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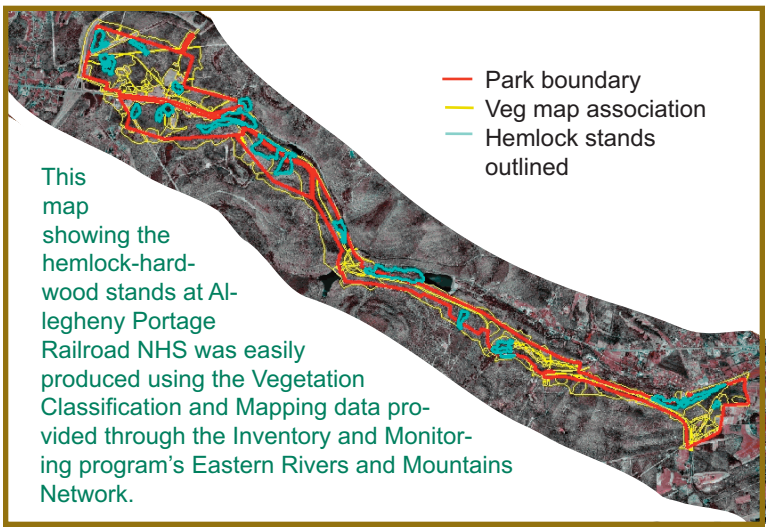
Inventory and Monitoring Data and Hemlock Woolly Adelgid Control Planning

By Kathy Penrod, Natural Resource Specialist; Diane Garcia, Park Interpretor; and Matt Marshall, Eastern Rivers and Mountains Network Program Manager

"What can we do to prevent the hemlocks from dying?" was the first thought of Natural Resource Management Specialist Kathy Penrod when she got the news from the US Forest Service (USFS) that hemlock woolly adelgid (*Adelges tsugae*, HWA) had invaded some hemlock-hardwood stands at Allegheny Portage Railroad National Historic Site (ALPO). To plan possible control efforts, Penrod needed to investigate the extent of the infestation and plot the location of the hemlocks (*Tsuga canadensis*) in the park. She quickly referenced the Vegetation Classification and Mapping at Allegheny Portage Railroad National Historic Site report and data (http://www.nps.gov/nero/science/FINAL/ALPO_veg_map/ALPO_veg_map.htm) that was provided by the Eastern Rivers and Mountains Network (ERMN). With the report, she found the table listing areas of hemlock-hardwood stands - just about 40 hectares or 100 acres. A glance at the color-coded map showed that all were at the Main Unit; no hemlocks had been found at the Staple Bend Tunnel Unit. That narrowed the problem to the eight-mile stretch between Duncansville and Cresson, Pennsylvania.



This map showing the hemlock-hardwood stands at Allegheny Portage Railroad NHS was easily produced using the Vegetation Classification and Mapping data provided through the Inventory and Monitoring program's Eastern Rivers and Mountains Network.

Using a geographic information system (GIS), Penrod called up the vegetation mapping data and highlighted the hemlock-hardwood stands. The data attributes table gave her the area of each stand. Comparisons to the park boundary showed which stands were entirely within the park, and which crossed the park's borders.

With that information in hand, park management began prioritizing stands for control by looking at land ownership, cultural and natural resource value, topography, potential for hazard trees, and difficulty of hazard tree removal. USFS staff providing technical assistance to the park used the vegetation mapping information and park priorities to begin their evaluation of the hemlock-hardwood stands.

Some stands were a higher priority for control of HWA than others. One forest type, dry Eastern hemlock-oak, was found in only two places at ALPO. These stands were infested by HWA and were a high priority for control because of their rarity. Stands near the visitor center and picnic area were also a high priority for control because of their natural and cultural resource value, heavy visitor use, and potential for hemlocks to become hazard trees if they should die. Fortunately, HWA had not infested the higher elevation stands near the visitor center or picnic area. However, should monitoring reveal an infestation, these stands would become the park's highest priority for control.

ALPO may not try to control HWA in all hemlock-hardwood stands and in these cases it is important to understand what resulting impacts may occur. At the Muleshoe area, most of the stand was beyond the park boundary, and the adjacent landowner, Altoona City Authority, did not want to use chemical treatment in this stand. There, the presence of three public water supply reservoirs in close proximity to ALPO would limit the use of chemical methods in the floodplains and stormwater

drainages of the water supply intakes. However, biological controls may still be possible.

