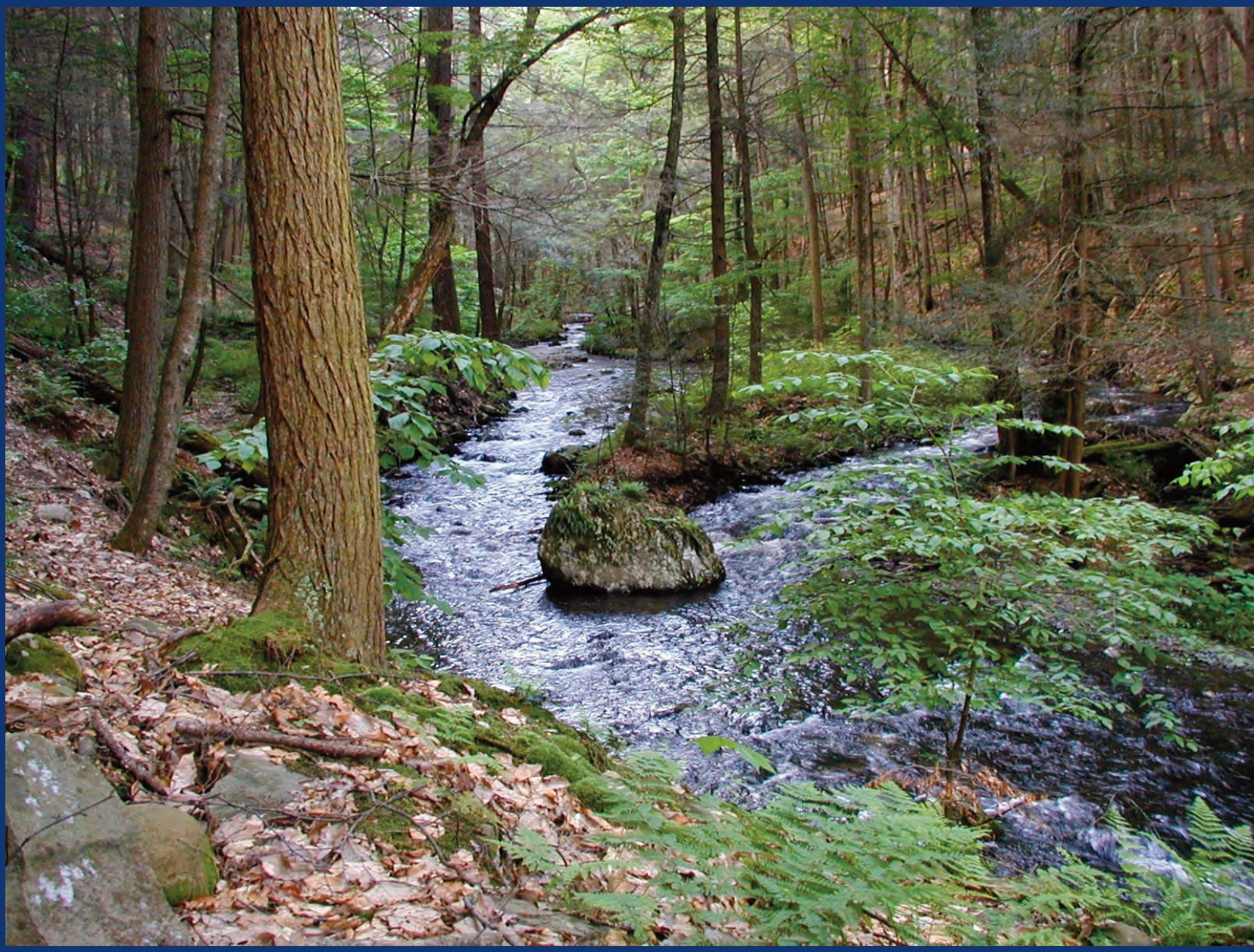
Northeast Region
Natural Resources and Science

National Park Service
U.S. Department of the Interior

Science and Management



Winter 2009-2010

Don't Move Firewood **2**
Combined Effects of Hemlock Decline, Deer, and Exotic Plants--Research at Delaware Water Gap **4**
Managing Mosquitoes for Public Health at Fire Island 8
Toxic Spill and Cleanup Threaten Resources at Saratoga **11**

Don't Move Firewood!

The National Park Service is addressing the widely recognized problem of the spread of devastating forest insect infestations by the movement of firewood from infected areas to as yet healthy forests. In October 2008, the National Park Service circulated a set of recommendations for preventing the dispersal of these pests via firewood transport. The recommendations include educating concessioners, employees, and visitors, and noting the sources of firewood carried in by visitors to analyze degree of risk coming into a park. In the Northeast Region the major threats are the emerald ash borer, (*Agrilus planipennis*), the Asian longhorned beetle *(Anoplophora glabripen nis*) that attacks hardwoods, and the Sirex woodwasp (*Sirex noctilio*), a killer of pine trees. National parks, open to visitors all along their boundaries and river banks, face a big challenge in protecting their forests from these imported threats.

