



## **Early Detection of Invasive Species: Surveillance, Monitoring, and Rapid Response**

*Eastern Rivers and Mountains Network and  
Northeast Temperate Network*

Natural Resource Report NPS/ERMN/NRR—2010/196



**ON THE COVER**

Spotted knapweed (*Centaurea stoebe* ssp. *micranthos*).

Photograph by: Jennifer Stingelin Keefer.

---

# **Early Detection of Invasive Species: Surveillance, Monitoring, and Rapid Response**

## *Eastern Rivers and Mountains Network and Northeast Temperate Network*

Natural Resource Data Series NPS/ERMN/NRR—2010/196

Jennifer Stingelin Keefer<sup>1</sup>, Matthew R. Marshall<sup>2</sup>, and Brian R. Mitchell<sup>3</sup>

<sup>1</sup>The Pennsylvania State University  
School of Forest Resources  
309 Forest Resources Laboratory  
University Park, Pennsylvania 16802

<sup>2</sup>National Park Service  
Eastern Rivers and Mountains Network  
420 Forest Resources Building  
University Park, Pennsylvania 16802

<sup>3</sup>National Park Service  
Northeast Temperate Network  
Marsh-Billings-Rockefeller NHP  
54 Elm Street  
Woodstock, Vermont 05091

May 2010

U.S. Department of the Interior  
National Park Service  
Natural Resource Program Center  
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from (<http://science.nature.nps.gov/im/units/ermn/> and <http://science.nature.nps.gov/im/units/netn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/NRPM>). Please cite this publication as:

Keefer, J. S., M. R. Marshall, and B. R. Mitchell. 2010. Early detection of invasive species: surveillance, monitoring, and rapid response: Eastern Rivers and Mountains Network and Northeast Temperate Network. Natural Resource Report NPS/ERMN/NRR–2010/196. National Park Service, Fort Collins, Colorado.

# Contents

	Page
Figures.....	v
Tables.....	vii
Standard Operating Procedures (SOPs).....	ix
Appendixes.....	xi
Revision History.....	xiii
Executive Summary.....	xv
Acknowledgments.....	xvii
Introduction.....	1
Background and History.....	1
Why Perform Invasive Species Early Detection (ISED)?.....	2
Measurable Objectives.....	3
Parks Involved.....	4
Sampling Design.....	7
Selecting Early Detection Species.....	7
Invasive Species Early Detection Field Guide.....	7
Opportunistic Sampling.....	8
Alert System.....	11
Rapid Response.....	11
Mapping.....	12
Field Methods.....	13
Field Season Preparations and Equipment Set-up.....	13

Gathering Field Data.....	13
Sample Collection and Post-collection Processing.....	14
Data Management and Reporting .....	15
Database.....	15
Data Entry, Verification, and Validation.....	15
Data Archival Procedures .....	15
Data Analysis and Reporting.....	15
Protocol Revision.....	15
Personnel Requirements and Training .....	17
Roles and Responsibilities.....	17
Training Procedures.....	17
Operational Requirements .....	19
Annual Workload and Field Schedule.....	19
Budget and Staffing Scenarios.....	19
Facility and Equipment Needs.....	19
Interagency Cooperation and Education.....	20
Literature Cited.....	21

# Figures

	Page
<b>Figure 1.</b> Emerald ash borer ( <i>Agrilus planipennis</i> ). Photo taken by Jennifer Stingelin Keefer. ....	2
<b>Figure 2.</b> Location of parks in the Eastern Rivers and Mountains Network (ERMN). ....	4
<b>Figure 3.</b> Location of parks in the Northeast Temperate Network (NETN). ....	5
<b>Figure 4.</b> Early Detection of Invasive Species Surveillance Monitoring Field Guide title page and species card example. ....	9
<b>Figure 5.</b> Park-specific target early detection species list card example. ....	10





# Tables

Page

**Table 1.** General field season sampling months for each monitoring crew in the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN). ..... 18

**Table 2.** Estimated yearly costs for one part-time Invasive Species Early Detection Coordinator (ISED) to coordinate all invasive species early detection activities for the Eastern Rivers and Mountains Network (ERMN). ..... 19

**Table 3.** Computer software required to perform invasive species early detection duties in the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN). ..... 20



# Standard Operating Procedures (SOPs)

	Page
<b>Standard Operating Procedure (SOP) #1. Updating Invasive Species Early Detection Lists.</b> .....	25
<b>Standard Operating Procedure (SOP) #2. Data Collection</b> .....	29
<b>SOP #2, Table 1. Qualified botanists available to assist in plant identification.</b> .....	30
<b>SOP #2, Figure 1. Early Detection of Invasive Species Surveillance Monitoring and Rapid Response pest species reporting form.</b> .....	32
<b>SOP #2, Figure 2. Early Detection of Invasive Species Surveillance Monitoring and Rapid Response plant species reporting form.</b> .....	33
<b>Standard Operating Procedure (SOP) #3. Rapid Response Procedures.</b> .....	35
<b>SOP #3, Figure 1. Early Detection of Invasive Species Rapid Response system for the Eastern Rivers and Mountains Network (ERMN).</b> .....	37



# Appendixes

	Page
<b>Appendix A. Eastern Rivers and Mountains Network (ERMN) Invasive Species Prioritization Process.</b> .....	39
Appendix A, Table 1. Resources reviewed for each park during the species prioritization process to build a list of all invasive species known to exist in each park in the Eastern Rivers and Mountains Network (ERMN). .....	40
Appendix A, Table 2. All invasive species known or thought to occur in the Eastern Rivers and Mountains Network (ERMN). .....	41
Appendix A, Table 3. Invasive early detection candidate species and October 2009 final invasive early detection species for the Eastern Rivers and Mountains Network (ERMN) by park and taxa category. ....	48
<b>Appendix B. Northeast Temperate Network (NETN) Invasive Species Prioritization Process</b> .....	53
Appendix B, Table 1. Resources reviewed for each park during the species prioritization process to build a list of all invasive species known to exist in each park in the Northeast Temperate Network (NETN). .....	54
Appendix B, Table 2. All invasive species known or thought to occur in the Northeast Temperate Network (NETN). .....	55
Appendix B, Table 3. All invasive plant species known or thought to occur in Boston Harbor Islands National Recreation Area (BOHA), Northeast Temperate Network (NETN), by island and taxa category. ....	59
Appendix B, Table 4. Invasive early detection candidate species and October 2009 final invasive early detection species for the Northeast Temperate Network by park and taxa category. ....	65
Appendix B, Table 5. Invasive early detection candidate species and October 2009 final invasive early detection species for Boston Harbor Islands National Recreation Area (BOHA), Northeast Temperate Network (NETN), by island and taxa category. ....	68
<b>Appendix C. Interagency contact list by state and taxa for the Eastern Rivers and Mountains Network (ERMN).</b> .....	73
Appendix C, Table 1. State and federal contact information for reporting new noxious weed and plant pest occurrences. ....	73

**Appendix D.** Interagency contact list by state and taxa for the Northeast  
Temperate Network (NETN). ..... 75

Appendix D, Table 1. State and federal contact information for reporting new  
noxious weed and plant pest occurrences. .... 75

## Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

### Revision History Log

Version #	Date	Revised by	Changes	Justification





## Executive Summary

Early detection monitoring of incipient invasive plants, animals, and diseases was ranked among the top priorities in the Eastern Rivers and Mountains Network (ERMN) and the Northeast Temperate Network (NETN) in the vital signs selection process due to the clear identification of, and concern about, the effects these organisms can have on park ecosystems. The known ecological impacts of invasive species include loss of threatened and endangered species, altered structure and composition of terrestrial and aquatic communities, and reduction in overall species diversity.

While long-term changes associated with invasive species are being monitored through other protocols, it is also critical to catch new populations of invasive species early in their invasion of new and sensitive habitats. Only when invasions are caught early will the chance of eradication remain high.

Early detection monitoring in the ERMN and NETN will include three main components: 1) creation of individual park early detection species lists; 2) opportunistic surveillance monitoring of invasive plant and forest pest species that will focus on educating monitoring field crews, cooperators, volunteers, and resource managers on invasive species identification; and 3) development and maintenance of a coherent framework for reporting and disseminating information on potential infestations. These components will allow park resource managers to assess each invasive species early detection on an individual basis and target limited management resources and coordination toward the highest priority risks.



## Acknowledgments

This protocol uses some text and ideas without citations from the “Invasive Exotic Plant Monitoring Protocol for the Heartland Network Inventory and Monitoring Program” (Young et al. 2007) and the “Early Detection Monitoring of Invasive Plant Species in the San Francisco Bay Area Network, A Volunteer Approach” (Williams et al. 2007). We want to acknowledge both of these Networks for helping to lay the foundation for invasive species early detection work within the NPS Inventory & Monitoring Program. In addition, we would like to thank Kathryn Miller, NETN Plant Ecologist, Wayne Millington, Northeast Regional Integrated Pest Management Coordinator, Les Mehrhoff, Director, Invasive Plant Atlas of New England (IPANE), and all ERMN and NETN park resource managers and staff. All contributed their time and assistance in developing early detection species lists, synthesizing protocol logistics, and/or providing general feedback.



# Introduction

## Background and History

An “invasive species is an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” (USPEO 1999). Presidential Executive Order 13112 further defines an “alien species, with respect to a particular ecosystem, as any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem” (USPEO 1999). In broad terms, an invasive species is an organism that has been introduced deliberately or unintentionally into an environment in which it did not evolve, is capable of establishing self-sustaining populations in “untransformed ecosystems” (MacDonald et al. 1989), has no natural enemies to limit its reproduction and spread, and is likely to cause harm to human health or the environment.

Successful invasive species tend to have broad ecological requirements and tolerances, effective reproductive and dispersal mechanisms (Rejmanek and Richardson 1996), competitive ability superior to that of natives in the original or modified system, and the capability of altering the site by significantly changing resource ability and/or disturbance regimes (Baker 1965). Invasive species negatively impact park resources and visitor enjoyment by altering landscapes and fire regimes, reducing native plant and animal habitat, blocking and altering viewsheds, and increasing the need for and cost of additional trail maintenance. Examples from national parks include alteration of geochemical cycling by feral pigs (*Sus scrofa*) in Great Smoky Mountains National Park, acceleration of soil erosion rates by feral mammals in Channel Islands National Park, alteration of hydrological cycles by salt cedar (*Tamarix* sp.) in Death Valley National Monument and Big Bend National Park (MacDonald et al., 1989), and obstruction of cultural viewsheds by common mullein (*Verbascum thapsus*) on Skyline Drive in Shenandoah National Park (James Åkerson, personal communication, March 2, 2010). Both the Eastern Rivers and Mountains Network (ERMN) and the Northeast Temperate Network (NETN) are witnessing the destruction of the eastern hemlock (*Tsuga canadensis*) in multiple parks by the hemlock woolly adelgid (*Adelges tsugae*) and the imminent demise of ash species (*Fraxinus* spp.) caused by the advancing front of the emerald ash borer (*Agrilus planipennis*) (Figure 1) in New River Gorge National River.

National parks are clearly susceptible to invasions. Each park within the ERMN and NETN is in close proximity to a major waterway, dissected by roads and trails, and/or bordered by developing communities and private lands. These waterways, roads/trails, and borders are all major “vector pathways” or means of introducing and moving invasive species from one point to another (Mack 2003). Each park is also impacted by visitor and animal use on a daily basis. MacDonald et al. (1989) linked increased visitor use to an increase in number of invasive species in 41 southern Africa nature reserves, and Hodkinson and Thompson (1997) demonstrated that motor vehicles act as seed dispersal mechanisms. Animals, such as horses (Wells and Laurenroth 2007), deer (Myers et al. 2004), and birds (Simberloff and Von Holle 1999), are also potentially important seed dispersal vectors. In addition, parks like Marsh-Billings-Rockefeller National Historic Site are dealing with invasive plants that were deliberately planted as part of the historic estate design (Christina Marts, pers. comm., February 13, 2009).



**Figure 1.** Emerald ash borer (*Agrilus planipennis*). Photo taken by Jennifer Stingelin Keefer.

### **Why Perform Invasive Species Early Detection (ISED)?**

Early detection followed by rapid response can detect and eradicate incipient populations of invasive species before they have a chance to become widely established, thus eliminating the need for costly and resource-intensive control programs (Ashton and Mitchell 1989, OTA 1993, Atkinson 1997, Myers et al. 2000, Harris et al. 2001, Timmins and Braithwaite 2001, Rejmanek and Pitcairn 2002, FICMNEW 2003). Only when invasions are caught early will the chance of eradication remain high (Rozenfelds et al. 1999, NISC 2008). In addition to saving money, early detection and rapid response efforts minimize ecological damage by preventing habitat fragmentation and ecosystem degradation associated with large or widespread invasive species populations and related management activities (Smith et al. 1999, Timmins and Braithwaite 2001).

One of the most vital steps in confronting new invasive species problems is to know they exist (FICMNEW 2003). “Early Detection and Rapid Response” is one of five long-term strategic goals of the National Invasive Species Council’s (NISC) Management Plan (NISC 2008). It is also a main element of the Federal Interagency Committee for the Management of Noxious and Exotic Weed’s (FICMNEW) “National Early Detection and Rapid Response System for Invasive Plants” (FICMNEW 2003). Next to prevention, “early detection, rapid assessment and rapid response (EDRR) is a critical second defense against the establishment of invasive populations” (NISC 2008).

To understand the benefits of early detection, it is easier to calculate the costs of an invasion where early detection was not performed. Damages associated with alien invasive species effects and their control amount to approximately \$120 billion/year (Pimentel et al. 2005). For example, the total cost of destruction by introduced rats on U.S. farms is more than \$19 billion per year, while invasive weeds, pest insects, and plant pathogens cause several billion dollars worth of losses to crops, pastures, and forests annually in the United States (Pimentel et al. 2005). The chestnut blight fungus (*Cryphonectria parasitica*) and the virtual elimination of the American

chestnut (*Castanea dentata*) in the early 1900's (von Broembsen 1989) demonstrate the potentially devastating economic and ecological consequences of invading species.