When planning for control progressed, Penrod needed to consider the effects to other natural resources as well as effects to hemlocks. If no control is undertaken, or if hemlocks die despite attempts to control HWA, infested stands would likely lose their hemlock component and revert to the hardwood type now sharing each site. That is what Penrod expected to happen at the hemlock/sugar maple floodplain forest at the Muleshoe area. Likely, it would become a sugar maple floodplain forest when the hemlocks die.

Other changes that might occur involve animal resources and invasive plants. The Level I Water Quality Inventory project coordinated by the ERMN included a special Assessment of Wild Trout Populations in Blair Gap Run (http://science.nature.nps.gov/im/units/ERMN/reports/ALPO_633643_WildTrout_TzilkowskiAndSheeder_NPS_NER_NRTR_2006_067.pdf). Brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) were found to occur and reproduce at the Muleshoe area, and changes to water temperature might occur as hemlocks die, affecting these trout populations. Penrod expects that, if hemlocks die, warmer water temperatures could favor the nonnative brown trout and negatively affect the native brook trout.

A study on Connecticut forest bird communities looked at effects of hemlock mortality on 49 bird species. Penrod again turned to an early ERMN inventory project, this time pulling out the well-worn copy of the Comprehensive Inventory of Birds at Six National Parks (http://www.nps.gov/nero/science/FINAL/Birds6parks/Birds6parks.htm) including ALPO. She found that 47 of the 49 species occurred at ALPO. Likely, effects on these bird species at ALPO would be similar to the effects found in Connecticut. For example, blackburnian warblers, black-throated green warblers, and Acadian flycatchers might decline; early vital signs monitoring also has found these species to be strongly associated with the hemlock-hardwood stands at ALPO. Some species that might increase following hemlock mortality include brown-headed cowbird, tufted titmouse, and woodpeckers.

Other ERMN inventory reports that ALPO used in planning for HWA control are the Inventory of Amphibians, Reptiles and Mammals (http://www.nps.gov/nero/science/FINAL/ALPOJOFL_amphibs/ALPJOFL_amphibs.htm), Distribution and Abundance of Nonnative Plant Species (http://science.nature.nps.gov/im/units/ERMN/reports/ALPO_JOFL_651211_Nonnative-PlantSpecies_Zimmerman_NPS_NER_NRTR_2007_083.pdf), and Rare Plants at Four National Park Service Units. Seven sample plots for the animals' inventory occurred in, or on the edge of, hemlock-hardwood stands. Eight amphibian, two reptile, and seven mammal species were observed at these plots. Of those, none are expected to be extirpated if the hemlocks die, but some effects might occur as their habitat changes. Penrod is especially concerned about salamander species, which could be affected by increased water temperatures if hemlocks are lost near streams.

An analysis of the nonnative plant data showed only low percentage cover by four nonnative species in the hemlock-northern hardwood stands. It seemed likely that garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), oriental ladysthumb (*Polygonum caespitosum*), and Japanese stiltgrass (*Microstegium vimineum*) already present would increase if hemlocks are lost, and new invasions by other nonnative plants might occur. In the hemlock-tulip-tree-birch stands, three nonnative

HWA has not yet reached the stands at higher elevation near the Visitor Center that may be protected by colder winter temperatures. High cultural and natural resource value and potential for hazard trees make this stand a high priority for HWA control if infestation is detected.

This dry eastern hemlock stand at Allegheny Portage Railroad NHS is a high priority for adelgid control because of the rarity of this forest stand type.

US Forest Service staff Karen Felton (left) and Bradley Onken (right) inspect for hemlock woolly adelgid at Allegheny Portage Railroad NHS.

species have the potential to increase. The dry hemlock-oak stands showed no nonnative plant species during the inventory, but the loss of the hemlock component there could lead to new invasions by nonnative plants.

Although the rare plant report for ALPO contained no federally-listed species, two state-listed species and one additional plant species of management concern were documented. Neither of the state-listed plants occurred in any of the hemlock-hardwood stands. However, the report indicated that the management-concern species, ginseng (*Panax quinquefolius*), did occur in one of the hemlock stands. The loss of hemlocks could affect this species' survival.