In the Northeast Region the major threats are the emerald ash borer, the Asian longhorned beetle, and the Sirex woodwasp.

Shenandoah National Park is implementing a ban on all firewood brought into the park. Until March 1, 2010, wood coming from within 35 miles of the park is permitted, but after that date, reports biologist Rolf Gubler, all firewood or wood scraps that enter the park must be burned immediately on site or double-bagged and left inside the vehicle that carried it. Park campground staff spot the firewood and inform the visitors of the ban, and they will be especially alert to vehicles with license plates from the Midwest, where these insects are established. When visitors apply for campground

reservations, they receive information about the ban along with their reservations. Visitors also receive information from the park's website, newspaper, signs, posters, radio message, press releases, and ranger contacts. Early education is essential, so visitors don't just show up with their firewood at the entrance station.

Campers need firewood, and it is available in the park. Hazard trees (dead and down only) and fallen branches can be found along the Skyline Drive for visitors to collect. Firewood can also be purchased from concessioners whose supply comes from four nearby woodlots that are monitored with traps for emerald ash borers, Shenandoah's primary insect concern. If emerald ash borers are detected in these traps, the woodlot will no longer be used.

Enforcement of the ban at Shenandoah, or of regulations at other parks, may be difficult. The Superintendent's Compendium, where the Code of Federal Regulations is adjusted to the circumstances at each park, is the place where new firewood laws can be promulgated. At Delaware Water Gap National Recreation Area, a park with territory in two states (PA and NJ, and is adjacent to NY), staff is trying to formulate law pertaining to firewood for the compendium, to be enforced by rangers.

Enforcement of the ban [at sprawling parks with open boundaries and waterways] may be difficult.

How can an effective quarantine be realistically and effectively enforced? In large parks there will never be enough law enforcement rangers available to patrol the entire park, especially where visitors can paddle down the river and make camp on the bank or enter from the many roads that run through the park. Delaware Water Gap, like many other parks, has private inholdings where there may be little enforcement of local or state law, (e.g., Pennsylvania bans wood brought across state lines). Larry Hilaire, wildlife biologist at Delaware Water Gap, notes that where infested trees have been cut there is fear that people might collect this for firewood, despite the quarantine, and take it wherever they please. At this park, Asian longhorned beetle is the number one threat; it's already been reported on Long Island in New York and Jersey City, New Jersey.

Education is the best hope for dealing with the problem, says Hilaire. Outreach efforts produced by the parks and other agencies, such as the posters pictured on the opposite page, are vital sources of information that may persuade the public of the consequences of assisting the forest invaders in their rampage.

Sirex noctilio Fabricius

The female Sirex woodwasp injects a toxic mucus and a fungus while she is laying her eggs. She seems to prefer pine trees already suppressed or stressed. The mucus prevents anti-fungal toxins from being formed at the site of infection, quickly killing tree cells from the egg-laying site upwards. The fungus grows in the wood causing it to dry out and the trees die in a few weeks or months. The fungus feeds on the killed wood, and the insect larvae actually feed on the fungus. As larvae grow, they bore galleries deep into and through the wood, unlike bark beetles, which typically confine themselves to the cambium layer, just under the bark.

Photo: David R. Lance USDA APHIS PPQ

Combined Effects of Hemlock Decline, Deer Herbivory, and Exotic Plants Escalate Management Challenges

By Richard Evans, Ecologist, Delaware Water Gap National Recreation Area

"Nature in the 21st century will be a nature we make; the question is the degree to which this molding will be intentional or unintentional, desirable or undesirable."
- Dr. Daniel Botkin (1990)

Many parks in the eastern United States are experiencing combinations of hemlock decline, high deer population densities, and exotic plant invasions. A series of recently published studies conducted at Delaware Water Gap National Recreation Area (DEWA) has revealed significant interactions among these factors that have important implications for park management. Taken together, these studies indicate that failure to address the "triple threat" of hemlock decline, deer herbivory, and invasive plants in an integrated manner could result in the unintended and undesirable consequence of park forests full of exotic plants.