Eradication of established invasive species is difficult, if not impossible in many cases, but early detection and associated management responses have proven effective in reducing, if not eliminating, the associated costs and consequences (MacDonald et al. 1989, Braithwaite 2000). Early detection and rapid response success stories include retharrow (*Ononis alopecuroides*) in San Luis Obispo County, California (Tu 2002a), *Egeria* (*Egeria densa*) in the Connecticut River (Tu 2002b), and water hyacinth (*Eichhornia crassipes*) and parrot-feather watermilfoil (*Myriophyllum aquaticum*) in the Shawnee National Forest, Mississippi (Corey 2008).

### **Measurable Objectives**

The goal of this protocol is to assist park managers in identifying high priority invasive species, quickly disseminating new occurrence information to all interested parties (NPS, public, private, etc.), assessing the risk presented by incipient populations, and assist with management of newly detected species.

The focus of early detection monitoring in the ERMN and NETN will begin with surveillance monitoring of invasive plant and forest pest species and will focus on educating all field crews and interested cooperators, resource managers, and volunteers on invasive species identification. The protocol will also provide a coherent framework for reporting and disseminating information on potential infestations.

The primary monitoring objective is to:

- Detect incipient populations (i.e., small or localized) and new introductions of target invasive species on each park's early detection list through opportunistic observations before the species become established.

To achieve the monitoring objective, this protocol describes the following components:

1. Develop and maintain a list of target species that occur in localized areas of parks, are extremely rare, or are not currently present within a park, but have the potential to cause major ecological, cultural, or economic problems if they were to become established;
2. Develop, maintain, and distribute appropriate target species identification information to all ERMN and NETN field crews and other interested cooperators, resource managers, and volunteers; and
3. Develop and maintain an early detection reporting and tracking system that disseminates information on potential infestations in a timely and efficient manner.

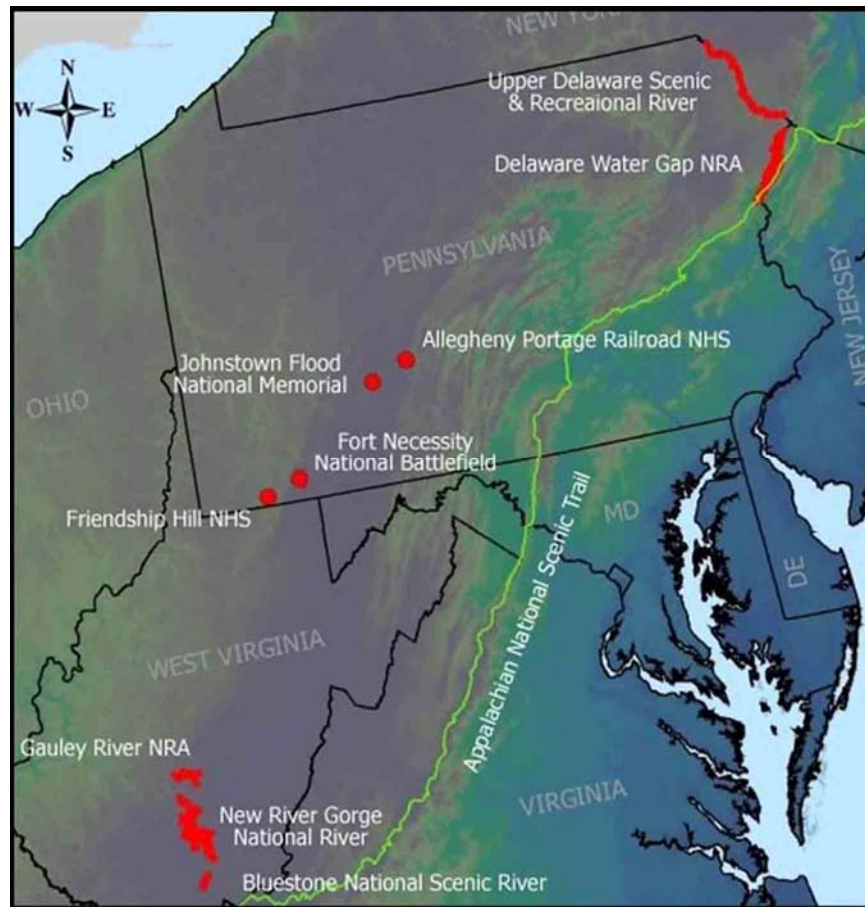
These components will allow ERMN and NETN member park resource managers to assess each invasive species early detection on an individual basis and target limited management resources and coordination toward the highest priority risks.

## Parks Involved

The following parks are included in Early Detection of Invasive Species; Surveillance, Monitoring, and Rapid Response:

### ***Eastern Rivers and Mountains Network (ERMN)***

All ERMN parks (Figure 2): Allegheny Portage Railroad National Historic Site (ALPO), Bluestone National Scenic River (BLUE), Delaware Water Gap National Recreation Area (DEWA), Fort Necessity National Battlefield (FONE), Friendship Hill National Historic Site (FRHI), Gauley River National Recreation Area (GARI), Johnstown Flood National Memorial (JOFL), New River Gorge National River (NERI), and Upper Delaware Scenic and Recreational River (UPDE).

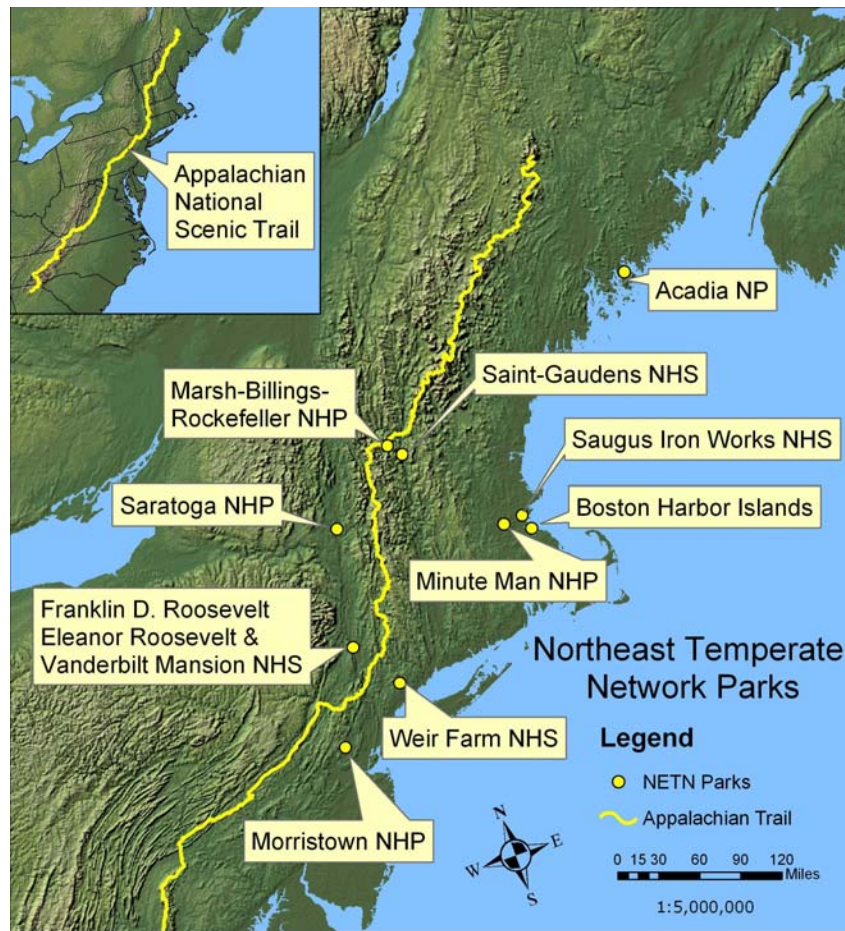


**Figure 2.** Location of parks in the Eastern Rivers and Mountains Network (ERMN).



**Northeast Temperate Network (NETN)**

All NETN parks (Figure 3): Acadia National Park (ACAD), Appalachian National Scenic Trail (APPA), Boston Harbor Islands National Recreation Area (BOHA), Marsh-Billings-Rockefeller National Historical Park (MABI), Minute Man National Historical Park (MIMA), Morristown National Historical Park (MORR), Roosevelt-Vanderbilt National Historic Sites (ROVA), Saint-Gaudens National Historic Site (SAGA), Saugus Iron Works National Historic Site (SAIR), Saratoga National Historical Park (SARA), and Weir Farm National Historic Site (WEFA).



**Figure 3.** Location of parks in the Northeast Temperate Network (NETN).



# Sampling Design

## Selecting Early Detection Species

The process for selecting a short list of target invasive species for each park in the ERMN and NETN consists of four main components: 1) Review existing park datasets and literature and compile a list of all invasive species known or thought to occur in the parks; 2) Immediately eliminate all common and well-established species from this list; 3) Consult relevant existing invasive species data sources from nearby parks, towns, counties, and states for incipient invasive species not yet present in the parks and add them to the candidate invasive species early detection (ISED) list; and 4) Conduct more extensive species research and consult with park natural resource managers to narrow down and create the final species lists for each park. Initially, the protocol will focus on terrestrial plants and insect pests. Aquatic plants and animals, as well as terrestrial animals, will be added eventually, as time and resources permit.

See Appendixes A and B to view the ERMN and NETN invasive species early detection prioritization process.

The final ISED park lists generally consist of between 10 and 20 species, although 10-15 is a more realistic number of species individuals can be expected to recall and identify in the field while conducting other duties (Leslie Mehrhoff, pers. comm., January 15, 2008). Parks that employ volunteers for the ISED protocol may also have a subset of species suitable for individuals with very limited botanical experience.

Every year each park ISED list will be reviewed by network staff, park natural resource managers, and other pertinent contacts to ensure that the list is current and contains the top priority species. New invasive species threats should be evaluated for possible inclusion in a park's ISED list, while the prior year's list of species should be evaluated to determine if any should be removed from the list. For example, if an early detection (ED) species is detected and eradicated, the species will likely remain on the park ISED list. However, if an ED species is detected at high levels and not eradicated due to lack of resources or type of infestation, the natural resource manager, Exotic Plant Management Team (EPMT), and field crew leaders will be consulted to determine whether the species should be removed from the park ISED list. In situations where ED species are present in localized areas of the park and are predicted to spread but absent from the rest of the park, the park natural resource manager will be consulted regarding species list inclusion or removal and included in all decision making processes. See Updating Invasive Species Early Detection Lists SOP 1 to see the process for creating new invasive species short lists of candidate species and questions to ask when prioritizing new species.

## Invasive Species Early Detection Field Guide

To assist with the identification of target early detection species, ISED cards will be provided to monitoring crews and all interested parties. Two separate field guides will be used to distribute target species identification information. The first is a hand-held, weather-proof pocket guide provided cost-free by the USDA Forest Service (USFS), "Invasive Plants Field and Reference Guide: An Ecological Perspective of Plant Invaders of Forests and Woodlands," (USFS field guide) (Huebner et al. 2005). The second is a supplemental identification field guide developed by the ERMN. Production of the ERMN "Early Detection of Invasive Species Surveillance

Monitoring Field Guide” (NPS field guide) and nine species cards were completed in 2009. Additional cards will be added in the future on an as-needed basis. Each completed species card, as well as the entire field guide, will be posted on the ERMN Web site and available for download at <http://science.nature.nps.gov/im/units/ermn/monitoring/earlydetection.cfm>.

The USFS’s Adobe® InDesign® template for the USFS field guide was utilized to create the NPS field guide with the same look and feel of the aforementioned publication. Each species card in the NPS field guide contains a concise species description, photos, and commonly misidentified species/look-alikes. Title, index, and reference pages are also included. Each card is color-coded to easily identify the general taxonomic category or life form, in the case of plants. For the purpose of this protocol, the word “Pest” represents non-plants. The NPS field guide title page and an early detection card example are presented in Figure 4.

Park-specific cards that contain a list of target species for each park and designated park contact information were designed to be integrated into the NPS field guide. Figure 5 shows a specific park example. When arriving at a new park, each monitoring crew (or participating staff and volunteers) will insert the new park species list card and then add the designated early detection species list cards to the field guide.


Each taxonomic group will have a different data reporting form (i.e. pests and plants). Forms are produced on “Rite in the Rain”® all weather paper, are compatible with the NPS and USFS field guides, and contain early detection reporting directions (See SOP 2: Data Collection). Directions include information on how to properly mark the observation location, how to take a descriptive photo, and where to send the observation information. Form fields can be viewed in SOP 2: Data Collection at the end of this document.

Initial coordination and production of new species identification cards for 19 parks will be implemented over a period of 2-3 years and will complement, not duplicate, species information already present in the USFS field guide. As new park species threats arise and additional funding is available, new species cards will be produced.

### **Opportunistic Sampling**

“Every person working or recreating in a national park has the potential to serve as an early detector” (Williams et al. 2007). Given available funding in the ERMN and NETN, the networks’ existing monitoring crews initially will be used for opportunistic sampling. Because these crews are already performing monitoring field work in the parks, there are no additional travel and personnel costs. Knowledgeable crew members provide an additional “set of eyes and ears” to detect incipient species occurrences while they are collecting data at monitoring sites, walking to and from monitoring sites, and driving along park roads. Park natural resource managers, EPMTs, volunteers, and other NPS individuals with scientific backgrounds will be used for their daily park presence also. If time and resources permit, other individuals, like park maintenance crews and local organizations, will be trained to aid in the effort.