Vital signs monitoring conducted by the ERMN will help detect long-term changes that may occur in the hemlock stands as a result of HWA. The Vegetation Monitoring Protocol for the ERM (http://science.nature.nps.gov/im/units/ermn/monitoring/VegetationDynamics.cfm) outlines methods that would document changes over time in canopy species, tree mortality, nativity, soil chemistry, and other variables. ERMN's Streamside Bird Monitoring Protocol (http://science.nature.nps.gov/im /units/ermn/monitoring/StreamsideBirds.cfm) and the Benthic Macroinvertebrate Monitoring Protocol (http://science.nature.nps.gov/im/units/ermn/monitoring/VegetationDynamics.cfm) include methods to detect long-term changes in streamside bird communities, and basic water quality and stream insect communities, respectively.

During the planning, Penrod also consulted with USFS and Delaware Water Gap National Recreation Area staff who have been dealing with HWA for a long time. The park's options for controlling HWA include chemical treatment applied by soil drench, soil injection or stem injection methods, several species of biological controls including cold-tolerant strains, a combination of chemical and biological controls, or, perhaps in some stands, no treatment at all. The park likely will use a variety of methods tailored to each specific site.

"Without the I&M studies, management at ALPO would be making decisions for HWA control and other park resource management issues based solely on educated guesses. With the use of inventory data and long-term vital signs monitoring, the park had much useful information on which to make sound, science-based decisions," stated Penrod. She realized that although the battle to control HWA would be difficult, the probability of hemlocks dying could be reduced with proper science, planning, research, and treatment.

Monitors Discover Plight of Least Terns

BOSTON HARBOR ISLANDS NATIONAL RECREATION AREA: Lovells Island has historically supported a breeding colony of state-listed least terns (*Sternula antillarum*), which lay their eggs right on the gravel beach. A vital sign for the Northeast Temperate Network is the health of coastal breeding bird populations including least and common terns. In keeping with the protocol for monitoring these birds, monitors were walking the beach in the spring of 2007 doing nest and egg counts, and noticed that some of the nests had been attacked by predators. Within the week, they discovered that all the nests had been destroyed. The monitoring, says park Stewardship Program Manager Marc Albert, alerted the park to the issue and facilitated a cooperative project with mammalogist Dr. Lauren Nolfo-Clements of Suffolk University. In spring 2008, Dr. Nolfo-Clements placed empty quail eggs near the colony location and set up motion-sensitive cameras to detect predators. The resulting images showed nest destruction visits by American crows (*Corvus brachyrhynchos*), brown rats (*Rattus norvegicus*) and, most surprisingly, European rabbits (*Oryctolagus cuniculus*). Unfortunately, monitoring has shown that terns have not returned to Lovells Island in 2008 or 2009.

Least tern nest--the eggs are laid directly on the beach. Photo: Carl Johnson.

Forest Monitoring Informs Deer Management

At Valley Forge National Historical Park, forest vegetation monitoring provides the feedback necessary to evaluate the impact of deer browsing and to indicate the effectiveness of the proposed deer management program. The park is a green oasis in a busy suburb of Philadelphia, but its forest understory has been browsed clean. For several decades, park managers have watched the deer population increase as forest regeneration and native biodiversity have diminished. In 2009, the density of the deer population had reached 241 per square mile. Before European settlement in this country, deer density is estimated to have been between 8 and 11 deer per square mile.

In 1992, park managers established 30 paired plots, fenced and unfenced, to compare species richness and abundance in the presence and absence of browsing deer. Data on trees, shrubs, vines and herbaceous plants, and tree seedling counts, were collected in 1993, 1995, 1998 and 2003. Data showed that, over time, species richness increased significantly in fenced plots and tree seedling counts were generally higher in fenced plots compared to unfenced plots. On average, only 28% of species present in the fenced plots were found in the unfenced plots.

Unfenced plots in the park have not demonstrated acceptable levels of tree regeneration since 1995. The guideline for acceptable seedling abundance is defined as 25 seedlings per 12.57 m^2 (135 ft^2). The percentage of plots with at least that number of seedlings is the stocking rate. In 1993, the stocking rate at Valley Forge in both fenced and unfenced plots was 3%, that is, only 3% of plots exhibited an adequate number of tree seedlings to ensure forest regeneration. By 2003, the stocking rate in the fenced plots was 27%. In the unfenced plots it was zero.