Researchers Anne Eschtruth and John Battles of the University of California – Berkeley studied ten eastern hemlock stands at DEWA for four years, from 2003 to 2006. All of these stands had been infested with hemlock woolly adelgid (*Adelges tsugae*) prior to 2003 and exhibited various levels of hemlock decline (Table 1). In each hemlock stand Dr. Eschtruth established 18 vegetation plots, 20 deer pellet plots (as an index of deer density within each stand), and 40 deer exclosure plots (fenced) with paired control plots (unfenced). She measured the amount of sunlight that could pass through the forest canopy as well as the types and abundance of plants in each of the 400 pairs of deer exclosure and control plots in 2003 and again in 2006.

Because hemlock trees create a very dark shade, and hemlocks account for more than half of the trees in these stands, hemlock decline can result in large increases in the amount of light reaching the forest understory (Table 1). In many healthy hemlock stands, less than 5% of incident sunlight passes through the forest canopy to reach the understory.

The researchers also estimated seed availability (propagule pressure) of three species of exotic plants at each of the plots: garlic mustard (*Alliaria petiolata*), Japanese stiltgrass (*Microstegium vimineum*), and Japanese barberry (*Berberis thunbergii*). Seed availability for each exotic plant species was calculated by two methods: a seed rain index (based on seed production, dispersal distance, and the distance to a study plot), and a seed bank germination index (greenhouse study).

These measurements produced an abundance of detailed data that enabled the researchers to develop sophisticated statistical models to identify and quantify the influences and interactions among hemlock decline, deer herbivory, and exotic plant seed availability. Results and conclusions were presented in three recent publications, each assessing a different aspect of these interactions. Man-

Table 1. Characteristics of the 10 hemlock stands studied.

Hemlock Stand Characteristic	Range of Values
hemlock trees in stand in 2003	52 – 84 %
2003 hemlock trees in severe decline or dead	1 – 82 %
2003 vascular plant cover	2 – 20 %
2003 light available	6 – 16 %
2006 light available	8 – 28 %
Ave. deer density index (# / km^2)*	5 – 23

*Average of three summer and two winter estimates, from 2004, 2005, and 2006.

agement-relevant results and conclusions of the studies include the following:

Deer herbivory alters forest response to hemlock decline (Eschtruth and Battles 2008).

- Deer herbivory had a relatively severe impact on black gum and eastern hemlock saplings even at relatively low deer densities. Black gum and hemlock were more severely impacted by deer herbivory than the other tree species.

- The negative effects of deer herbivory on red maple, sugar maple, black birch, and chestnut (rock) oak saplings increased exponentially--not linearly--with increasing deer density.

- Hemlock decline (increasing light availability) magnified the negative impact of deer herbivory on a number of native species (Figure 1). "Deer densities should be lower in declining hemlock stands than in healthy stands to maintain the same level of herbivory impact."

- "Deer herbivory may significantly alter forest successional trajectories" following hemlock decline.

Deer accelerate exotic plant invasions (Eschtruth and Battles 2009a).

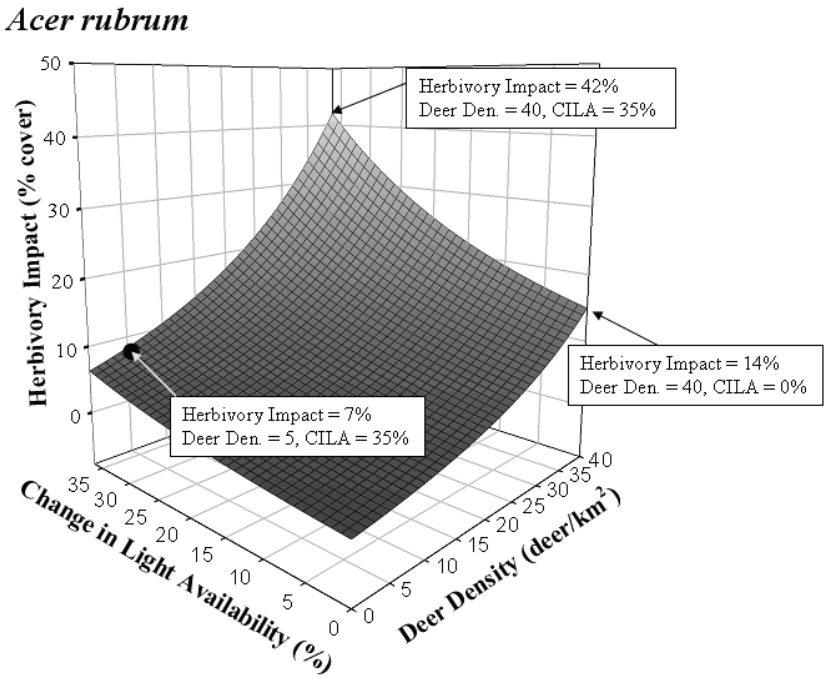
- Overall, deer had significant, exponentially positive effects on the abundance of the exotic plants studied (Figure 2 A).