National Park Service  
U.S. Department of the Interior



Northeast Region

Eastern Rivers and Mountains Network

## Early Detection of Invasive Species

### Surveillance Monitoring Field Guide

Jennifer Stingelin Keefer

National Park Service  
The Pennsylvania State University  
422 Forest Resources Bldg.  
University Park, PA 16802

Jennifer\_Stingelin\_Keefer@partner.nps.org

U.S. Department of the Interior  
National Park Service  
Northeast Region  
Inventory and Monitoring Program  
Eastern Rivers and Mountains Network  
Forest Resources Bldg.  
University Park, PA 16802

2009

### NARROWLEAF BITTERCRESS [*Cardamine impatiens* L.] CAIM




Fig. 1 © 2005 L. J. Mehrhoff Fig. 2 © 2002 L. J. Mehrhoff

**Problem:** Native to Eurasia,<sup>3</sup> narrowleaf bittercress has the ability to rapidly spread and colonize a variety of habitats,<sup>6</sup> creating dense stands that outcompete native species.<sup>2</sup>

**Habit:** Erect, shade tolerant, annual or biennial (Fig. 1).<sup>1,2,3,5,6</sup>

**Reproduction:** Prolific seeder; may self pollinate.<sup>4</sup>




Fig. 3 © 2003 M. Storey

**Leaves:** Numerous, 6-20<sup>1</sup> narrow, sharply toothed, sparsely ciliate leaflets;<sup>5</sup> basal leaves (Fig. 2) can reach 10 cm (~4 in) and can have 3 to 11 leaflets along the rachis; leaflets are generally 3-lobed and lobes are rounded<sup>3</sup>; leaf bases sagittate to auriculate<sup>1-2,3,6</sup> or clasping (Figs. 3 and 4).

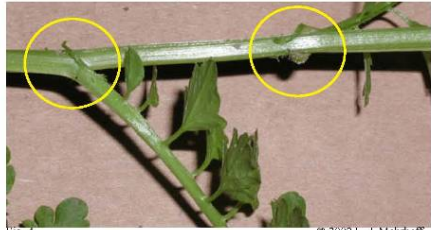


Fig. 4 © 2002 L. J. Mehrhoff

HERE

### NARROWLEAF BITTERCRESS *Cardamine impatiens* L.




Fig. 5 © 2002 L. J. Mehrhoff




Fig. 6 © 2002 L. J. Mehrhoff

**Stems:** 1.5 to 8 dm tall (6 to 30 in);<sup>1,6</sup> glabrous; stems do not branch near the base of the plant, only above in the inflorescence.<sup>3</sup>

**Flowers:** May to September;<sup>2</sup> Petals white or lacking,<sup>1,3,6</sup> up to 2.5 mm (less than 1/16 in);<sup>1,6</sup> short-lived<sup>3</sup> (Fig. 5).

**Fruits/Seeds:** 10-24+ seeds per fruit;<sup>1,2</sup> seeds orange to brown,<sup>3</sup> enclosed in long (1 1/2 to 2 cm; ~3/8 to 3/4 in) slender capsules (siliques);<sup>1,3,6</sup> ascending or borne upright on short pedicels<sup>1,3,6</sup> (Fig. 6); mechanical dispersal where seeds are cast short distances from the plant;<sup>3,4</sup> flowing water is also a primary means of seed dispersal.<sup>3,4</sup>

**Habitat:** Mesic woods,<sup>5,6</sup> floodplains, roadsides, trails and lawns.<sup>3</sup>

**Similar Species:** Pennsylvania bittercress (*Cardamine pennsylvanica* Muhl. ex Willd.),<sup>3,5</sup> sand bittercress (*C. parviflora* L.), and hairy bittercress (*C. hirsuta* L.) are all most commonly confused with narrowleaf bittercress.<sup>5</sup> Narrowleaf bittercress is the only species that exhibits sagittate to auriculate or clasping leaf bases (Figs. 3 and 4).<sup>2</sup> Figure 7 shows the leaf base of Pennsylvania bittercress.




Fig. 7 K. Tomaglia

Figure 4. Early Detection of Invasive Species Surveillance Monitoring Field Guide title page and species card example.



**WEST VIRGINIA  
Bluestone National Scenic River  
BLUE**

Designated park contact for noxious and high priority species **ONLY**:

John Perez  
104 Main St.  
Glen Jean, WV 25846  
304-465-6537  
John\_Perez@nps.gov

Noxious weeds and high priority species are designated with an asterisk. Please see "Species Reporting Forms" for contact information when reporting **ALL OTHER** early detection species for the WV parks.

**Pest**

*Agrilus planipennis*      emerald ash borer\*

**Herb**

*Dioscorea oppositifolia*      Chinese yam  
*Heracleum mantegazzium*      giant hogweed\*  
*Oplismenus hirtellus* ssp.  
    *undulatifolius*      wavyleaf basketgrass  
*Phragmites australis*      phragmites  
*Polygonum cuspidatum/*      Japanese/giant knotweed\*  
    *P. sachalinense*  
*Ranunculus ficaria*      lesser celandine

**Vine**

*Akebia quinata*      chocolate vine  
*Ampelopsis brevipedunculata*      Amur pepervine  
*Celastrus orbiculata*      Oriental bittersweet  
*Polygonum perfoliatum*      mile-a-minute  
*Pueraria montana* var.  
    *lobata*      kudzu

**WEST VIRGINIA: BLUE  
CONTINUED**

**Shrub**

*Berberis thunbergii*      Japanese barberry  
*Frangula alnus*      glossy buckthorn  
*Rhamnus cathartica*      common buckthorn

**Tree**

*Acer platanoides*      Norway maple

**Aquatic**

*Didymosphenia geminata*      didymo

**SPECIES**

**Figure 5.** Park-specific target early detection species list card example.

The benefit of utilizing volunteers for ISED has been successfully demonstrated nationwide (Williams et al. 2007, Leslie Mehrhoff, pers. Comm., 2008, Webb n.d.). Although volunteer training and coordination is not feasible at most parks, given available funding, an example of volunteer training and use for ISED occurred in 2009 at Boston Harbor Islands National Recreation Area (BOHA). The one-day training was coordinated by the ERMN Invasive Species Early Detection Coordinator (ISED), park natural resource manager, and NETN personnel, and was conducted by Les Mehrhoff, Director of the Invasive Plant Atlas of New England (IPANE). The training included protocol background information, a PowerPoint presentation, specimen identification, field walk, and an identification quiz. All volunteer surveillance activities are being coordinated by the BOHA Natural Resource Manager. To obtain a copy of the BOHA volunteer training agenda and PowerPoint presentation, contact Marc Albert, BOHA Natural Resource Manager.

### **Alert System**

Data acquired from ISED are time-sensitive, and all new detections should be immediately reported through the appropriate chain of command. In both networks it is the responsibility of each observer or monitoring crew leader to promptly report all new species detections and deliver completed field reporting forms (originals or copies), photographs, and/or specimens to the designated park contact prior to completing field work in that park. In the NETN, it is then the responsibility of the designated park contact to forward all ISED information to the ISED, additional park and regional personnel, EPMTs, and outside agencies, as appropriate. In the ERMN, each observer or monitoring crew leader will also be responsible for alerting the ISED to all new species detections and delivering completed field reporting forms (originals or copies), photographs (originals or copies), and/or specimens upon return to the network office. Alerting the ISED, in addition to the designated park contact, ensures the species will be reported in a timely manner and removes the added burden of relaying information to the network from the designated park contact. In cases where noxious weeds or high priority pests are detected, the ISED will follow-up with each designated park contact and may assist with alerting relevant outside agencies. See SOP 3: Rapid Response for more information on the ISED alert system.

### **Rapid Response**

Rapid responses to invasions are effective and can prevent the spread and permanent establishment of invasive species. Coordinating and/or executing a rapid response are primarily the responsibility of the respective park resource manager(s) in which the infestation was detected. Rapid response should include positive species identification and management/eradication activities, and may involve coordination with the EPMT, agencies such as the Bureau of Plant Industry and the Animal and Plant Health Inspection Service (APHIS) within the U.S. Department of Agriculture, local weed management organizations, and network and park personnel, as well as park interns. Each response will be based on the individual needs of the park and the resources available (SOP 3: Rapid Response).

At the conclusion of the field season, park resource managers should evaluate their responses to invasive species early detections and ask the question, “could they do better next time?” Rapid response assessments will provide critical information that will improve the quality and timeliness of future rapid responses.

## Mapping

To accomplish additional invasive species tracking and reporting, we plan to use the Mid-Atlantic Invasive Species Mapping System. This 3-year project began on Oct. 1, 2009. The Principal Investigators are Chuck Barger and David Moorhead of the University of Georgia's Center for Ecosystem Health and Invasive Species. The Internet application will combine Google Maps, interactive county-level species introductions and document distribution over time in the Mid-Atlantic states. This system is based on the [Early Detection and Distribution Mapping System \(EDDMapS\)](#) developed for the southeastern U.S. in 2005 (see <http://www.se-eppc.org/>).

EDDMapS will eventually provide a convenient solution for the storage, display, and sharing of occurrence and distribution data on known and newly introduced invasive species. The system will continue to expand and be increasingly valuable as more data are obtained and entered. National parks and other organizations and individuals in the mid-Atlantic region will be able to input location information on invasive species in seven states (Delaware, Maryland, New Jersey, New York, Pennsylvania, Virginia, and West Virginia) and the District of Columbia. These data would then be immediately accessible to all system users and, more specifically, users who request occurrence alerts for user-defined alert areas. Once well populated with species occurrence reports, it will vastly expand the ability of land managers to review and prioritize invasive species management and prevention needs and identify potential information gaps that need to be addressed. For now, parks that are not located in these states are still able to input and view distribution data through the main EDDMapS site. As time and resources permit, direct collaboration with other mapping programs, like IPANE and iMapInvasives, would be beneficial to both networks. All new ISEDs will be entered annually into EDDMapS by the ISEDC by late fall.

Use of the Mid-Atlantic Mapping System, in conjunction with the ERMN and NETN websites, will provide a data entry port, alert system, and a one-stop resource for invasive species information, including links to other invasive species websites, photos, important contacts, and other information for potential use by the entire Northeast Region. To view the current ERMN website, visit: <http://science.nature.nps.gov/im/units/ermn/monitoring/EarlyDetection.cfm>.



## **Field Methods**

### **Field Season Preparations and Equipment Set-up**

Prior to the commencement of a field season (see Annual Workload and Field Schedule below), the ISEDC is responsible for coordinating and making any changes or additions to each park species list, creating new species cards, and printing park species lists, reporting forms, and field guides. Materials will be distributed on an as-needed basis.

Because this protocol is initially being carried out by existing network monitoring crews, additional equipment preparation and set-up will be minimal. Each ERMN and NETN monitoring crew will utilize their own respective monitoring equipment (i.e., GPS unit, digital camera, and first aid kit) with the exception of the following items that will be provided by the ISEDC:

- Early Detection of Invasive Species Surveillance Monitoring Field Guide
- USFS Invasive Plants Field and Reference Guide
- Individual park species lists
- Pest and Plant Reporting forms
- Additional species identification materials (as necessary)

Volunteers and park personnel not involved with network monitoring should have the following list of supplies before performing invasive species surveillance monitoring:

- GPS unit and spare AA batteries
- GPS antennae and spare battery (if applicable)
- Biodegradable flagging (red or pink)
- Pencils (sharpened or with extra lead)
- Permanent markers
- 10x hand lens
- Digital camera, extra batteries
- Sealable gallon-sized plastic bags for plant or pest samples
- Early Detection of Invasive Species Surveillance Monitoring Field Guide
- USFS Invasive Plants Field and Reference Guide
- Individual park species lists
- Pest and plant reporting forms
- Additional species identification materials (as necessary)

### **Gathering Field Data**

The primary directions and details regarding field data gathering can be found in SOP 2: Data Collection. Generally, when an ED species is encountered by a monitoring crew member, he/she will physically mark the location of a detected species with biodegradable flagging, record species occurrence, location information, and confidence of identification and take photograph(s) of distinguishable features and/or signs and symptoms, in the case of pests. If a plant is observed, the infested area, stem count, habitat, vigor, and site accessibility will be recorded. If a pest is observed, host species, host species evidence, such as crown dieback, foliar injury symptoms, and general injury, and additional factors, such as habitat and site accessibility, will be recorded.

### **Sample Collection and Post-collection Processing**

Photographic or specimen vouchers may be taken and/or collected to confirm identification of ED species, especially those that are likely to be identified incorrectly. Photographic specimens are preferred to avoid potential spread of invasive plant and pest material. In some cases, if collecting is permitted by the specific park, small or partial specimens may be collected and stored in a plastic bag or vial. Research specimens are only used for confirmation of ED species identity and will not be stored in a collection.

Photographs received from field observations will be named in accordance with network file naming standards. For example, park, protocol, name of specimen or brief description, location or site code, sequence number, date (yyyymmdd), observer:

DEWA\_ISED\_*Viburnum dilatatum*\_Hialeah\_03\_20091020\_JShreiner.jpg

# **Data Management and Reporting**

## **Database**

Currently, the ERMN and NETN are using a Microsoft Excel spreadsheet to keep track of all new invasive species occurrences. However, both networks are in the process of developing the ISED database, which is a Microsoft Access based and Natural Resource Database Template (NRDT) compliant relational database. This database keeps track of new species occurrences (documents presence), assessments, and all management or rapid responses at the documented location.

## **Data Entry, Verification, and Validation**

Data processing typically involves the following steps: initial raw data verification, data entry, electronic data verification, data processing, and storage/backups. The initial raw data verification includes reviewing photos and confirming species identification. Data entry consists of transferring raw data from field data forms and/or ISED e-mail alerts into a database. Data verification immediately follows data entry and involves checking the database records, GPS coordinates, and the original data entry forms for accuracy. Validation procedures seek to identify generic errors (i.e. missing, mismatched, or duplicate records), as well as logical errors specific to the protocol. The ISEDC will initially be responsible for data entry and 100% verification and validation, and will be in charge of contacting field observers to rectify any discovered GPS coordinate or observation form inaccuracies.

## **Data Archival Procedures**

Raw and back-up copies of field data forms will be stored at the ERMN and NETN respective offices. Data forms and databases will be archived and backed up according to each network's data management plan.

## **Data Analysis and Reporting**

The ISEDC will communicate with all park contacts on an annual basis in late fall or winter to review associated park ED species lists, receive feedback, and make any necessary adjustments to the protocol. Summary year-end reporting will be conducted by the ISEDC annually in the fall and will consist of two major formats: annual report and resource brief. A formal written report targeted towards natural resource managers summarizing species detections, rapid responses, and success stories will be distributed every year. An informational resource brief targeting park interpreters and superintendents will also be distributed. In addition, e-mails to network and regional staff, as well as other federal, state, and private organizations, and website updates will be conducted on an as-needed basis.