Those numbers say that the park's forests will not flourish under current conditions. Biodiversity is declining, as is the forest's structure and composition. The park has therefore produced a "White-tailed Deer Management Plan/Environmental Impact Statement" that supports protection, preservation, and restoration of native vegetation and other natural and cultural resources. A full range of reasonable alternatives was developed using the best available science and input from the public. The management plan has been available for public review and comment and, if accepted, will be implemented in the fall of 2009. The NPS preferred alternative proposes lethal actions (sharpshooting and capture and euthanasia) to reduce the size of the deer population to the desired deer density of 31-35 deer per square mile and non-lethal actions (reproductive control) to maintain the population at this level into the future. The deer density suggested in scientific literature as necessary to promote forest regeneration ranges from 10 to 40 deer per square mile. The desired density for the park is based on estimated population size in 1983, when forest health was described as "excellent." This number may be modified, up or down, over time based on the results of long-term monitoring.

Since the 1992 forest monitoring plots were established, the Mid-Atlantic Inventory and Monitoring Network (MIDN) has come into being and has expanded the forest monitoring. The park will maintain the old plots while the network establishes new plots (unfenced) according to its peer-reviewed Forest Vegetation Monitoring Protocol. Monitoring will inform the adaptive management approach used by the park to determine whether the deer management actions have been successful in achieving plan objectives to promote native plant and wildlife communities and ensure adequate tree and shrub regeneration.

The forest vegetation monitoring program is also being implemented in other parks in the MIDN, and by other networks across the region. Monitoring forest regener-

On the left, an unfenced plot where deer have been free to browse. On the right, a fenced plot with an understory.

ation not only provides feedback for parks that are managing ungulates, but also other parks concerned about various aspects of forest management. Altered patterns of regeneration detected in the monitoring plots will alert managers to the need for research to determine the cause and suggest recommendations for proper management actions. As an example, staff at Hopewell Furnace NHS, located just west of Valley Forge NHP, was concerned that deer may be damaging forests in the park. Evaluation of the first years of regeneration monitoring by MIDN indicates that this may not be the case. The park is surrounded by state forests where deer are hunted and although deer are very visible around the village in Hopewell Furnace NHS where they are attracted to the orchards, monitoring data show that their densities are not adversely impacting the surrounding forest regeneration. Monitoring provides the data that park staff need to plan management actions that respond to actual, but not always obvious, conditions.

To see the report on the park's monitoring project, go to *Statistical Analysis of Understory Vegetation Data from Valley Forge National Historical Park 1993-2003* http://www. nps.gov/nero/science/FINAL/VAFO_understoryveg/VAFO_understoryveg.htm

For the Valley Forge NHP deer management plan, see *White-tailed Deer Management Plan/ Environmental Impact Statement* http://parkplanning.nps.gov/document.cfm?parkId=284&projectId=16911&documentID=25318

Rare Swamp Community, Rare Orchid

Coastal Plain/Piedmont Acidic Seepage Swamp at Richmond National Battlefield Park.

Small whorled pogonia in bloom.

Robert H. Mohlenbrock @ USDA-NRCS PLANTS Database / USDA NRCS. 1995. *Northeast wetland flora: Field office guide to plant species.* Northeast National Technical Center, Chester

MID-ATLANTIC NETWORK: Although the I&M program in the Mid-Atlantic Network is relatively new and parks have not had an opportunity to see trends emerge from monitoring, inventories have produced some interesting results. Three parks in the Mid-Atlantic Network, Richmond National Battlefield Park, Petersburg National Battlefield, and Fredericksburg Battlefield Memorial National Military Park, were known to have swampy areas, but not until vegetation mapping and classification was done did staff learn that their acidic seepage swamps were globally significant. This community is called "Coastal Plain/Piedmont Acidic Seepage Swamp" or *Acer rubrum-Nyssa sylvatica-Magnolia virginiana/Viburnum nudum var./Osmunda cinnamomea-Woodwardia areolata* Forest. It occurs along the east coast from southeastern New York to southeastern Virginia and extends into the extreme eastern portion of the piedmont. This association is ranked G3, meaning that it is vulnerable globally and has only between 21 and 100 occurrences.

