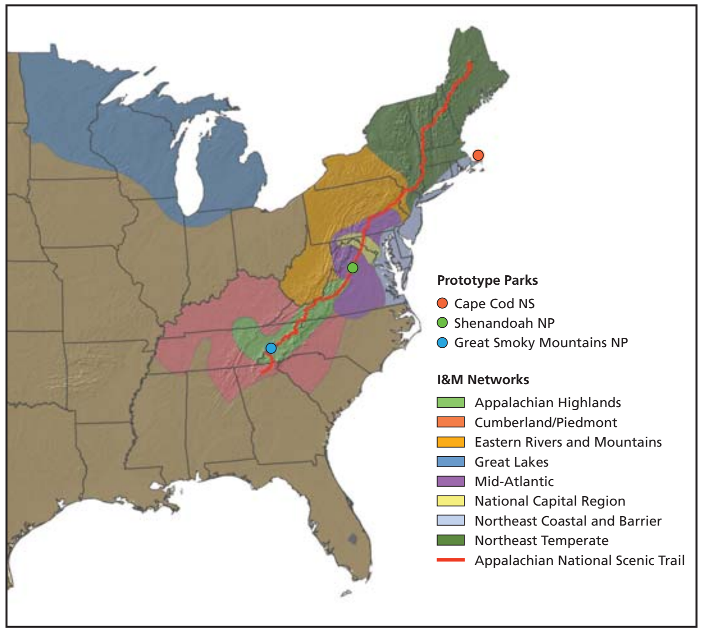


**Figure 2.** Parks and networks collaborating in the eastern forest vegetation monitoring initiative.

## A regional coverage

By 2010, the regional forest monitoring program will be largely implemented, including eight networks in four national park regions covering 18 states. Sixty-one parks and three prototypes will have comparable data from more than 2,000 plots. Parks as far apart as Voyageurs National Park in Minnesota, Great Smoky Mountains National Park in Tennessee and North Carolina, and Acadia National Park in Maine are now monitoring forest vegetation in a comparable way. Information derived from this network is compatible with data collected by the Forest Service's FIA Program and a variety of other state and federal programs that share similar monitoring approaches.

## Reporting results

The forest monitoring group is developing standardized approaches for reporting results. The goal is to ensure that data collected by the parks and networks reach resource managers and decision makers in a timely and usable fashion. Currently two similar approaches are being adopted. The Northeast Temperate Network staff is testing ecological integrity metrics (Tierney et al. 2009) and the National Capital Region Network participants are developing integrated assessment scores (Schmit et al. 2009). Both assessment methods measure the composition, structure, and function of an ecosystem compared with the system's natural or historical range of variation. Threshold values for each metric are defined, and ratings assigned, for example "good" or "significant concern," based on deviation from threshold value. For each metric, sound science supports the definition of these threshold values to ensure credible reporting. The range of ecological systems and conditions across networks means that the threshold values will likely vary throughout the region. Nevertheless, reporting the same metrics will provide a measuring stick for assessing impacts by natural or man-made agents of change as well as the effectiveness of management.

## Initial Findings

A strength of the forest monitoring initiative is the ability to share information across such a wide geographic area, facilitating evaluation of trends in a variety of forest health and condition metrics. Though the program is still being implemented, and for the most part data on the status and trends of forest resources are limited, some preliminary analyses are possible. As an illustrative example, 808 plots in 40 parks belonging to five networks (Eastern Rivers and Mountains, Great Lakes, Mid-Atlantic, National Capital Region, and Northeast Temperate) and two prototypes (Cape Cod and Shenandoah) were combined to evaluate the distribution and extent of exotic plant species. There were a total of 1,557 observations of 136 exotic invasive plant species, representing an average of 1.9 exotic plant species per plot. All parks had plots with exotic plants except Allegheny Portage Railroad National Historic Site, largely due to chance and the low number of plots currently present in the park. The majority of parks had exotic species in over half of their plots (fig. 4). On average,