## **Protocol Revision**

This protocol is a living document. Changes and revisions will be incorporated into the protocol as we learn more about invasive species early detection and rapid response. Changes will be documented in the Change History logs at the beginning of this narrative and in each SOP. Changes to this narrative will also be tracked using the ERMN and NETN file naming conventions and archived at the network level.



# Personnel Requirements and Training

## Roles and Responsibilities

The ISEDC for each network serves as the project manager and works closely with existing monitoring crews, especially the NETN and ERMN Vegetation Monitoring crew leaders. The ISEDCs are responsible for protocol development, refinement, overall quality assurance, database development, Web site development, and coordinating with their counterpart in the other network, as well as outside agencies, private organizations, and regional mapping programs (e.g. IPANE and iMapInvasives). See Appendix C for a list of interagency contacts by state and taxa. Data management is the responsibility of the ISEDC, and occasional assistance will be needed from network data managers to assist with database and Web site development. The ISEDC is also responsible for training field crews how to identify invasive ED plant and pest species and, on occasion, making site visits to confirm ED species occurrences. This position requires moderate to high skill with plant and pest identification, writing, and ability to effectively communicate with park personnel and citizen scientists. Basic database management and development, GIS, and Web design skills are also required. The ISEDC is designated, supervised, and/or contracted by the respective network program managers.

## Training Procedures

Training is essential for the proper identification of invasive pests and plants. The ISEDC must ensure that all monitoring crew members and other observers have a clear understanding of the major identifying characteristics of each early detection species as well as characteristics of common look-alike species. Training materials will include NPS and USFS field guides, photographs, and supplemental texts or presentations.

Because this protocol is initially being carried-out by existing network monitoring crew members, additional training will be minimal. Prior to field season, all monitoring crew members and observers must review the network safety plan and the entire ISED protocol. All will engage in training exercises (i.e. test plot or site) designed to meet their individual monitoring protocol needs. Each ERMN and NETN monitoring crew will utilize their own respective monitoring protocol SOPs for training specifics. For example, for field season preparation and Global Positioning System utilization, the ERMN vegetation monitoring crew will utilize Using the Global Positioning System (GPS) and Field Season Preparation SOPs (Perles et al. 2009).

Training will occur prior to each monitoring crew's respective field season (Table 1); for other observers it will occur prior to the peak of the growing season. If a single training does not work for all monitoring crews, some crews will receive separate pest and plant identification training provided by the ISEDC. The vegetation monitoring crew will receive separate pest and plant identification training provided by the ISEDC. Crews deficient in plant and pest identification skills will receive additional training on a case-by-case basis. In the future, as additional non-natural resource park personnel (i.e. interpretation and/or maintenance staff), and possibly volunteers, become involved, this protocol will be modified to include specific training instructions geared towards these focus groups.

**Table 1.** General field season sampling months for each monitoring crew in the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN).

<b>Monitoring Protocol Crews</b>	<b>ERMN Parks</b>	<b>NETN Parks</b>	<b>Field Season</b>
Vegetation	All parks except UPDE	All parks except APPA and BOHA	May-August
Benthic Macroinvertebrate	All parks		March, October <sup>1</sup>
Streamside Birds	ALPO, BLUE, DEWA, FONE, FRHI, GARI, NERI		Spring and early Summer
Coastal Breeding Birds		BOHA	May-July
Water Quality and Quantity		All parks except APPA and BOHA	May - October

<sup>1</sup> BLUE, FONE, FRHI, NERI, GARI are sampled in March and ALPO, DEWA, JOFL and UPDE are sampled in October.

# Operational Requirements

## Annual Workload and Field Schedule

While ISED can occur year-round, the majority of surveillance will commence with each monitoring field season. Table 1 lists general field season sampling months for each monitoring crew. The ISEDC will be responsible for year-round data management, annual reporting, Web site updates, and communications with individual parks.

## Budget and Staffing Scenarios

This protocol is flexible and can operate on varying budget levels. Initially, field staffing will consist of existing monitoring crew members and park personnel and will not require additional staffing costs with the exception of the ISEDC (if this responsibility is not taken on by network staff). Currently, the ISEDC position is a contracted cooperator, and includes 50% part-time ISED work split with 50% ERMN data management responsibilities. Future citizen scientist involvement would require sufficient additional funds to provide coordination, training, and development of training materials. Table 2 details the estimated cost for implementing the protocol with a half-time ISEDC. Personnel costs cover a part-time University contractor position. Materials include costs for ISED card production and field data forms printed on “Rite in the Rain”® all-weather paper. Travel covers local network travel and sufficient funding for two conferences, one being the biennial Mid-Atlantic Exotic Pest Plant Council (MA-EPPC) conference. Since all equipment is on-hand and being used by existing monitoring crews, the budget does not include equipment and supply costs.

**Table 2.** Estimated yearly costs for one part-time Invasive Species Early Detection Coordinator (ISED) to coordinate all invasive species early detection activities for the Eastern Rivers and Mountains Network (ERMN).

	Estimated Yearly Costs
Salary and Benefits 6 mos (GS-9 equivalent)	\$18,000
Materials	\$1,000
Travel	\$1,000
Indirect Rate if Univ/CESU (17.5%)	\$3,500
Total	\$21,500

Rapid response will be assessed on an as-needed basis. Depending on the size of the infestation and whether the species is a pest, pathogen, or plant, EPMTs, network, and park staff, and/or outside agencies will be contacted to curb rapid response costs. Currently, qualified monitoring crews may remove small infestations of plants if the population size is small and the complete removal of the plant is feasible. Generally, it is up to the park to conduct rapid response measures and the network will assist on an as-needed and as-available basis.

## Facility and Equipment Needs

Minimally, the ISED coordinator will need a regular phone line with long-distance calling for inter- and intra-network communications, an e-mail account, and a computer with several software programs installed. Table 3 shows computer software required to perform ISED.

**Table 3.** Computer software required to perform invasive species early detection duties in the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN).

<b>Software Programs</b>	<b>Reason</b>
Microsoft Office Access/Excel Word	ISED database; General database management Publications development and reporting
Adobe Products InDesign Dreamweaver Acrobat Photoshop	ISED card development and production ISED web site development ISED card production ISED card production
ESRI ArcMap or ArcView	ISED Mapping

Occasionally, transportation will be required for park visits and rapid responses.

### **Interagency Cooperation and Education**

Invasive species do not conform to political boundaries, and interagency cooperation and information sharing is vital to the battle waged against them. Partnerships and networking is one of the main goals listed in the “National Early Detection and Rapid Response System for Invasive Plants in the United States” (FICMNEW 2003). ERMN and NETN staffs are already working closely with network parks, EPMT, and the Northeast Region Integrated Pest Management Coordinator. In addition, several of the network parks are currently cooperating with the United States Forest Service (USFS), Animal and Plant Health Inspection Service (APHIS), state agencies, Cooperative Weed Management Areas (CWMA), and private organizations for guidance and technical rapid response assistance. Similar cooperation and information sharing should be encouraged whenever appropriate. See Appendix C for a list of interagency contacts by state and taxa.

If time and resources permit, network staff will work closely with parks to educate the public on the importance of invasive species early detection. Visitor centers, campgrounds, and boat launch areas are examples of areas where informative posters or displays could be placed to make an impact regarding public invasive species awareness.



## Literature Cited

- Ashton, P. J., and D. S. Mitchell. 1989. Aquatic plants: Patterns and modes of invasion, attributes of invading species and assessment of control programmes. *In* J. A. Drake, H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, M. Rejmanek, and M. Williamson (Eds.). *Biological invasions: A global perspective*. Pp. 111-154. Chichester, England. John Wiley & Sons, Ltd.
- Atkinson, I. A. E. 1997. Problem weeds on New Zealand islands. *Science Conservation* 45. Wellington, Department of Conservation.
- Baker, H. G. 1965. Characteristics and modes of origin of weeds. *In* Baker, H. G., and G. L. Stebbins (eds.). *The genetics of colonizing species*. Pp.147-168. New York, NY. Academic Press.
- Braithwaite, H. 2000. Weed surveillance plan for the Department of Conservation. Wellington, Department of Conservation.
- Corey, S. 2008. Early detection and rapid response: Shawnee National Forest early response at work. <http://www.fs.fed.us/r9/ssrs/story?id=4224>. United States Forest Service, Eastern Region. Accessed February 24, 2009.
- Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). 2003. National early detection and rapid response system for invasive plants in the United States. Washington, DC. [http://www.fws.gov/ficmnew/FICMNEW\\_EDRR\\_FINAL.pdf](http://www.fws.gov/ficmnew/FICMNEW_EDRR_FINAL.pdf).
- Harris, S., J. Brown, and S. Timmins. 2001. Weed surveillance—how often to search? *Science for Conservation* 175.
- Hodkinson, D. J., and K. Thompson. 1997. Plant dispersal: the role of man. *Journal of Applied Ecology*. 34:1484-1496.
- Huebner, C. D., C. Olson, and H. C. Smith. 2005. *Invasive plants field and reference guide: An ecological perspective of plant invaders of forests and woodlands*. NA-TP-05-04. Morgantown, WV. U.S. Department of Agriculture, Forest Service, Northeastern Area State & Private Forestry. <http://www.treearch.fs.fed.us/pubs/20715>.
- MacDonald, I. A.W., L. L. Loope, M. B. Usher, and O. Harmann. 1989. Wildlife conservation and the invasion of nature reserves by exotic species: a global perspective. *In* Drake, J., F. diCastri, R. Groves, F. Kruger, H. A. Mooney, M. Rejmanek, and M. Williamson, (eds.). *Biological invasions: a global perspective*. Wiley and Sons.
- Mack, R. 2003. Global plant dispersal, naturalization, and invasion: Pathways, modes, and circumstances. *In* Ruiz, G. M., and J. T. Carlton (eds.). *Invasive species: Vectors and management strategies*. Island Press.

- Myers, J. A., M. Velland, S. Gardescu, and P. L. Marks. 2004. Seed dispersal by white-tailed deer: Implications for long-distance seed dispersal, invasion, and migration of plants in Eastern North America. *Oecologia*. 139:35-44.
- Myers, J. H., D. Simberloff, A. M. Kuris, and J. R. Carey. 2000. Eradication revisited: Dealing with exotic species. *Trends in Ecology and Evolution*. 15(8):316-320.
- National Invasive Species Council (NISC). 2008. 2008-2012 National Invasive Species Management Plan. <http://www.invasivespeciesinfo.gov/council/mp2008.pdf>.
- National Research Council. 2002. Predicting invasions of non-indigenous plants and plant pests. National Academy of Sciences. Washington, DC.
- Perles, S., J. Finley, and M. Marshall. 2009. Vegetation monitoring protocol for the Eastern Rivers and Mountains Network. Natural Resource Report NPS/ERMN/NRR—2009/DRAFT. National Park Service. Fort Collins, CO.
- Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*. 52(3):273-288.
- Rejmánek, M. 2000. Invasive plants: approaches and predictions. *Austral Ecology* 25:497-506.
- Rejmánek, M., and M. J. Pitcairn. 2002. When is eradication of exotic plant pests a realistic goal? Pp. 169–176. *in* Veitch C. R, Clout, M. N., eds. *Turning the tide: The eradication of invasive species*. Gland (Switzerland): IUCN.
- Rejmánek, M., and D. M. Richardson. 1996. What attributes make some plants more invasive? *Ecology* 77(6):1655-1661.
- Rozenfelds, A. C. F., L. Cave, D. I. Morris, and A. M. Buchanan. 1999. The weed invasion in Tasmania since 1970. *Australian Journal of Botany* 47:23-48.
- Simberloff, D., and B. Von Holle. 1999. Positive interactions of nonindigenous species: Invasional meltdown? *Biological Invasions* 1:21-32.
- Smith, H. A., W. S. Johnson, J. S. Shonkwiler, and S. R. Swanson. 1999. The implications of variable or constant expansion rates in invasive weed infestations. *Weed Science* 47(1):62-66.
- Timmins, S. M., and H. Braithwaite. 2001. Early detection of invasive weeds on islands. Pp. 311-318 *In* Veitch, C. R., and Clout, M. N. (eds.). *Turning the tide: the eradication of invasive species*. IUCN SSC Invasive Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.
- Tu, M. 2002a. A new invader to North America, rapidly controlled in San Luis Obispo County, California. The Nature Conservancy. Press Release. <http://tncinvasives.ucdavis.edu/stories/ca004.html>. Accessed February 12, 2009.

- Tu, M. 2002b. Early detection and cooperation prevents the establishment and spread of a severe invasive plant pest into the Connecticut River. The Nature Conservancy. Press Release. <http://tncinvasives.ucdavis.edu/stories/ct001.html>. Accessed February 12, 2009.
- U.S. Congress Office of Technology Assessment (OTA). 1993. Harmful non-Indigenous species in the United States. U.S. Government Printing Office. Washington, DC.
- U.S. Presidential Executive Order. 1999. Executive Order 13112 of February 3, 1999. Federal Register: February 8, 1999. Volume 64, Number 25.
- von Broembsen, S. L. 1989. Invasions of natural ecosystems by plant pathogens. *In* J. A. Drake, H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, M. Rejmanek, and M. Williamson (Eds.). *Biological invasions: A global perspective*. Pp.77-83. Chichester, England. John Wiley & Sons, Ltd.
- Webb, B. (n.d.). Early Detection & Spot Removal Team of The Nature Conservancy's Southern Lake Champlain Valley Program. Retrieved February 6, 2008, from the National Invasive Species Information Center (NISIC) Web site.: <http://www.invasivespeciesinfo.gov/toolkit/detspot.shtml>.
- Wells, F. H., and W. K. Lauenroth. 2007. The potential for horses to disperse alien plants along recreational trails. *Rangeland Ecology and Management* 60:574-577.
- Williams, A. E., S. O'Neil, E. Speith, and J. Rodgers. 2007. Early detection monitoring of invasive plant species in the San Francisco Bay Area Network: A volunteer-based approach. Natural Resource Report NPS/PWR/SFAN/NRR—2007/00N. National Park Service, Pacific West Regional Office. Oakland, CA.
- Young, C. C., J. L. Haack, L. W. Morrison, and M. D. DeBacker. 2007. Invasive exotic plant monitoring protocol for the Heartland Network Inventory and Monitoring Program. Natural Resource Report NPS/HTLN/NRR-2007/018. National Park Service. Fort Collins, CO.