- Garlic mustard benefited most positively from deer, stiltgrass benefited least.

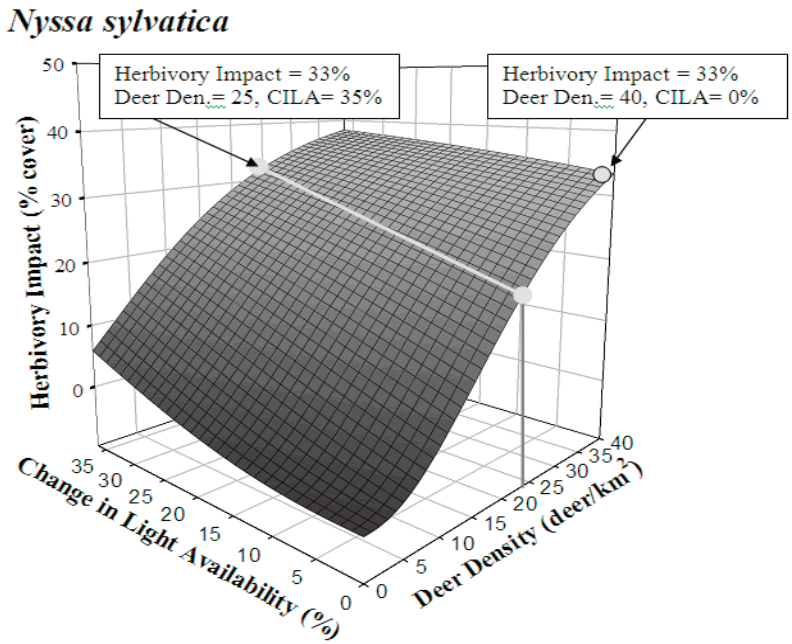
- "Deer can accelerate the invasion of exotic plants, and hemlock decline interacts with herbivory to magnify the effect."

Assessing the relative importance of hemlock decline, herbivory, exotic plant seed availability, and plant diversity in exotic plant invasion (Eschtruth and Battles 2009b).

Figure 1. Negative impacts of deer herbivory on regeneration of native trees is magnified by hemlock decline (increasing light available).



A. Red maple: Herbivory impact increased exponentially (not linearly) with increasing deer density, and also with increasing light. The combination of high light with high deer density produced herbivory impacts much greater that that of high deer density alone. The herbivory impact with 35% change in light availability and 40 deer/km² is three times higher than that with the high deer density alone (42% vs. 14%) and six times higher than that with high light and 5 deer/km² (42% vs. 7%).



B. Black gum: Herbivory impact increased with increasing deer density and increasing light. However, herbivory impact on black gum approached a maximum "total impact" level at either high deer densities, or moderate deer densities combined with high light availability. For example, the herbivory impact of 25 deer/km² with a 35% change in light available equalled the impact of 40 deer/km² with no change in light available, and herbivory impact increased relatively little with additional increases in deer density.

- Overall rates of invasion between 2003 and 2006:
42% of plots invaded by garlic mustard
23% of plots invaded by stiltgrass
15% of plots invaded by barberry

- For all three exotic plant species, seed availability and hemlock decline were the most important factors determining the extent of invasion.

- Japanese stiltgrass was the least dependent on hemlock decline for invasion.

- Contrary to the commonly held theory that species-rich communities are less susceptible to invasion, pre-existing plant diversity was not a significant factor determining the extent of invasion for any of the exotic plants studied.

- Exotic plant invasion increased exponentially with increasing seed availability, hemlock decline, and deer herbivory levels.