The Virginia Department of Environmental Quality had classified some streams in other swampy areas as impaired because of low pH. The NPS inventory determined that the low pH was related to the acidity of the swamps and was a natural condition. Now, the streams are no longer listed as impaired.

And, at Fredricksburg and Spotsylvania County Battlefields Memorial National Park, the crew doing vegetation mapping discovered the federally threatened small whorled pogonia (*Isotria medeoloides*), a delicate orchid not previously documented in the park.

I&M Data Protect Wildlife and Rare Plants

By Robert Cook, Wildlife Ecologist; Megan Tyrrell, I&M coordinator; and Steve Smith,I&M Plant Ecologist

At Cape Cod National Seashore (CACO), construction and maintenance activities are routine. Roads, parking lots, and bike trails are resurfaced, updated, and sometimes re-aligned, and park infrastructure is repaired and maintained. All of these activities can impact nearby wildlife and vegetation where sensitive habitats are disturbed, and small wildlife may be killed as work crews and heavy equipment go about their business.

Minimizing negative impacts, particularly to threatened and endangered species, is an important aspect of the planning and implementation of these activities. To aid in this process, park managers and planners consult data on park vegetation and wildlife generated by the Inventory and Monitoring (I&M) program. This includes both data from formal inventory and monitoring surveys conducted by CACO staff as part of the efforts of the Northeast Coastal and Barrier Network, as well as data from incidental observations of rare and/or hard to find species. These data, which collectively detail many species' distribution, habitat affinity, and seasonality in the park are important factors in deciding where and when construction can occur. Park managers and planners use this information to determine when construction can be done with the least likelihood of disturbing or destroying wildlife. It also suggests when special action is needed, such as sweeps of the construction area to make sure vulnerable animals are out of harm's way. Similarly, routine maintenance can be scheduled or adapted to take wildlife activities into consideration.

Park activities must comply with local laws, such as the Massachusetts Endangered Species Act and the Massachusetts Wetland Protection Act. Project review under these acts includes consulting the state's Natural Heritage database on rare species occurrences within the park. Often, special conditions are attached to permits from state and local regulatory agencies to minimize impacts to rare species. Most of the data these agencies use as a basis of their environmental review and permit conditions are actually the very data that the I&M program has generated because the I&M staff share data on state-listed species in the park with the state's Natural Heritage program.

The park has significant populations of the eastern spadefoot toad (*Scaphiopus holbrookii*, state threatened) and eastern box turtle (*Terrapene Carolina*, special concern). Several projects and routine operations have been influenced by considerations for these species. In recent work to rehabilitate a bike trail through the Province Lands area of the park, which includes prime habitat for spadefoot toads, decisions on re-alignment were guided by knowledge of breeding sites, and construction was scheduled for the cold months, partly to avoid conflicts with their activity season, as well as that of box turtles.

Eastern spadefoot toad, state threatened in Massachusetts. Photo: Brad Timm

Mowing operations, although important for a number of reasons, can be particularly hazardous to the terrestrial box turtle. These turtles hibernate in the forest where winter cold temperatures are less extreme than in open areas. In late April they are found at the edges of fields, and in June and July they lay eggs in the fields. Aquatic turtles also come onto land to lay eggs in open fields in June and July. In those areas of the park where box turtles are common, two approaches to mowing are used to minimize impacts to turtles. Where mowing is infrequent, designed to maintain open habitat, it is done between November and mid-

Eastern box turtle, species of concern. Photo: Robert Cook

Broom crowberry, a shrub that is regionally and globally rare.

April, which is outside of the box turtle activity season. Where mowing is done to maintain lawns, it must be done during the warm months, when box turtles and snakes are active. In this case, frequent mowing makes it easier to spot any turtles present. If the grass is long enough to obscure a box turtle, staff check ahead of the mowers and chase off any other animals that may be present. Because warm season mowing has the potential to kill box turtles and nesting birds, parks engaged in mowing, particularly to restore and maintain open fields, are well advised to inventory these habitats first.