## **Standard Operating Procedure (SOP) #1. Updating Invasive Species Early Detection Lists.**

### **ERMN and NETN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #1 Updating Invasive Species Early Detection Lists.**

Every year, each park invasive species early detection (ISED) list will be reviewed by network staff, park natural resource managers and other pertinent contacts to ensure that the list is current and contains the top priority species. New invasive species threats should be evaluated for possible inclusion in a parks ISED list, while the prior year's list of species should be evaluated to determine if any should be removed from the list. For example, if an ED species is detected and eradicated, the species will likely remain on the park ISED list. However, if an ED species is detected at high levels and not eradicated due to lack of resources or type of infestation, the natural resource manager, Exotic Plant Management Team (EPMT), and field crew leaders will be consulted to determine whether the species should be removed from the park ISED list. The following steps should be taken to produce a new short list of invasive candidate species to add to a park list:

1. Review the previous year's candidate species and invasive species early detection lists (Appendices A and B). Species marked as low priority (L) or species waiting to receive confirmation regarding presence/absence (?) are good candidates. Pay attention to species presence (P) status at nearby parks. A species could be absent at one park, but present at an adjacent park or park that is located several counties away.
2. Speak with the park natural resource manager or relevant park contact to determine if he or she has any new information or concerns.
3. Speak with the EPMTs to determine if they have any new information or concerns.
4. Check the Early Detection and Distribution Mapping System (EDDmapS), Invasive Plant Atlas of New England (IPANE), Non-indigenous Aquatic Species (NAS) database and other pertinent databases and invasive species information storehouses for updates on species distributions and new species occurrences.
5. Network and call local and regional invasive species contacts. Each federal, state, and private agency, non-profit group, and invasive species expert may have new information regarding the spread of a new invasive species.

Once a short list of possible candidates is generated, the species prioritization process must take place. The following questions should be asked when prioritizing each new invasive species:

1. Does the species have an invasive history? "A species is likely to become invasive in a new habitat if it has a prior history of invasion elsewhere" (Rejmanek 2000, National Research Council 2002).
2. What is the species current distribution and have there been any recent outbreaks? What is the species proximity to the park? If aquatic, does it occur up or downstream of the park?
3. Does the species have the potential to become naturalized in the park?

4. Does species have the potential to establish in minimally managed habitats?
5. What is the species' habitat suitability (i.e. wetland or upland forest)? A wetland species is not as high a threat to a park that does not contain wetland habitat.
6. Are there host species present (pests and diseases only)?
7. Is the species a significant threat to park resources and communities of ecological significance (bogs, river scour communities, cliff communities etc.)?
8. Does the species negatively affect forest crop production, commercial agriculture or human health?
9. Does the species possess reproductive strategies and dispersal mechanisms that enable it to disperse rapidly and widely? A species that reproduces by seed and is dispersed by animals is more likely to be a threat than a species that reproduces only by vegetative means.
10. Does the species have a competitive ability? For example, if the species is a plant, does it have an advantage over native plants when acquiring resources like water, light, and nutrients?
11. If the species already exists in the park, have there been any disturbances or changes in the park landscape that would alter or enhance the species' invasibility?
12. What are the individual parks desires? Didymo might be impossible to currently control, but species tracking and spread prevention via public education might be important to the park.
13. What is the NatureServe Explorer Invasive Species Impact Rank (I-Rank) if available? I-Rank should only be used for guidance in the prioritization process. "Species for which I-Rank information is currently available do not represent a random sample of species exotic in the United States; available assessments may be biased toward those species with higher-than-average impact." (NatureServe 2009).

In some cases it might be helpful to discuss each species with other natural resources professionals to help narrow down parks invasive early detection species. It is important to remember that this process is not perfect and outcomes can vary depending on who is involved in the prioritization process and how much weight is placed on the answer to each prioritization question listed above.

After completing species prioritization, each park species list must be updated in each network's respective yearly invasive early detection candidate species and final invasive early detection species tables.

## References

- National Research Council. 2002. Predicting Invasions of Non-indigenous Plants and Plant Pests. National Academy of Sciences. Washington, D.C., 198 pp.
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available [<http://www.natureserve.org/explorer>]. (Accessed: November 24, 2009 ).

Rejmánek, M. 2000. Invasive plants: approaches and predictions. *Austral Ecology* 25:497-506.

## Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
-----------	------	------------	---------	---------------





## Standard Operating Procedure (SOP) #2. Data Collection.

### ERMN and NETN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #2 Data Collection

Once a new early detection species is observed, it is imperative that an Early Detection Plant or Pest Reporting form as well as accompanying photos and/or specimens be completed and submitted to the designated park contact and/or ISEDC. Each form provides specific detailed instruction regarding data collection procedures. Observers are to follow these steps when reporting a new species observation:

- 1) Fill out the appropriate Early Detection Species Reporting Form
  - a) Name
  - b) Email
  - c) Phone
  - d) Date
  - e) Time
  - f) Park
  - g) Species name (scientific or common)
  - h) GPS coordinates [Universal Transverse Mercator (UTM) coordinates, UTM zone or Decimal Degrees (DD)], Datum, and Coordinate error (meters)
  - i) Body of water name if the species is aquatic
  - j) Specific location of the species including road names, trails, signs etc.
  - k) Circle stem count (plants only): 1-5, 6-25, 26-50, 51-150, 151-500, 500+
  - l) Circle infested area (plants only):
    - i) 0.001 ac = 3.7 ft radius
    - ii) 0.01 ac = 12 ft radius
    - iii) 0.1 ac = 37 ft radius
    - iv) ½ ac = 83 ft radius
    - v) 1 ac = 118 ft radius
  - m) Host species involved (pests only)
  - n) Type of evidence present (pests only):
    - i) Crown dieback
    - ii) Foliar injury (chlorosis, necrosis, other discoloration)
    - iii) Sawdust
    - iv) Exit holes
    - v) other
  - o) Certainty of identity:
    - i) Extremely Confident
    - ii) Moderately confident
    - iii) Not very confident
  - p) Additional comments (habitat, vigor, number of individuals present, site accessibility etc.).

- 2) Flag the species location with biodegradable forestry tape. The tape must be labeled with “EDRR” or Early Detection and Rapid Response, the name of the observer, and the date of the observation. In some cases permits or study numbers are required.
- 3) Photos should be taken of distinguishable features or identifying characteristics. In some cases photos of the surrounding area may assist in relocation.
- 4) If collection of a plant specimen is warranted by a trained botanist, the following procedures apply to plants:
  - a) Collect as many identifying characteristics of the plant as you can (i.e. flowers, fruits, leaves, roots, etc.)
  - b) Before pressing, clean dirt from plant roots and try not to press wet specimens. When pressing try to orient leaves so that you can see both upper and lower surfaces. Press flowers so the interior reproductive structures are visible (open faced).
  - c) Place each plant in a single fold of newspaper or between a couple blank field sheets in a field notebook. If needed, bend plants into a 'V' or 'N' shape before pressing. Parts that stick out won't dry properly and may get broken off.
- 5) Identify the plant or pest as soon as possible. See Figure 1 for a list of qualified botanists available to assist in plant identification.
- 6) Pest specimens should be placed in a sealed plastic bag or vial. See Appendix C for State and Federal contact information for reporting new plant pest discovery information.
- 7) Send or deliver card and photographic evidence to the designated park contact or the ISEDC. Original forms should always be sent back to the appropriate network office for data entry and archival purposes.

**SOP #2, Table 1.** Qualified botanists available to assist in plant identification.

Name	Contact Information
Leslie J. Mehrhoff, Director Invasive Plant Atlas of New England (IPANE)	University of Connecticut Unit 3043, 75 North Eagleville Rd. Storrs, CT 06269-3043 860-486-5708 Les.Mehrhoff@uconn.edu
Steve Grund, Botanist Western Pennsylvania Conservancy	800 Waterfront Drive Pittsburgh, PA 15222-4718 412 586-2350 sgrund@paconserve.org
John Kunsman, Botanist Western Pennsylvania Conservancy	208 Airport Drive Middletown, PA 17057 717.948.3841 JKunsman@paconserve.org
Ann F. Rhoads, Senior Botanist Morris Arboretum of the University of Pennsylvania	100 E. Northwestern Avenue, Philadelphia, PA 19118 215-247-5777 ext. 134 rhoadsaf@pobox.upenn.edu
Jim Vanderhorst, Community Ecologist West Virginia Natural Heritage Program	Division of Natural Resources, Wildlife Section PO Box 67, Ward Road Elkins, WV 26241 304-637-0245x2058 jimvanderhorst@wvdnr.gov

SOP Figures 1 and 2 show examples of pest and plant reporting forms for the Eastern Rivers and Mountains (ERMN) and Northeast Temperate (NETN) Networks.

### **Revision History**

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

#### Revision History Log

<b>Version #</b>	<b>Date</b>	<b>Revised by</b>	<b>Changes</b>	<b>Justification</b>
------------------	-------------	-------------------	----------------	----------------------

**EARLY DETECTION PEST  
SPECIES REPORTING FORM**

DIRECTIONS

- 1) Fill out this form.
- 2) Flag location with pink flagging and label flagging with "EDRR," name of person making ID and date.
- 3) Take a photo(s) and make sure species and any distinguishable features are visible in the photo(s). Include additional photos of signs and symptoms.
- 4) ASAP, send card and/or information on card and photos to designated park contact (see species list pages) and Jennifer Stingelin Keefer at the ERMN office:

309 Forest Resources Laboratory  
University Park, PA 16802  
Phone: 814-865-8497  
Fax: 814-863-4710

Jennifer\_Stingelin\_Keefer@partner.nps.gov

GENERAL INFORMATION

Name(s): \_\_\_\_\_

Email: \_\_\_\_\_

Phone: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

SPECIES INFORMATION

Park: \_\_\_\_\_

Species name: \_\_\_\_\_

GPS Coordinates (UTMs or DD's--circle):

Y (Northing): \_\_\_\_\_

X (Easting): \_\_\_\_\_

UTM Zone: \_\_\_\_\_

Datum: \_\_\_\_\_

Coordinate error (meters): \_\_\_\_\_ (Over)

**EARLY DETECTION PEST  
SPECIES REPORTING FORM**

SPECIES INFORMATION (cont.)

Location Description (be as specific as possible):

Host Species Involved: \_\_\_\_\_  
\_\_\_\_\_

Type of evidence present (circle):

- 1. Crown dieback
- 2. Foliar injury (chlorosis, necrosis, other discoloration)
- 3. Sawdust
- 4. Exit holes
- 5. Other \_\_\_\_\_

Certainty of identity (circle one):

- Extremely confident
- Moderately confident
- Not very confident

Other comments (habitat, # individuals, site accessibility etc):

PEST

**SOP #2, Figure 1.** Early Detection of Invasive Species Surveillance Monitoring and Rapid Response pest species reporting form.

## EARLY DETECTION PLANT SPECIES REPORTING FORM

### DIRECTIONS

- 1) Fill out this form.
- 2) Flag location with pink flagging and label flagging with "EDRR," name of person making ID and date.
- 3) Take a photo(s) and make sure any flowers, fruits, and any other distinguishable features are visible in the photo(s).
- 4) ASAP, send card and/or information on card and photos to designated park contact (see Species List pages) and Jennifer Stingelin Keefer at the ERMN office:

309 Forest Resources Laboratory  
University Park, PA 16802  
Phone: 814-865-8497  
Fax: 814-863-4710  
Jennifer\_Stingelin\_Keefer@partner.nps.gov

### GENERAL INFORMATION

Name(s): \_\_\_\_\_

Email: \_\_\_\_\_

Phone: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

### SPECIES INFORMATION

Park: \_\_\_\_\_  
Species name: \_\_\_\_\_

GPS Coordinates (UTMs or DD's--circle):

Y (Northing): \_\_\_\_\_

X (Easting): \_\_\_\_\_

UTM Zone: \_\_\_\_\_

Datum: \_\_\_\_\_

Coordinate error (meters): \_\_\_\_\_ (Over)

## EARLY DETECTION PLANT SPECIES REPORTING FORM

### SPECIES INFORMATION (cont.)

Body of Water Name (aquatic species only):

Location Description (be as specific as possible):

Stem Count (circle one):

1-5    6-25    25-50    51-150    151 - 500

500+

Infested Area (circle one):

0.001 ac = 3.7 ft. radius

0.01 ac = 12 ft. radius

0.1 ac = 37 ft. radius

1/2 ac = 83 ft. radius

1 ac = 118 ft. radius

Certainty of identity (circle one):

Extremely confident

Moderately confident

Not very confident

Other comments (habitat, vigor, site accessibility etc):

PLANT

**SOP #2, Figure 2.** Early Detection of Invasive Species Surveillance Monitoring and Rapid Response plant species reporting form.