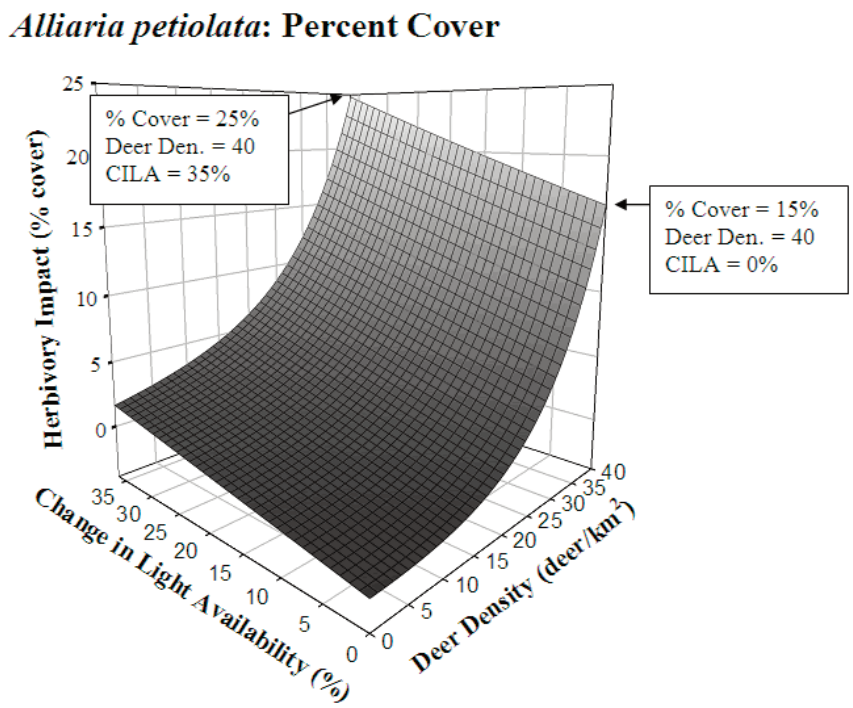
- Healthy hemlock forests (with low light) have high resistance to Japanese barberry. Barberry "didn't increase substantially until relatively high canopy decline."

- "Canopy disturbance magnified invasion at a given propagule pressure" (seed availability), and "propagule pressure intensified invasion at a given canopy disturbance" (Figure 2B).

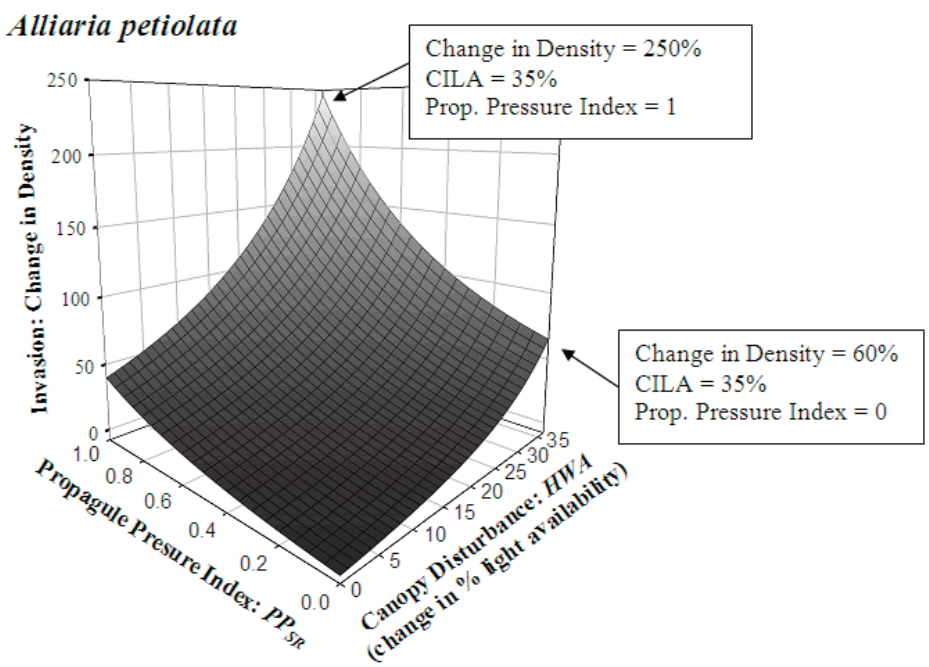
Management Implications and Applications

Results from these studies clearly indicate that as park hemlock stands decline, they are increasingly vulnerable to impacts from deer herbivory and invasions of exotic plants. This is an important issue in many eastern parks like DEWA that have already experienced substantial hemlock decline and mortality. This will likely continue to be an important issue as HWA continues to spread and given our limited ability to prevent hemlock decline and mortality (i.e., we can only save individual trees, not whole forests). In light of these study results, managers should

Figure 2. Effects of deer density, hemlock decline (increasing light available), and propagule pressure (seed availability) on the invasion of garlic mustard (*Alliaria petiolata*).



A. Garlic mustard cover increased exponentially with deer density (15% cover at 40 deer/km^2 and no change in light available), and increased even more with increasing light due to hemlock decline (25% cover at 40 deer/km^2 and 35% increase in light available).



B. Garlic mustard invasion was much greater with a combination of high propagule pressure and hemlock decline (high light levels) than with either of those factors alone.

The canopy opens up as the hemlocks decline. Photo (not taken at DEWA): Courtesy Will Blozan, Appalachian Arborists, Inc.; Asheville, NC

Hemispherical photos were taken at the center of each vegetation plot at DEWA (above) at a height of 1 meter. Gap light analyzer software was used to calculate the fraction of sunlight transmitted through the forest canopy throughout the growing season.

consider the need to reduce or exclude deer populations and suppress exotic plants in declining hemlock stands in order to maintain and regenerate native forests.