As with wildlife, I&M vegetation data allow managers to evaluate both special projects and routine activities for their impacts to sensitive plant species and communities, and for their potential to encourage invasive nonnative species. Having thorough and up-to-date rare plant surveys allows for quicker, more efficient planning, review, and impact analysis. At Cape Cod, broom crowberry (*Corema conradii*) is locally common. In Massachusetts it is species of special concern. Regionally and globally it is rare. Because the park is one of the most significant sites for this species, data on its distribution here are used to evaluate project location and implementation to minimize their impacts. For example, the construction of a new water tower and fire cache relied upon detailed maps of broom crowberry locations.

The golden club, state threatened.

Another example of how park management is guided by I&M data is an ongoing attempt to discourage Canada geese from grazing on a state threatened aquatic species – the golden club (*Orontium aquaticum*). Historic data and photography along with more recent monitoring has shown that this species has declined from many thousands of plants to under 100 throughout the permanent ponds of the Province Lands region of CACO. Although there has been no significant change in hydrology or water quality in this region, and because goose grazing of the species has been repeatedly observed, actions have been taken to encourage the geese to locate elsewhere.

Data on invasive plant species distributions and their behavior are critical to any project that causes vegetation or ground disturbance because such activities can encourage the spread of nonnative plants. This risk can be eliminated or minimized by (1) pre-emptive control of nearby source populations, (2) examination of alternative locations or methods, and (3) post-project monitoring and management. In some cases, a more proactive approach has been taken that involves active seeding or planting with natives immediately after soil disturbance. The I&M program has generated a plethora of useful data and maps on invasive species, and as a result, their locations, population size, and potential to increase in abundance are fairly well understood.

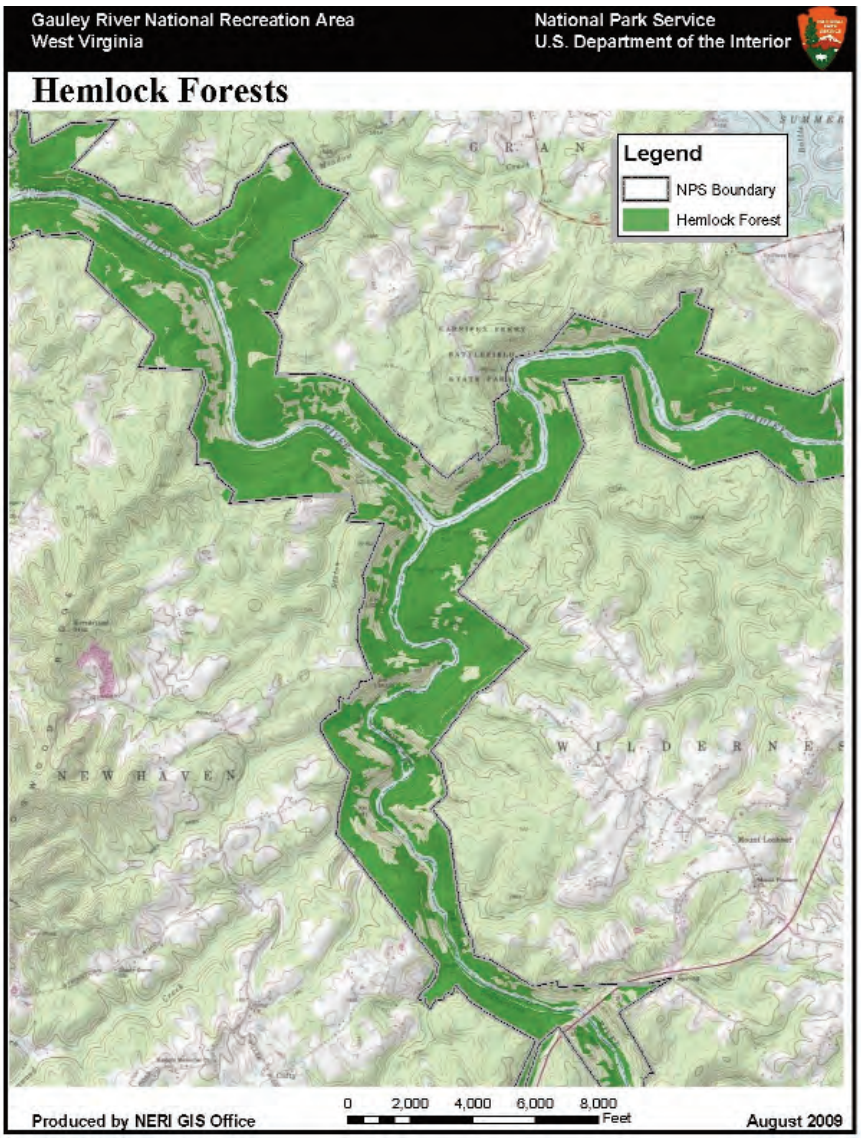
Knowledge gained from the I&M program about where vegetation of interest is located or where and when vulnerable wildlife is found can make the difference between activities being conducted in a manner that protects park natural resources from impairment or that threatens them. Although very basic, and perhaps not glamorous, data generated by the Cape Cod National Seashore I&M program have gone a long way toward making the park's routine operations and construction and rehabilitation projects harmonious with our mission to protect the park's natural resources.