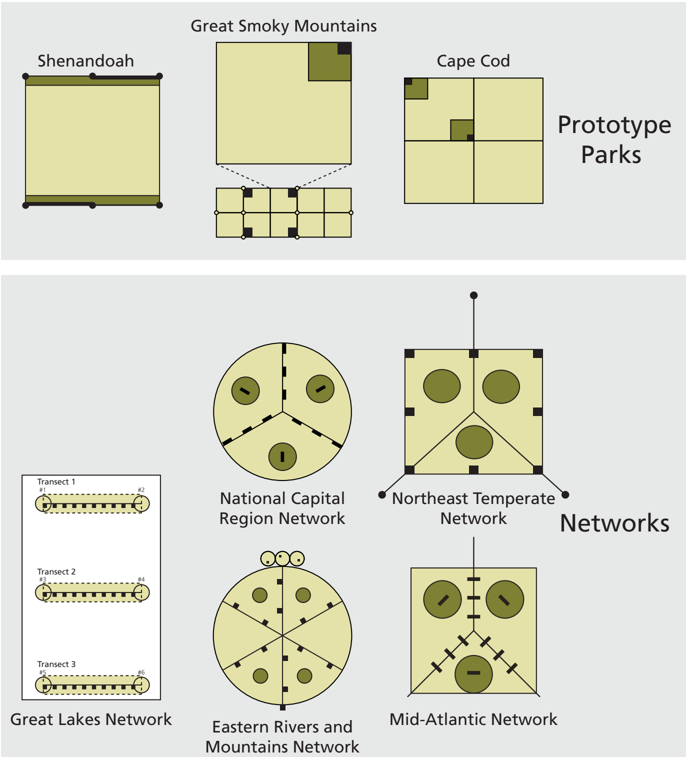


**Figure 3.** Plot configurations used by different parks and networks. Plots are composed of a main plot area (light olive), microplots (olive), and quadrats (black). Some of the plots also include transects (black lines).

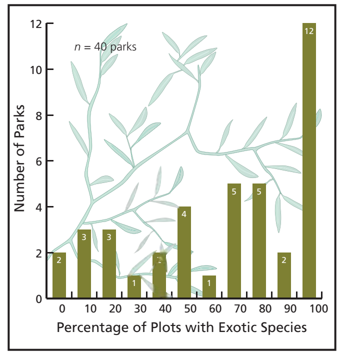


**Figure 4.** Percentage of plots in each park with exotic species. For example, of the 40 parks included in this analysis, two parks had plots with no exotics (0%), while 12 parks had exotics in all their plots (100%).

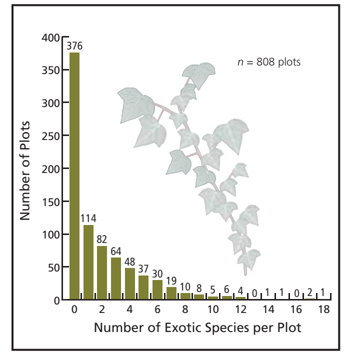


**Figure 5.** Number of exotic species found per plot. For example, of the 808 plots included in this analysis, 376 plots had no exotic species and 114 plots had one exotic species, while only four plots had 15 or more exotic species.

PLANT SYMBOLS COURTESY OF THE INTEGRATION AND APPLICATION NETWORK (IAN.UMCES.EDU/SYMBOLS), UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE

there were 10.9 exotic plant species found per park. Just fewer than half the plots did not have any exotic plant species (47%), while one plot had 18 species (fig. 5). The most common exotic plant species, occurring in more than 100 plots and 20 parks, were *Alliaria petiolata* (garlic mustard) found on 159 plots in 20 parks: *Lonicera* spp. (honeysuckle), on 166 plots in 30 parks; *Microstegium vimineum* (Japanese stiltgrass), on 130 plots in 20 parks; and *Rosa multiflora* (multiflora rose), on 105 plots in 22 parks.

## Integration with management

Park staff and subject matter experts prioritized the vital signs according to their importance for managing park resources, providing managers with information that will allow them to determine appropriate courses of action (Fancy et al 2009). Nevertheless, the forest vegetation monitoring program provides an overall measure of the health and condition of the forests, and not the effectiveness of management actions. For example, over time, monitoring may indicate changes in distribution and abundance of invasive exotic plant species, but does not measure how effective management efforts are; tactical monitoring aimed at evaluating management effectiveness still needs to be implemented by park staff. However, the vital signs forest vegetation monitoring will augment management-based monitoring that the parks are conducting. For example, a park that is managing deer densities to reduce overgrazing impacts on herbaceous plant communities and forest regeneration will need to monitor vegetation to evaluate understory vegetation recovery. Currently, I&M efforts are being incorporated in deer management planning at Valley Forge National Historical Park (National Park Service 2009), but the I&M forest monitoring program does not replace effectiveness monitoring conducted by the park.