Similarly, plans to rehabilitate Childs Recreation Site, another popular visitor use area, include insecticide treatments for hemlock trees, fencing to exclude deer from hemlock stands, and suppression of invasive plants.

threat" of hemlock decline, deer herbivory, and invasive plants in an integrated manner. Failure to do so could result in unintended consequences and undesirable park forests in the future.

[This research] has revealed the importance of addressing the "triple threat" of hemlock decline, deer herbivory, and invasive plants in an integrated manner.

At DEWA, we have applied these study results to a number of planning and management projects in hemlock stands. For example, in 2006 DEWA initiated a Hemlock Reforestation Demonstration Project at Raymondskill Falls Visitor Use Site with funding from the Northeast Regional Science Program. This project included hemlock tree insecticide treatments, construction of a fence to exclude deer from 2.5 acres, and suppression of invasive plants. Japanese barberry, multiflora rose, exotic honeysuckle species, "tree-of-heaven," and garlic mustard have been largely eliminated from this site through repeated herbicide treatments and removal by hand.

We have worked to suppress HWA infestations and exotic plants in more than a dozen priority hemlock stands throughout the park. With support from the USDA Forest Service we have treated more than 8,000 hemlock trees with imidacloprid insecticide at priority sites. With funding from the Northeast Regional Science Program and assistance from the NER Exotic Plant Management Team, we have suppressed Japanese barberry, garlic mustard, and several other exotic plants in 300 acres of hemlock stands.

In conclusion, the research by Eschtruth and Battles has revealed the importance of addressing the "triple

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Monitoring and Managing Mosquitoes for Public Health

Michael Bilecki, Chief, Resources Management, Fire Island National Seashore

At Fire Island National Seashore, mosquitoes are an annoying pest that can sometimes carry disease to wildlife and humans. The Seashore includes resident (human) communities and is adjacent to a dense urban and suburban population. Protecting Fire Island's natural ecosystems as well as public health required the park to develop a program for monitoring and managing mosquitoes that would be acceptable to neighbors. The protocol has been adapted by other parks with similar problems.

Fire Island's Mosquito Surveillance and Management Protocols enable the park to make sound decisions, based on public health threat, for mosquito control on park federal lands.

The south shore of Long Island, which includes the Fire Island barrier island and the William Floyd Estate unit, has some of the most intact and undeveloped salt marshes within the Great South Bay ecosystem. These marshes have naturally functioning ecosystems, despite the impacts of the 1940s ditching projects undertaken to control mosquito populations.

In the mid 1970's, Fire Island National Seashore started coming under pressure by local communities on Fire Island and mainland Long Island to allow Suffolk County Vector Control to expand its mosquito control program within the boundaries of the park. The major concern at this time was the nuisance created by mosquitoes thought to be coming from the park. The National Park Service (NPS) stated that mosquito control would only be allowed if there was a threat of disease. The NPS was and is very concerned about the impact on the naturally functioning ecosystem when using mosquito adulticides and larvacides. The NPS was also uncertain of the validity of statements that the mosquitoes breeding within the marshes of the park's northern shoreline were responsible for the inundation of biting mosquitoes in the communities across the bay from the park.

In early 1980, after years of correspondence between the park and community officials, a new public health issue arose related to eastern equine encephalitis (EEE), a serious mosquito-borne disease that started showing up in and around Suffolk County.

Personal protective equipment used for setting and retrieving mosquito traps.

NPS scientists and U.S. Public Health Service staff advised the park that Fire Island salt marshes were not the habitat from which EEE would be expected to emerge. Scientists with expertise on mosquito ecology, along with park staff, initiated a project to determine the actual impact of Fire Island saltmarsh breeding mosquito populations flying across the bay to communities on the south shore of Long Island.

Utilizing a capture-mark-recapture program over the course of three years, the park determined that on average, 0.15% to 5% of the total mosquito population during any emergence impacted communities up to 0.8 miles from the Fire Island marshes. Utilizing this information, the park was able to make a case that certainly some mosquitoes from the park's salt marshes reached the communities of the south shore, but not nearly enough to cause the park to implement a program of mosquito control (use of adulticide and larvacide aerial applications) within its boundaries. Also, there was the fact that the mosquitoes breeding and hatching in the salt marshes of Fire Island were salt marsh mosquitoes, not the EEE vector mosquitoes in Suffolk County, which are mostly associated with freshwater wetlands.