Data from Vegetation Classification Project Yield Species Maps

"The data resulting from the vegetation classification and mapping projects is incredibly rich," says John Perez, biologist for three West Virginia national parks. He has used these data to create maps that show the location of particular species. Maps of individual species are consulted in planning to control disease and insect outbreaks, protect endangered species, locate important wildlife foraging habitat, and for many other purposes.

Recently, Perez made maps of hemlock stands for New River Gorge National River, Gauley River National Recreation Area, and Bluestone National Scenic River. They were created at the request of the West Virginia Hemlock Working Group, a collaboration of federal, state, non-profit, and private organizations concerned about controlling the devastating spread of hemlock woolly adelgid. For his data, Perez consulted the database containing the information from the sampled vegetation plots and tables in the vegetation mapping reports that show the floristic cover by stratum of each species within a vegetation community. Cover is the percentage of the area of a community type that is occupied by a species in a stratum. Where he found the mean cover for hemlock to be 40% or greater in a stratum or substratum, polygons of that vegetation community were shown on Perez's maps as sites of hemlock stands.

Perez has also made maps for USDA and APHIS locating ash forests in the three parks. Those maps showed polygons of vegetation communities where the forest canopy cover includes an ash component of 10% or greater. Within these ash forest polygons, the parks are planning to establish long-term monitoring plots to measure change over time as the emerald ash borer, a devastating forest pest, begins its destructive march throughout the parks. The emerald ash borer was first detected at New River Gorge National River in 2009.



The plots databases and GIS map layers can also furnish information on plant species important to wildlife. For example, oak-hickory stands and other hard mast species have been mapped to predict potential habitat for small mammals including the rare Allegheny woodrat (*Neotoma magister*). Maps of the location of protected species also allow staff to check on areas where poachers of ginseng, for instance, might be working. From the concise data and the maps produced by the vegetation and mapping projects, managers can easily glean information that they don't even know yet that they need.

Filling Ditches to Restore Marshes

ASSATEAGUE ISLAND NATIONAL SEASHORE: In the 1930s and 40s, before the national seashore was established, all of the tidal salt marsh at Assateague was drained by ditches constructed in an effort to control mosquitoes. Those ditches failed to control mosquitoes, but they did disrupt marsh hydrology by altering how tidal waters move into and out of the marshes and diverting much of the natural sheet flow to ditches. Now park staff are plugging and filling the ditches with beach sand to return to the conditions that existed before the marshes were disturbed. Because all the marshes in the park are ditched and because this was done many decades ago, the park's Chief of Resource Management Carl Zimmerman says "We don't know what 'natural' looks like on Assateague."

In this first year, more than 2000 meters of ditches in a 35-acre marsh have been filled; this is a trial run to test the method for efficacy, observe the resultant changes in hydrology, and evaluate the impact of equipment traffic during consruction (though the equipment is ultra-low-ground pressure) The assessment will be helped by the availability of a protocol for monitoring salt marsh vegetation developed by the Northeast Coastal and Barrier Network as one of its vital signs. Park staff are using the protocol to assess both the recovery of vegetation impacted by the ditch filling process and the longer term response stimulated by a return to more natural conditions.

The hydrologic changes caused by ditching are known to affect numerous measures of marsh health and functionality, including sedimentation and vertical accretion rates (critical in maintaining elevation in the face of sea level rise), water storage capacity, and fish and wildlife-habitat values. Ditched marshes also export more nitrogen to the adjacent estuary where excess nurients are already a significant problem. As the ditches are filled and these conditions are mitigated, other attributes will also be affected. The long term results will likely influence the entire marsh community, but exactly what that will look like remains to be seen.