## Benefits of the forest monitoring group

The forest vegetation monitoring group's activities resulted in a number of benefits to participants. One advantage is the ongoing collaboration and experience sharing between prototype parks and networks. The prototypes provide a model of how long-term monitoring can be incorporated into park-based natural resource management. The three participating prototype parks have monitored forest vegetation communities for more than a decade and all three have recently redesigned their protocols. The networks

*Though [vegetation monitoring] plots may vary in size and shape, the collaborative effort has ensured a standardized approach to what is measured within the plots and how.*

*Scientists will [likely] be attracted to our parks due to the wealth of information and data related to forest condition.*

have benefited by directly incorporating those components that have strengthened the new prototype protocols. The resulting protocols can also be extended to other regions of the country, including the western portion of the United States.

The working group is also an important sounding board for new ideas and approaches. As the first networks developed draft monitoring protocols, working group participants provided reviews that helped refine the final products. The reviewers were then likely to adopt the same protocols for their own networks, thus ensuring standardization. As results emerged from pilot testing and the first year of implementation, these data were used by other networks to evaluate whether the protocols met their monitoring and sampling objectives prior to conducting their own field-based pilot tests (for example, Comiskey et al. 2009).

For monitoring to be successful, the programs need to be sustainable over the long term. Thus, cost-saving measures and building successful field teams are essential. Working group members are now employing a variety of resource-sharing options that reduce costs and increase monitoring efficiencies. One such example is a combined field team that operates in three networks to implement the forest monitoring plots from Maine to southern Virginia. The combined team further promotes standardized monitoring approaches across the networks and increases opportunities for data sharing.

This collaborative effort creates a model that can be used for developing, implementing, and sharing data from other monitoring protocols. Several participating networks are now exploring other protocols that will benefit from collaborative development. Additional information and resources are located at http://science.nature.nps.gov/im/units/midn/Forest_Monitoring_Meeting.cfm.

## Future direction

Forests form an important habitat matrix for a wide variety of plants and animals in the eastern and midwestern United States. As stresses on these forests increase, the I&M Program will monitor their effects on forest composition and dynamics across latitudinal and altitudinal gradients, for example, individual responses of plant species or pest and pathogen effects in relation to climate change. Such regional analyses require continued standardization and refinement of the monitoring methods. As protocols are finalized and implemented, the focus will shift to data sharing, regional analyses, and combined reporting. Over time, it is likely that scientists will be attracted to our parks due to the wealth of information and data related to forest condition. Such intellectual investment will benefit park natural resource management.

## References

Comiskey, J. A., J. P. Schmit, and G. Tierney. 2009. Mid-Atlantic Network forest vegetation monitoring protocol. Natural Resource Report NPS/MIDN/NRR–2009/119. National Park Service, Fort Collins, Colorado.

Fancy, S., J. Gross, and S. Carter. 2009. Monitoring the condition of natural resources in US national parks. Environmental Monitoring and Assessment 151:161–174.

National Park Service. 2009. White-tailed deer management plan/environmental impact statement. National Park Service, Valley Forge National Historical Park, Pennsylvania.

Schmit, J. P., G. Sanders, M. Lehman, and T. Paradis. 2009. National Capital Region Network long-term forest monitoring protocol. Natural Resource Report NPS/NCRN/NRR–2009/113. National Park Service, Fort Collins, Colorado.

Tierney, G., B. Mitchell, K. Miller, J. Comiskey, A. Kozlowski, and D. Faber-Langendoen. 2009. Long-term forest monitoring protocol and SOPs for the Northeast Temperate Network. Natural Resource Report NPS/NETN/NRR–2009/117. National Park Service, Fort Collins, Colorado.

## About the authors

### Primary authors

***Jim Comiskey*** *is coordinator of the Mid-Atlantic Network. He can be reached at 540-654-5328 or jim_comiskey@nps.gov.* ***John Paul Schmit*** *is an ecologist with the National Capital Region. He can be reached at 202-342-1443 x221 or john_schmit@nps.gov.* ***Suzanne Sanders*** *is an ecologist specializing in inventory with the Great Lakes Network. She can be reached at 715-682-0631 or suzanne_sanders@nps.gov.* ***Patrick Campbell*** *is coordinator of the National Capital Region Network. He can be reached at 202-342-1443 x229 or j_patrick_campbell@nps.gov.* ***Brian Mitchell*** *is coordinator of the Northeast Temperate Network. He can be reached at 802-457-3368 x37 or brian_mitchell@nps.gov.*

### Other work group members

*Geri Tierney, Wendy Cass, Kate Miller, Fred Dieffenbach, Stephen Smith, Mike Jenkins, Stephanie Perles*