For almost 10 years, the park was embroiled in a yearly response to the local communities and elected officials concerning its position on mosquito control within the park. In 1998, with the EEE issue active and a newly elected Congressman from the area who threatened to suspend the park's base funding, the issue became one that needed higher-level NPS resolution. A meeting was held in January 1998 with regional and local agency participants that resulted in develop-

ment of the Fire Island National Seashore Mosquito Surveillance and Management Protocols.

These protocols enable the park to make sound management decisions for mosquito control on park federal lands based on public health threat. The representatives at the meeting understood that the NPS needed to relate mosquito control to public health and were satisfied with the NPS actions. The park has recently developed a Mosquito Action Plan that, along with the protocols, reduces mosquito breeding habitat within developed areas of the park. The surveillance protocols outline the steps the park takes from the beginning of the mosquito season, approximately mid May, through September.

Every year since about 2000, the park has been contacted by other NPS areas, other states, local municipalities, and non-government agencies that want to utilize these surveillance and monitoring protocols as templates for dealing with their mosquito control needs. Fire Island staff have also helped other national park system units in working through mosquito management issues.

When the West Nile Virus (WNV) outbreak began in 1999, Fire Island already had its surveillance and monitoring protocols in place, helping the park make decisions about WNV and mosquito control when local communities became concerned about the health risks associated with mosquito populations. As with EEE, WNV is mostly associated with freshwater mosquitoes and Fire Island was in a good position to stress that its surveillance and monitoring protocols would be as important as ever in protecting public health and ensuring that chemical applications for mosquito control would only be used when a public health threat was determined.

Another issue the park has been dealing with is the use of adulticide and larvacide applications on private community lands within its boundaries. The park continues to work with Suffolk county on a plan acceptable for a Special Use permit that would allow use of adulticides and larvacides on private lands within its borders when its protocols have determined a public health threat.

One night's collection on a Fire Island salt marsh equals aproximately 125,000 mosquitoes.

Summary of Surveillance Protocols for Mosquito Management at Fire Island National Seashore

For more information contact the author (Michael_Bilecki @nps.gov)

General criteria for active management within the park:

Presence of WNV or EEE in the park could trigger interventions within the park if intervention would mitigate disease risk to humans.

Interventions can include closing portions of the park to the public, mosquito management methods such as applications of *Bacillus thuringiensis israelensis* (Bti), *Bacillus sphaericus* (Bs), or methoprene to prevent emergences, or adulticide applications to areas with high levels of adult *Culex* spp. or *Aedes sollicitans*. The final decision on all management interventions within Fire Island National Seashore will be made by the park superintendent in accordance with NPS management policies.

Three levels of action, based on stated guidelines for moving to the next higher level of surveillance and management, are proposed: (1) Education and Surveillance, (2) Detection and Public Notification, and (3) Mosquito Management.

Level 1 – Education and Surveillance

Education of the public consists of materials and programs about mosquitoes and their management.

Basic surveillance consists of (1) passive surveillance for dead birds. Reports of bird mortality will be investigated by resource management staff, and candidates for possible viral infection will be submitted for testing; (2) mosquito monitoring including using CO_2-baited CDC (Center for Disease Control) miniature light traps to catch host-seeking females. The CO_2 attracts mosquitoes because their hosts also give off CO_2. Gravid traps (baited for females ready to deposit eggs) will be used, as well as larvae sampled in consultation with Suffolk County and mosquito experts; and (3) viral testing. Mosquitoes captured in the surveillance traps will be sorted to species and sent for viral testing to the state lab.

Most mosquito species have preferred but not exclusive sources from which to draw blood. Catches of over 1,000 female mosquitoes in a CO_2 baited CDC light trap from Fire Island and detection of WNV or EEE virus in birds, mammals, or mammal-feeding mosquitoes (eg., *Aedes vexans*) on Fire Island or at mainland Long Island sites within five miles of Fire Island will trigger an increase to Level 2 surveillance. Detection of EEE virus in bird-feeding mosquitoes (e.g., *Cs. melanura*) will trigger a move to Level 2 if there are signs of higher than normal prevalence.

Level 2 — Detection and Public Notification

If WNV or EEE is detected within the park, visitors will be notified about mosquito densities, realistic possibility of viral infection, and self-protection methods to minimize the number of mosquito bites. Arrangements will be finalized for pesticide application in case conditions warrant such intervtion. Larval management in artificial wetland areas will be intensified and surveillance will continue. Consultation will be initiated with federal, state, and local agencies.

Detection of WNV in a potential human biter (e.g., *Culex salinarius, Ae. sollicitans*, or *Ae. vexans*) and positive bird samples, or of EEE in a potential epidemic vector (e.g., *Ae. sollicitans, Coquillettidia perturbans, Ae. vexans*) in the park will trigger a move to Level 3.