Tracked truck filling a ditch.

Bio Tech Eric Sherry guiding installation of plugs.

Locating Rattlers, Wood Turtles, and the Best Spot for a Swim Beach

DELAWARE WATER GAP NATIONAL RECREATION AREA: Biologist Jeff Shreiner reports that the amphibian and reptile inventory funded by the Eastern Rivers and Mountains Network (ERMN) identified and mapped timber rattlesnake (*Crotalus horridus*) dens and basking areas in the park. This park straddles two states, New Jersey and Pennsylvania. The timber rattler is endangered in New Jersey and a species of concern in Pennsylvania.

The timber rattlers occupy the high ridges along the spine of the Appalachians. The Kittatinny Ridge, a key habitat, runs through the park. Snakes are especially vulnerable to disturbance as they bask in the sun after emerging from their dens in early spring. Knowing this, when park staff develop new trails, they avoid areas where these snakes are found, both for the protection of the snakes and the hikers. The park also collaborated with the Appalachian Mountain Club, a park coop-

Inventory team conducting rattler survey.

Inventory team surveying for wood turtles.

erator that operates on the Kittatinny, to develop an information and education program to educate Appalachian Trail hikers on how to "share" the mountain with the snakes. Thanks to the ERMN inventory, the rattlers will not be disturbed by human visitors on park trails.

A significant population of wood turtles (*Glyptemys insculpta*), threatened in New Jersey and a species of concern in Pennsylvania, was also identified during the inventory. This species has since been studied in depth. Researchers found that the presence of wood turtles is often associated with cropland; the park has acreage leased to local farmers. With new information on how farming operations may affect turtles, park managers are working with the farmers to make them aware of the turtles so that they can choose crop varieties to plant and harvest whose timing will not harm the turtles. At two sites, native grasses were planted along the edges of cornfields to provide foraging habitat and to buffer key wetlands.

Also to protect rare wildlife, the park used results of wildlife inventories to help locate a new swim beach on the Delaware River. Through the National Environmental Policy Act process, inventory data were used to screen potential sites and analyze effects on state-listed threatened and endangered species.

NPS Natural Resource Condition Assessments (NRCAs)

All parks that are part of the Inventory & Monitoring Network Program are receiving funding from the WASO Water Resources Division for the development of an NRCA. Cooperators from Penn State, Virginia Tech, NC State, and University of Maryland have initially been selected to conduct the assessment projects. Regional management of the assessments is being coordinated by Charles Roman and Mary Foley. As funds become available, parks will be contacted regarding an initial project meeting to define the study design and reporting products.

What is an NRCA: A spatially explicit multi-disciplinary synthesis of existing scientific data and knowledge, from multiple sources, to help answer the question: what are current conditions for important park natural resources?

An NRCA
- is multi-disciplinary (ecological) in scope, though breadth and number of resources/indicators evaluated remains a project level decision
- relies on existing data from NPS and other sources
- reports on current conditions across the entire park
- highlights resource condition threats and concerns to park managers

It does not
- define a park's desired resource conditions
- establish park resource management targets
- recommend specific park management actions or strategies

Expected Uses: A successful NRCA will have practical value to park managers for their ongoing efforts to
- engage in watershed or landscape scale resource partnerships and education efforts
- conduct formal planning at all levels (General Management Plans and Resource Stewardship Strategies)
- report to "resource condition status" performance/accountability measures as defined by the Department of the Interior and the Office of Management and Budget.

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Please let *Science and Management* know of projects and practices at your park or network that might be useful to colleagues elsewhere. Contact the editor at bmb4@psu.edu.

Sound science is the foundation for good resource management decisions. The National Park Service invests in science programs to responsibly protect and manage the precious resources entrusted to our care. The power of this research is multiplied when the information is shared. This publication, *Science and Management*, is brought to you from the Northeast Region's Natural Resources and Science Division. Its goal is to share with park staff, scientists, and the public, the innovative resource management work being done throughout the region.

Dennis Reidenbach, Regional Director

Front Cover photo: Coastal Plain/Piedmont Acidic Seepage Swamp at Richmond National Battlefield Park.
Back cover: Same community type at Fredericksburg and Spotsylvania National Military Park