Level 3 - Mosquito Management

The approach to mosquito management will depend on the nature of the disease risk, as projected from the surveillance data.

Intervention when EEE is detected in mosquitoes: Application of adulticide (resmethrin, sumithren, or other approved material) to Fire Island at the site of viral identification and to the barrier island for specified distances in both directions from the identification site(s). Larviciding can occur in natural areas with high larval densities of potential vector species.

CDC light trap used with dry Ice (CO_2 bait) helps determine biting mosquito populations levels.

Intervention when WNV is detected in mosquitoes: Increased trapping to assess risk of human disease. Multiple positive samples in an area with previously-demonstrated epizootic (epidemic) activity could result in adulticide and/or larvicide application.

Intervention when multiple WNV or EEE detections occur in vertebrates in Fire Island National Seashore: Increased mosquito trapping and testing, and increased larval management and/or adulticiding when there is evidence of intensive epizootic activity (e.g., numerous or increasing numbers of positive birds within a two-week period, or positive birds coupled with positive mosquito samples), especially when accompanied by high mosquito numbers.

Intervention when WNV or EEE detections occur outside but near the park, or in enzootic (less than epidemic) vectors within the park, with current or imminent emergence of epidemic vector species within the park: Multiple evidence of WNV in mosquitoes or vertebrates within two miles of Fire Island National Seashore can trigger adulticide application within the park if large populations of *Culex* spp. are in park areas within two miles of the viral isolations. Evidence of EEE within five miles of Fire Island National Seashore, or in *Cs. melanura* within the park, will trigger the consultation process. Park staff will contact the CDC, NY State, Suffolk County, U.S. Department of the Interior, university, and/or other experts as needed. Appropriate interventions will be applied in accordance with NPS management policies.

Above left and center: ***Culex salinarius*** **adult** and **larva** (courtesy of University of Florida, Florida Medical Entomology Laboratory) .Above right: ***Aedes vexans***, Copyright © 2004 Troy Bartlett. Right: ***Coquillettidia perturbans***, © Charley Eiseman,

Spill and Clean-up

Threaten Archeological and Natural Resources at Saratoga NHP

Most Northeast Temperate Network (NETN) parks were established for their cultural resources but they have now become important to the maintenance of native biological diversity and ecological integrity in the urbanizing landscapes where they occur, and many of them are threatened by external impacts, especially land use change, habitat fragmentation, and invasive species.

...park staff discourage some traditional visitor activities... in order to minimize the public's exposure to PCBs.

That theme from the NETN website resonates with the issues being managed at Saratoga National Historical Park. The outstanding “external impact” to both cultural and natural resources is the pollution of the Hudson River from decades of releases of polychlorinated biphenyls (PCBs) into the river from two General Electric plants that manufactured capacitors. PCBs are probable human carcinogens and linked to other adverse health effects; fish and other wildlife are also detrimentally affected.

Last summer (2009), dredging of the river sediment began. The contaminated material will be dewatered and is scheduled to be hauled to a facility in Texas. However, in the course of dredging, important archeological remains of several wars, including the American Revolution and the War of 1812, may be destroyed. Archival research has identified locations in the river where there is a high probability of archeological remains. The park is working with its partners at the U.S. Environmental Protection Agency and New York State agencies to insure that a comprehensive pre-dredging underwater archeological assessment is performed.

The U.S. Department of the Interior, the National Atmospheric and Oceanographic Administration, and the New York State Department of Environmental Conservation are the federal and state trustees of natural resources affected by the release of PCBs into the Hudson River. These agencies collaborate in an effort to assess the environmental effects upon those resources. The U.S. Department of the Interior's Fish and Wildlife Service and other state and federal agencies are assessing the damage to biological resources by, among other things, identifying PCBs in the eggs of waterfowl and in the fatty tissue of waterfowl, mink, and other species, including fish.

PCBs also contaminate the Hudson River's floodplain. As a result, park staff discourage some traditional visitor activities, such as fishing and spending time along the shore, in order to minimize the public's exposure to PCBs. Park management also altered vegetation management techniques in order to address safety concerns of staff working in the floodplain.

The park is also dealing with the pressure of urbanization and is working with local municipalities, non-profit organizations, and the American Battlefield Protection Program to raise awareness of the historical significance of events that took place in the park and beyond its borders so that development will not erase history and compromise the context of the historic setting. Satellite photography, used for monitoring the vital signs of land use and land cover, is showing the change taking place on the landscape, demonstrating, to local agencies that can regulate land use, the threats to important sites and viewscapes needing protection.

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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.

Front cover photo: Adam's Creek at Delaware Water Gap National Recreation Area, Karen Felton, USDA Forest Service

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