## Standard Operating Procedure (SOP) #3. Rapid Response Procedures.

### ERMN and NETN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #3 Rapid Response

When a new species or occurrence is detected an assessment must be made before a response can be initiated. The following questions and actions must be asked and carried out:

- Is it a State or Federal noxious weed? A weed such as *Heracleum mantegazzianum* (giant hogweed) should only be handled by experts due to its phototoxicity.
- Is it a new county record and is it considered a significant threat? A pest species such as *Agrilus planipennis* (emerald ash borer) would be a good candidate for this category.
- Has the species been positively identified? If not, the site must be re-visited or photographs must be examined by an expert.
- If the observer is confident in his/her identification and is highly skilled in plant identification, can the population be eradicated on-site (plants only). For example, a crew leader would be considered skilled, but probably not a volunteer unless the volunteer's skills are vetted. In some cases, if the number of plants is small and the plant is easy to pull, a rapid response can occur on site at the initial identification.
- If a rapid response is required, who does the observer contact? Each park has a designated park contact (DPC). The name of this contact is listed on each park's Early Detection Species List. This is either the park natural resource manager or the Invasive Species Early Detection Coordinator (ISED). It is the DPC's responsibility to alert the ISED or park natural resource manager (if different) of the new species detection. From this point on, it is up to the ISED and park natural resource manager to alert the appropriate agencies such as the Bureau of Plant Industry or the Animal and Plant Health Inspection Service (APHIS) within the U.S. Department of Agriculture, local weed management organizations, network and park personnel, and coordinate with the EPMTs.

Figure 1 depicts the Early Detection of Invasive Species Rapid Response system for the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN).

Each response will be based on the individual needs of the park and the resources available and the nature of the infestation. Because most of the parks in either network lack funding and resources to perform invasive species rapid response on their own, cooperation with EPMTs, both networks, and outside agencies will be necessary. In addition, in some cases, "no response" may be the appropriate action. Eradication or control of certain pest infestations may not be feasible due to pest abundance, lack of chemical or biological control measures, or the cost to implement control measures.

Unique circumstances as well as sufficient funding and resources exist at some parks within the ERMN and NETN and enable them to respond more quickly to new invasive species occurrences. For example, Fort Necessity National Battlefield (FONE) and Friendship Hill

National Historic Site (FRHI) are part of the Southern Laurel Highlands Plant Management Partnership (SLHPMP), a Cooperative Weed Management Area (CWMA). Potentially, this group that brings together state, federal, private and non-profit organizations will be able to respond to any new species occurrences. Saratoga National Historical Park (SARA) is fortunate to have trained maintenance personnel that enjoy and prioritize invasive species management and New River Gorge National River (NERI) uses a Biological Science Technician to rapidly respond to new species detections.

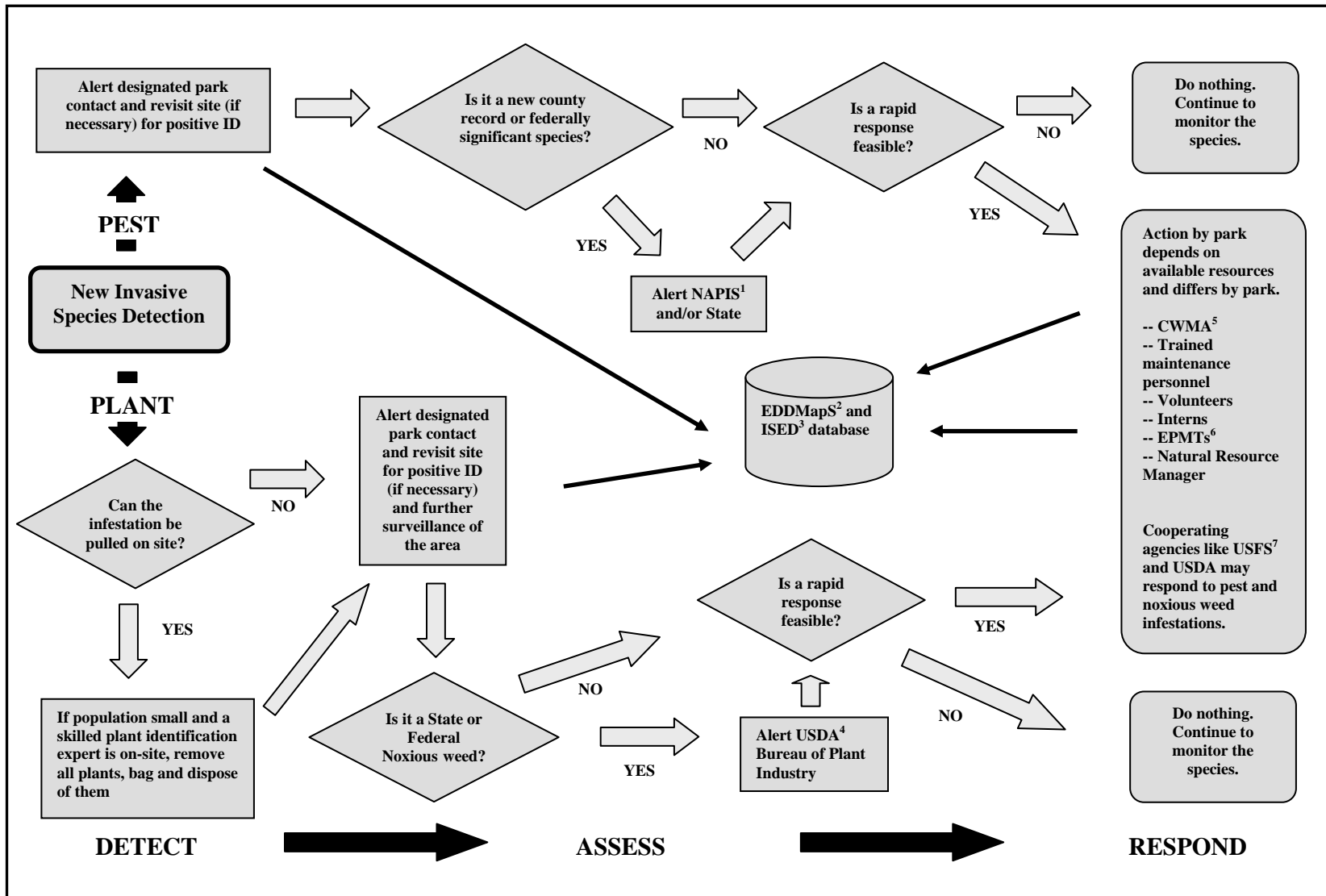
### **Revision History**

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

#### Revision History Log

<b>Version #</b>	<b>Date</b>	<b>Revised by</b>	<b>Changes</b>	<b>Justification</b>
------------------	-------------	-------------------	----------------	----------------------





SOP #3, Figure 1. Early Detection of Invasive Species Rapid Response system for the Eastern Rivers and Mountains Network (ERMN).

<sup>1</sup>National Agricultural Pest Information System (NAPIS); <sup>2</sup>Early Detection & Distribution Mapping System (EDDMapS); <sup>3</sup>Invasive Species Early Detection (ISED); <sup>4</sup>United States Department of Agriculture (USDA); <sup>5</sup>Cooperative Weed Management Area (CWMA); <sup>6</sup>Exotic Plant Management Team (EPMT); <sup>7</sup>United States Forest Service (USFS).



## Appendix A. Eastern Rivers and Mountains Network (ERMN) Invasive Species Prioritization Process.

There are various tools available, predominately for plants, to assist with invasive species prioritization, categorization, and risk assessment. Invasive plant prioritization tools focus on criteria such as specific geographic regions (Mehrhoff 2000, Warner et al. 2003), current level of species impact, and feasibility of control (Hiebert and Stubbendieck 1993), while invasive pest prioritization can involve cost criteria (Moffitt and Osteen 2006), life history measures (Causton et al. 2006), or in the case of gastropods, criteria such as survivability in shipments and difficulty of pest detection through visual inspection (Floyd 2008). For example, U.S. Invasive Species Impact Ranks (I-Ranks) and the associated Invasive Species Assessment Protocol, which guides individuals through a series of questions to determine I-Rank, use extensive biogeographical information as criteria to rank plant invasiveness at local, regional, national, and global scales (Morse et al. 2004). The Invasive Plant Atlas of New England (IPANE) uses six specific biological criteria to prioritize or “track” specific invasive plants in New England (IPANE 2009). Each of these systems provides a well-conceived model for ranking invasive plants. Other less formal lists draw on experience across a range of resource management disciplines. As an example, state and federal noxious weed lists have historically targeted agricultural pest plants.

Although the aforementioned ranking and prioritization tools were referenced and employed for guidance, a more informal procedure for prioritizing early detection species was used to focus on each individual park and the critical habitats contained therein. Prioritization systems like I-Ranks viewed in NatureServe Explorer <http://www.natureserve.org/explorer/index.htm> were only helpful in certain situations where common and widespread species information was required or more general information regarding a particular species was desired. The Invasive Species Assessment Protocol is “configured for use for regions of interest that are contiguous, as opposed to those with two or more separate parts...” and it is not recommended that “a highly fragmented area (such as an assemblage of scattered land holdings of a single government agency) be used as a region of interest with this protocol, since only a small sampling of a species’ regional status, impacts, trends, and dispersal dynamics would be considered.” (Morse et al., 2004). For example, when considering a species such as purple loosestrife (*Lythrum salicaria*), NatureServe lists the I-Rank of purple loosestrife (*Lythrum salicaria*) as High. Although this is true for sites that contain wetland and riparian habitats, purple loosestrife was not prioritized as High in some of our parks due to the lack of significant habitat. Rejmanek (2000) maintains that attention should be directed towards habitat-specific predictions and that “all-inclusive indices (scores for screening) might be helpful, but really relevant information might be suppressed.” Word of mouth, knowledge of each individual park’s habitats, and local field testimonials were by far the most valuable tools utilized to prioritize species in this protocol.

The process for selecting a short list of invasive species for each park in the ERMN consisted of four main components: Review existing park datasets and literature and compile a list of all invasive species known or thought to occur in the parks; immediately eliminate all common and well-established species from this list; review existing invasive species data from nearby parks, towns, counties, and states and add new invasive candidate species that are not already

present in the parks; conduct more extensive species research and consult with park natural resource managers to narrow down and create the final park species lists.

Because of the dispersed locations of the ERMN parks across four states and differences in park size and natural resources, it was necessary to examine each park on an individual basis. The process of developing thorough priority early detection species lists began by reviewing existing natural resources inventory reports and databases (Table 1) and compiling lists of all invasive species known or thought to occur in each park (Table 2). All common and well-established species were then immediately eliminated from this list as early detection species candidates.

**Appendix A, Table 1.** Resources reviewed for each park during the species prioritization process to build a list of all invasive species known to exist in each park in the Eastern Rivers and Mountains Network (ERMN).

<b>Resources</b>	<b>ERMN Parks</b>
Consultations with park Natural Resource Managers, EPMTs, park personnel and scientists familiar with park lands	All Parks
Exotic Plant Management Team (EPMT) Data sets-- Alien Plant Control and Management Database (APCAM).	All Parks
Eichelberger, B. A. and S. J. Perles. 2009. Determining the Status and Trends of Key Invasive Plant Species in the Delaware Water Gap National Recreation Area. Technical Report NPS/NER/NRTR—2009/DRAFT. National Park Service. Philadelphia, PA.	DEWA
Eichelberger, B. A. and S. J. Perles. 2009. Determining the Status and Trends of Key Invasive Plant Species in the Upper Delaware Scenic and Recreational River. Technical Report NPS/NER/NRTR—2009/DRAFT. National Park Service. Philadelphia, PA.	UPDE
Lieb, D. A., R. F. Carline, and H. M. Ingram. 2007. Status of Native and Invasive Crayfish in Ten National Park Service Properties in Pennsylvania. Technical Report NPS/NER/NRTR—2007/085. National Park Service. Philadelphia, PA.	ALPO, JOFL, FONE, FRHI, DEWA, UPDE
NPSpecies - The National Park Service Biodiversity Database. Secure online version. <a href="https://science1.nature.nps.gov/npspecies/web/main/start">https://science1.nature.nps.gov/npspecies/web/main/start</a> .	All Parks
Vegetation Classification and Mapping Report data	ALPO, JOFL, FONE, FRHI, DEWA, UPDE, NERI, BLUE
Zimmerman, E. March 2007. Distribution and abundance of nonnative plant species at Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site. Technical Report NPS/NER/NRTR—2007/083. National Park Service. Philadelphia, PA.	ALPO, JOFL
Zimmerman, E. and J. Yoder. August 2006. Distribution and Abundance of Non-native Plant Species at Fort Necessity National Battlefield and Friendship Hill National Historic Site. Natural Resource Technical Report NPS/NER/NRTR--2006/053. National Park Service. Philadelphia, PA.	FONE, FRHI

**Appendix A, Table 2.** All invasive species known or thought to occur in the Eastern Rivers and Mountains Network (ERMN).

Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<b>PESTS</b>										
<i>Adelges tsugae</i>	hemlock woolly adelgid	X		X				X		
<b>PLANTS</b>										
<i>Acer palmatum</i>	Japanese maple			X						
<i>Acer platanoides</i>	Norway maple	X		X				X		X
<i>Aegopodium podagraria</i>	bishop's goutweed			X						
<i>Ailanthus altissima</i>	tree of heaven	X	X	X	X	X	X		X	
<i>Akebia quinata</i>	five-leaf akebia			X						
<i>Albizia julibrissin</i>	mimosa		X	X					X	
<i>Alliaria petiolata</i>	garlic mustard	X	X	X	X	X		X	X	X
<i>Allium vineale</i>	wild garlic			X	X			X	X	
<i>Alnus glutinosa</i>	European alder	X						X		
<i>Amorpha fruticosa</i>	false indigo			X						
<i>Ampelopsis brevipedunculata</i>	Amur peppervine									X
<i>Anthoxanthum odoratum</i>	sweet vernalgrass	X	X		X	X	X	X	X	
<i>Anthriscus sylvestris</i>	wild chervil			X						X
<i>Artemisia vulgaris</i>	common wormwood	X		X	X				X	
<i>Arthraxon hispidus</i>	hairy jointgrass								X	
<i>Barbarea vulgaris</i>	garden yellowrocket	X	X	X	X	X		X	X	X
<i>Berberis thunbergii</i>	Japanese barberry	X		X	X	X		X		X
<i>Berberis vulgaris</i>	common barberry		X	X	X					X
<i>Butomus umbellatus</i>	flowering rush					X				
<i>Cardamine impatiens</i>	narrowleaf bittercress		X				X		X	
<i>Carduus nutans</i>	nodding plumeless thistle			X						X
<i>Celastrus orbiculatus</i>	Oriental bittersweet	X		X						X
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	X		X			X	X	X	X
<i>Chelidonium majus</i>	celandine	X					X		X	
<i>Cirsium arvense</i>	Canada thistle	X		X	X	X		X		X
<i>Cirsium vulgare</i>	bull thistle	X			X	X				
<i>Coincya monensis</i>	star-mustard			X						



Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<i>Morus alba</i>	white mulberry			X		X			X	X
<i>Myosotis scorpioides</i>	forget-me-not			X						X
<i>Ornithogalum umbellatum</i>	star-of-Bethlehem					X			X	
<i>Pastinaca sativa</i>	wild parsnip	X			X			X	X	
<i>Paulownia tomentosa</i>	Princess tree		X	X	X		X		X	
<i>Perilla frutescens</i>	beefsteakplant		X				X		X	
<i>Phalaris arundinacea</i>	reed canarygrass	X	X	X	X	X		X	X	X
<i>Phragmites australis</i>	common reed			X						X
<i>Plantago lanceolata</i>	narrowleaf plantain	X	X	X	X	X		X	X	X
<i>Plantago major</i>	common plantain	X		X	X	X		X	X	X
<i>Polygonum caespitosum</i>	Oriental lady's thumb	X	X	X		X	X		X	X
<i>Polygonum cuspidatum</i>	Japanese knotweed	X	X	X		X	X	X	X	X
<i>Polygonum perfoliatum</i>	mile-a-minute	X		X						X
<i>Polygonum persicaria</i>	spotted lady's thumb		X	X	X	X	X	X	X	X
<i>Polygonum sachalinense</i>	giant knotweed			X		X		X		X
<i>Potentilla recta</i>	sulphur cinquefoil								X	
<i>Pueraria montana</i> var. <i>lobata</i>	kudzu								X	
<i>Pyrus pyrifolia</i>	Chinese pear		X							
<i>Ranunculus repens</i>	creeping buttercup	X		X					X	X
<i>Rhamnus cathartica</i>	common buckthorn	X		X					X	
<i>Rosa multiflora</i>	multiflora rose	X	X	X	X	X	X	X	X	X
<i>Rubus phoenicolasius</i>	wine raspberry	X	X	X			X		X	
<i>Rumex acetosella</i>	common sheep sorrel	X	X	X	X	X		X	X	X
<i>Securigera varia</i>	crownvetch	X	X	X	X	X	X	X	X	X
<i>Sedum sarmentosum</i>	stringy stonecrop								X	
<i>Silphium perfoliatum</i>	cup plant								X	
<i>Solanum dulcamara</i>	bittersweet nightshade	X		X	X				X	X
<i>Sorghum halepense</i>	Johnsongrass								X	
<i>Spiraea japonica</i>	Japanese meadowsweet		X						X	
<i>Tussilago farfara</i>	coltsfoot	X	X	X		X	X		X	X
<i>Ulmus pumila</i>	Siberian elm			X					X	
<i>Urtica dioica</i> ssp. <i>dioica</i>	stinging nettle		X				X		X	

Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<i>Verbascum blattaria</i>	moth mullein		X						X	
<i>Verbascum thapsus</i>	common mullein	X	X	X		X	X	X	X	X
<i>Vinca minor</i>	common periwinkle	X		X	X	X			X	X
<i>Wisteria floribunda</i>	Japanese wisteria			X						
<i>Wisteria sinensis</i>	Chinese wisteria			X						

Parks include: Allegheny Portage Railroad National Historic Site (ALPO), Bluestone National Scenic River (BLUE), Delaware Water Gap National Recreation Area (DEWA), Fort Necessity National Battlefield (FONE), Friendship Hill National Historic Site (FRHI), Gauley River National Recreation Area (GARI), Johnstown Flood National Memorial (JOFL), New River Gorge National River (NERI), and Upper Delaware National Scenic and Recreational River (UPDE).



Although the numbers varied by park, approximately 30 common and well-established species were eliminated. Examples include Queen Anne's lace (*Daucus carota*), autumn olive (*Elaeagnus umbellata*), and garden yellowrocket (*Barbarea vulgaris*). Both Queen Anne's lace and autumn olive were present in every park and garden yellowrocket was present in every park with the exception of Gauley River National Recreation Area (GARI). Background data was not available for GARI, but due to the general widespread distribution of garden yellowrocket, it is thought to occur there.

Once a list of species known or thought to occur in each park was created and all common and widespread species were removed, existing invasive species data from nearby parks, towns, counties, and states were reviewed and new invasive species threats not present in the parks were added to the candidate list. The following resources, among others, were utilized to complete a candidate list of early detection species lists for each park:

1. USDA PLANTS database <http://plants.usda.gov/>
2. The Biota of North America Program (BONAP) web-based U.S. County-Level Atlas of the Vascular Flora of North America <http://www.bonap.org/MapSwitchboard.html>
3. Early Detection and Distribution Mapping System (EDDMapS) <http://www.eddmaps.org/>
4. National Agricultural Pest Information System (NAPIS) <http://pest.ceris.purdue.edu/index.php>
5. Invasive Plant Atlas of New England (IPANE) <http://nbii-nin.ciesin.columbia.edu/ipane/>
6. USGS Non-indigenous Aquatic Species (NAS) <http://nas.er.usgs.gov/>
7. Western Pennsylvania Conservancy (WPC)
8. PA Department of Agriculture Animal and Plant Health (<http://www.agriculture.state.pa.us/agriculture/cwp/view.asp?a=3&q=149376>)
9. West Virginia Wildlife Diversity Program and Natural Heritage Program (<http://www.wvdnr.gov/Wildlife/DirtyDozen.shtm>)
10. NatureServe Explorer <http://www.natureserve.org/explorer/>
11. Pennsylvania Game Commission (PGC)
12. Pennsylvania Fish and Boat Commission (PFBC) <http://www.fish.state.pa.us/ais.htm>
13. Pennsylvania Department of Conservation and Natural Resources (DCNR)
14. Wayne Millington, NPS Northeast Region IPM Coordinator
15. Betsy Lyman, Northeast Exotic Plant Management Team (EPMT), Liaison
16. Northeast Aquatic Nuisance Species Panel (NEANS) <http://www.northeastans.org/>
17. Central Jersey Invasive Species Strike Team (CJISST) <http://www.cjisst.org/index.html>
18. iMapInvasives <http://www.imapinvasives.org/>
19. West Virginia Natural Heritage Program (WVNHP)
20. Leslie Mehrhoff, Director, Invasive Plant Atlas of New England (IPANE)
21. Communications with park personnel and contractors familiar with the parks.
22. Eichelberger, B. A. and S. J. Perles. 2009. Determining the Status and Trends of Key Invasive Plant Species in the Delaware Water Gap National Recreation Area. Technical Report NPS/NER/NRTR—2009/DRAFT. National Park Service. Philadelphia, PA.
23. Eichelberger, B. A. and S. J. Perles. 2009. Determining the Status and Trends of Key Invasive Plant Species in the Upper Delaware Scenic and Recreational River. Technical Report NPS/NER/NRTR—2009/DRAFT. National Park Service. Philadelphia, PA.

Approximately 10 invasive species currently absent from ERMN parks were added to the candidate list. For example, Oriental photinia (*Photinia villosa*) was reported as a new threat in New Jersey by the Central Jersey Invasive Species Strike Team (CJISST). Delaware Water Gap National Recreation Area (DEWA) and Upper Delaware National Scenic and Recreational River (UPDE) border New Jersey and New York, respectively, and are located only counties away from the expanding populations in New Jersey.

Once the invasive species candidate list was constructed each species was then researched and prioritized. During this process, each park natural resource manager, the Regional Integrative Pest Management Coordinator and Exotic Plant Management Team Liaison were consulted for input. Initially, due to time constraints, species were marked as “priority” and “low priority.” The following questions were asked during the species prioritization process:

1. Does the species have an invasive history? “A species is likely to become invasive in a new habitat if it has a prior history of invasion elsewhere” (Rejmanek 2000, National Research Council 2002).
2. What is the species current distribution and have there been any recent outbreaks? What is the species proximity to the park? If aquatic, does it occur up or downstream of the park?
3. Does the species have the potential to become naturalized in the park?
4. Does species have the potential to establish in minimally managed habitats?
5. What is the species’ habitat suitability (i.e. wetland or upland forest)? A wetland species is not as high a threat to a park that does not contain wetland habitat.
6. Are there host species present (pests and diseases only)?
7. Is the species a significant threat to park resources and communities of ecological significance (bogs, river scour communities, cliff communities etc.)?
8. Does the species negatively affect forest crop production, commercial agriculture or human health?
9. Does the species possess reproductive strategies and dispersal mechanisms that enable a it to disperse rapidly and widely? A species that reproduces by seed and is dispersed by animals is more likely to be a threat than a species that reproduces only by vegetative means.
10. Does the species have a competitive ability? For example, if the species is a plant, does it have an advantage over native plants when acquiring resources like water, light, and nutrients?
11. If the species already exists in the park, have there been any disturbances or changes in the park landscape that would alter or enhance the species’ invasibility?
12. What are the individual parks desires? For example, didymo might be impossible to currently control, but species tracking and spread prevention via public education might be important to the park.
13. What is the NatureServe Explorer Invasive Species Impact Rank (I-Rank) if available? I-Rank was only be used for guidance during the prioritization process. “Species for which I-Rank information is currently available do not represent a random sample of species exotic in the United States; available assessments may be biased toward those species with higher-than-average impact.” (NatureServe 2009).

Although numbers vary by park, a total of 29 early detection species, 11 low priority species, and 11 questionable species were designated for ERMN parks. For example, wavyleaf

basketgrass (*Oplismenus hirtellus* ssp. *undulatifolius*) was recently reported as a new threat in Maryland by the Anacostia Watershed Society and the Maryland Department of Natural Resources. The species has since jumped as far as Shenandoah National Park in Virginia and regional invasive species experts are concerned about its potential spread. Wavyleaf basketgrass invasive traits include an effective seed dispersal mechanism, shade tolerance, and a seasonal advantage of staying green longer than native plants (Kyde and Marose n.d., Peterson et al., 1999). Visitors to parks on the east coast are potential long-distance vectors for this species. If this species spreads, it has the potential to become an aggressive invader in eastern forests. Low priority species are species that were reviewed, but dropped-out during the 2009 final prioritization process. These species will be considered in the future as possible early detection list additions. Species designated as questionable are species that will most likely be added to the next year's early detection list, but a general confirmation from the park regarding species absence is needed before the addition is made.

See Table 3 for a list of Invasive early detection candidate species and October 2009 final invasive early detection species for the Eastern Rivers and Mountains Network (ERMN) by park and taxa category. These tables will be updated on an annual basis to reflect new invasive early detection species inclusions, eliminations, and changing priorities.

**Appendix A, Table 3.** Invasive early detection candidate species and October 2009 final invasive early detection species for the Eastern Rivers and Mountains Network (ERMN) by park and taxa category. This list contains the remaining subset of species from the initial literature search and data review and the species obtained from nearby parks, towns, counties and states.

Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<b>PESTS</b>										
<i>Adelges tsugae</i>	hemlock wooly adelgid	P/ED		P	ED	ED		P		
<i>Agrilus planipennis</i>	emerald ash borer	ED	ED	ED	ED	ED	ED	ED	P	ED
<i>Anoplophora glabripennis</i>	Asian long-horned beetle	ED		ED	ED	ED		ED		ED
<i>Pyrrhalta viburni</i>	viburnum leaf beetle	ED		ED	ED	ED		ED		ED
<i>Sirex noctilio</i>	Sirex woodwasp	ED		ED	ED	ED		ED		ED
<b>PLANTS</b>										
<i>Acer ginnala</i>	amur maple									
<i>Acer palmatum</i>	Japanese maple			P						
<i>Acer platanoides</i>	Norway maple	P	ED	P			ED	P	ED	P
<i>Aegopodium podagraria</i>	goutweed			P						
<i>Ailanthus altissima</i>	tree of heaven	P	P	P	P	P	P	?	P	ED
<i>Akebia quinata</i>	chocolate vine			P						L
<i>Albizia julibrissin</i>	mimosa		P	P			L		P	L
<i>Alliaria petiolata</i>	garlic mustard	P	P	P	P	P	ED	P	P	P
<i>Alnus glutinosa</i>	European alder	P						P		
<i>Ampelopsis brevipedunculata</i>	Amur peppervine			?						P
<i>Anthriscus sylvestris</i>	wild chervil			P						P
<i>Aralia elata</i>	Japanese aralia			ED						ED
<i>Berberis thunbergii</i>	Japanese barberry	P	ED	P	P	P	ED	P	P/ED	P
<i>Berberis vulgaris</i>	common barberry		P	P	P					P
<i>Cardamine impatiens</i>	narrowleaf bittercress	ED	P	P/ED	ED	ED	P	ED	P	ED
<i>Carduus nutans</i>	nodding plumeless thistle			P						P
<i>Celastrus orbiculatus</i>	oriental bittersweet	P	ED	P	?	P	ED	?	P	P
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	P	P	P			P		P	P
<i>Chelidonium majus</i>	celandine	P		P			P		P	P
<i>Cirsium arvense</i>	Canada thistle	P		P	P	P		P		P
<i>Cirsium vulgare</i>	bull thistle	P		P	P	P			P	P
<i>Commelina communis</i>	Asiatic dayflower	P	P	P		P			P	
<i>Cynanchum louiseae</i> / <i>C. rossicum</i>	Louise's & European swallow-worts	L	L	ED	L	L	L	L	L	ED
<i>Dioscorea oppositifolia</i>	Chinese yam		P/ED				ED		P	

Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<i>Elaeagnus angustifolia</i>	Russian olive			P					P	P
<i>Euonymus alatus</i>	winged burning bush			P	P	ED		P	?	?
<i>Eupatorium serotinum</i>	lateflowering thoroughwort		P	P			P		P	
<i>Forsythia spp.</i>	forsythia	P		P	P				P	
<i>Frangula alnus</i>	glossy buckthorn	ED	ED	ED	ED	P	ED	ED	ED	P
<i>Hedera helix</i>	English ivy		L	P			L		P	L
<i>Hemerocallis fulva</i>	orange daylily	P		P			P		P	P
<i>Heracleum mantegazzium</i>	giant hogweed	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Humulus japonicus</i>	Japanese hop	P	P	P	L	L	L	L	?	P
<i>Iris pseudacorus</i>	paleyellow iris	P	P	P			P		P	
<i>Kochia scoparia</i>	common kochia									
<i>Lepidium latifolium</i>	perennial pepperweed									
<i>Lespedeza bicolor</i>	shrub lespedeza						P		P	
<i>Lespedeza cuneata</i>	Chinese lespedeza		P	P		P	P/ED		P	L
<i>Ligustrum obtusifolium/L. vulgare</i>	border/European privets	P	P	P	P	P/ED	P	P	P	ED
<i>Lonicera japonica</i>	Japanese honeysuckle	P	P	P	P	P	P	ED	P	ED
<i>Lonicera maackii</i>	amur honeysuckle	P		P						P
<i>Lonicera tatarica</i>	Tatarian honeysuckle	P		P	P			P	P	
<i>Lonicera X bella</i>	Bell's honeysuckle	P						P		
<i>Lychnis flos-cuculi</i>	ragged robin			P						P
<i>Lysimachia nummularia</i>	creeping Jenny	P	P	P		P	P		P	P
<i>Lythrum salicaria</i>	purple loosestrife	L	P	P	L	L	ED	L	P	P
<i>Microstegium vimineum</i>	Japanese stiltgrass	P	P	P	P	P	P	ED	P	P
<i>Miscanthus sinensis</i>	Chinese silvergrass			P	L	L			P	
<i>Morus alba</i>	white mulberry			P		P			P	P
<i>Myosotis scorpioides</i>	forget-me-not			P						P
<i>Oplismenus hirtellus ssp. undulatifolius</i>	wavyleaf basketgrass	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Ornithogalum umbellatum</i>	star-of-bethlehem	P		P		P			P	
<i>Paulownia tomentosa</i>	Princess tree		P	P	P		P		P	L
<i>Perilla frutescens</i>	beefsteakplant		P				P		P	
<i>Phellodendron amurense</i>	Amur corktree			P						?
<i>Photonia villosa</i>	Oriental photinia			?						?
<i>Phragmites australis</i>	phragmites		ED	P/ED		ED	ED		P	P
<i>Polygonum cuspidatum/sachalinense</i>	Japanese/giant knotweed	P	P/ED	P	P	P	P/ED	P	P	P

Scientific Name	Common Name	ALPO	BLUE	DEWA	FONE	FRHI	GARI	JOFL	NERI	UPDE
<i>Polygonum perfoliatum</i>	mile-a-minute	P/ED	ED	P/ED	ED	ED	ED	ED	ED	P
<i>Populus alba</i>	white poplar			P						
<i>Pueraria montana</i> var. <i>lobata</i>	kudzu	ED	ED	ED	ED	ED	ED	ED	P	ED
<i>Pyrus calleryana</i>	callery pear			?						?
<i>Pyrus pyrifolia</i>	Chinese pear		P	P			L		L	
<i>Ranunculus ficaria</i>	lesser celandine	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Ranunculus repens</i>	creeping buttercup	P		P					P	P
<i>Rhamnus cathartica</i>	common buckthorn	P	ED	P	ED	ED	ED	?	P/ED	ED
<i>Rubus phoenicolasius</i>	wine raspberry	P	P	P			P		P	
<i>Sedum sarmentosum</i>	stringy stonecrop		L	P			L		P	
<i>Silphium perfoliatum</i>	cup plant								P	
<i>Sorghum halepense</i>	Johnsongrass		L	L			L		P	L
<i>Spiraea japonica</i>	Japanese spiraea		P	P					P	
<i>Viburnum dilatatum</i>	linden arrowwood			P						?
<i>Viburnum sieboldii</i>	Siebold viburnum			?						?
<i>Vinca minor</i>	common periwinkle	P		P	P	P	P		P	P
<i>Wisteria floribunda</i> / <i>W. sinensis</i>	Japanese/Chinese wisteria			P						

ED=October 2009 final early detection species; P=already present within park; P/ED=present within park in small numbers, but early detection is still warranted to prevent spread to other areas of park; L=low priority (species was reviewed, but dropped-out during 2009 final prioritization process); ?=considering adding to 2010 early detection list; Parks include: Allegheny Portage Railroad National Historic Site (ALPO), Bluestone National Scenic River (BLUE), Delaware Water Gap National Recreation Area (DEWA), Fort Necessity National Battlefield (FONE), Friendship Hill National Historic Site (FRHI), Gauley River National Recreation Area (GARI), Johnstown Flood National Memorial (JOFL), New River Gorge National River (NERI), and Upper Delaware National Scenic and Recreational River (UPDE).

## References

- Causton, C. E., S. B. Peck, B. J. Sinclair, L. Roque-Albelo, C. J. Hodgson, and B. Landry. 2006. Alien Insects: Threats and Implications for Conservation of Galapagos Islands. *Annals of the Entomological Society of America*. 99(1):121-143.
- Floyd, J. 2008. New Pest Response Guidelines: Temperate Terrestrial Gastropods. USDA–APHIS–PPQ–Emergency and Domestic Programs, Riverdale, Maryland. [[http://www.aphis.usda.gov/import\\_export/plants/manuals/emergency/index.shtml](http://www.aphis.usda.gov/import_export/plants/manuals/emergency/index.shtml)].
- Hiebert, R. D., and J. Stubbendieck. 1993. Handbook for Ranking Exotic Plants for Management and Control. U. S. Department of the Interior, Natural Resources Report NPS/NRMWRO/NRR-93/08. National Park Service, Natural Resources Publication Office, Denver, CO.
- Invasive Plant Atlas of New England (IPANE). 2009. *IPANE Evaluation of Species*. [<http://nbiin.ciesin.columbia.edu/ipane/aboutproject/SpeciesEvaluationProtocols.htm>]. (Accessed February 17, 2009).
- Kyde, Kerrie L. and Betty H. Marose. nd. Wavyleaf Basketgrass in Maryland: An Early Detection Rapid Response Program in Progress. Poster. Maryland Department of Natural Resources. [[http://dnr.maryland.gov/wildlife/download/wlbg\\_poster011108.pdf](http://dnr.maryland.gov/wildlife/download/wlbg_poster011108.pdf)]. (Accessed April 16, 2009).
- Mehrhoff, L. J. 2000. *Criteria for Including a Species as a Non-Native Invasive Species or a Potentially Invasive Species In Connecticut*. Retrieved February 17, 2009 from the Connecticut Invasive Plant Working Group (CIPWG) Web Site: [<http://www.hort.uconn.edu/cipwg/>].
- Moffitt, L. J. and Craig D. Osteen. 2006. Prioritizing Invasive Species Threats Under Uncertainty. *Agricultural and Resource Economics Review*. 35(1):41-51.
- Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virginia.
- National Research Council. 2002. Predicting Invasions of Non-indigenous Plants and Plant Pests. National Academy of Sciences. Washington, D.C., 198 pp.
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available [<http://www.natureserve.org/explorer>]. (Accessed: November 24, 2009 ).
- Peterson, Paul M., Edward E. Terrell, Edward C. Uebel, Charles A. Davis, Hildemar Scholz, and Robert J. Soreng. 1999. *Oplismenus hirtellus* Subspecies *undulatifolius*, a new record in North America. *Castanea*. 64(2):201-202.
- Rejmánek, M. 2000. Invasive plants: approaches and predictions. *Austral Ecology* 25:497-506.

Warner, P.J., C. C. Bossard, M.L. Brooks, J. M. DiTomaso, J. A. Hall, A. M. Howald, D. W. Johnson, J. M. Randall, C. L. Roye, and A. E. Stanton. 2003. Criteria for Categorizing Invasive Non-native Plants that Threaten Wildlands. California Exotic Pest Plant Council and Southwest Vegetation Management Association.

## Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

### Revision History Log

Version #	Date	Revised by	Changes	Justification
-----------	------	------------	---------	---------------



## Appendix B. Northeast Temperate Network (NETN) Invasive Species Prioritization Process

There are various tools available, predominately for plants, to assist with invasive species prioritization, categorization, and risk assessment. Invasive plant prioritization tools focus on criteria such as specific geographic regions (Mehrhoff 2000, Warner et al. 2003), current level of species impact, and feasibility of control (Hiebert and Stubbendieck 1993), while invasive pest prioritization can involve cost criteria (Moffitt and Osteen 2006), life history measures (Causton et al. 2006), or in the case of gastropods, criteria such as survivability in shipments and difficulty of pest detection through visual inspection (Floyd 2008). For example, U.S. Invasive Species Impact Ranks (I-Ranks) and the associated Invasive Species Assessment Protocol, which guides individuals through a series of questions to determine I-Rank, use extensive biogeographical information as criteria to rank plant invasiveness at local, regional, national, and global scales (Morse et al. 2004). The Invasive Plant Atlas of New England (IPANE) uses six specific biological criteria to prioritize or “track” specific invasive plants in New England (IPANE 2009). Each of these systems provides a well-conceived model for ranking invasive plants. Other less formal lists draw on experience across a range of resource management disciplines. As an example, state and federal noxious weed lists have historically targeted agricultural pest plants.

Although the aforementioned ranking and prioritization tools were referenced and employed for guidance, a more informal procedure for prioritizing early detection species was used to focus on each individual park and the critical habitats contained therein. Prioritization systems like I-Ranks viewed in NatureServe Explorer <http://www.natureserve.org/explorer/index.htm> were only helpful in certain situations where common and widespread species information was required or more general information regarding a particular species was desired. The Invasive Species Assessment Protocol is “configured for use for regions of interest that are contiguous, as opposed to those with two or more separate parts...” and it is not recommended that “a highly fragmented area (such as an assemblage of scattered land holdings of a single government agency) be used as a region of interest with this protocol, since only a small sampling of a species’ regional status, impacts, trends, and dispersal dynamics would be considered.” (Morse et al., 2004). For example, when considering a species such as purple loosestrife (*Lythrum salicaria*), NatureServe lists the I-Rank of purple loosestrife (*Lythrum salicaria*) as High. Although this is true for sites that contain wetland and riparian habitats, purple loosestrife was not prioritized as High in some of our parks due to the lack of significant habitat. Rejmanek (2000) maintains that attention should be directed towards habitat-specific predictions and that “all-inclusive indices (scores for screening) might be helpful, but really relevant information might be suppressed.” Word of mouth, knowledge of each individual park’s habitats, and local field testimonials were by far the most valuable tools utilized to prioritize species in this protocol.

The process for selecting a short list of invasive species for each park in the ERMN consisted of four main components: Review existing park datasets and literature and compile a list of all invasive species known or thought to occur in the parks; immediately eliminate all common and well-established species from this list; review existing invasive species data from nearby parks, towns, counties, and states and add new invasive candidate species that are not already present in the parks; conduct more extensive species research and consult with park natural resource managers to narrow down and create the final park species lists.

Because of the dispersed locations of the NETN parks across the Northeast Region and differences in park size and natural resources, it was necessary to examine each park on an individual basis. In the case of Boston Harbor Islands National Recreation Area (BOHA), each accessible island that currently sustains plant life was examined individually. This model may be applicable to other parks that are comprised of multiple units. The process of developing thorough priority early detection species lists began by reviewing existing natural resources inventory reports and databases (Table 1) and compiling lists of all invasive species known or thought to occur in each park (Tables 2 and 3). All common and well-established species were then immediately eliminated from this list as early detection species candidates.

**Appendix B, Table 1.** Resources reviewed for each park during the species prioritization process to build a list of all invasive species known to exist in each park in the Northeast Temperate Network (NETN).

<b>Resources</b>	<b>NETN Parks</b>
Agius, B. December 2003. Forging Changes in an American Landscape: Invasive Plant Species at the Saugus Iron Works National Historic Site. Technical Report NPS/NER/NRTR—2005/010. National Park Service. Woodstock, VT.	SAIR
Agius, B. December 2003. Revolutionary Changes to an American Landscape: Invasive Plant Species at the Minute Man National Historical Park. Technical Report NPS/NER/NRTR—2005/009. National Park Service. Woodstock, VT.	MIMA
Consultations with park Natural Resource Managers, EPMTs, park personnel and scientists familiar with park lands	All Parks
Exotic Plant Management Team (EPMT) Data sets--Alien Plant Control and Management Database (APCAM).	All Parks
Elliman, T. 2005. Boston Harbor Islands Botanical Inventory. 165 p.	BOHA
Greene, C.W., J.E. Weber, S.C. Rooney, K.B. Anderson. December 2004. Invasive Plant Distribution and Abundance in Acadia National Park. Technical Report NPS/NER/NRTR—2004/003. National ParkService. Boston, MA.	ACAD
NPSpecies - The National Park Service Biodiversity Database. Secure online version. <a href="https://science1.nature.nps.gov/npspecies/web/main/start">https://science1.nature.nps.gov/npspecies/web/main/start</a> .	All parks
Redstart Forestry Consulting. 2008. MABI 2008 Invasives monitoring, assessment and treatment report.	MABI
Trocki, C. and P. Paton. 2007. Study Design for Assessing the Effects of Knapweed Control on Grassland Birds at Saratoga National Historical Park. Natural Resources Report NPS/NER/NRR--2007/015. National Park Service. Boston, Massachusetts.	SARA
Vegetation Classification and Mapping Report data	ACAD, MIMA, MORR, SAIR, SARA, WEFA

**Appendix B, Table 2.** All invasive species known or thought to occur in the Northeast Temperate Network (NETN). Parks include: Acadia National Park (ACAD), Appalachian National Scenic Trail (APPA), Marsh-Billings-Rockefeller National Historical Park (MABI), Minute Man National Historical Park (MIMA), Morristown National Historical Park (MORR), Roosevelt-Vanderbilt National Historic Sites (ROVA), Saint-Gaudens National Historic Site (SAGA), Saugus Iron Works National Historic Site (SAIR), Saratoga National Historical Park (SARA), and Weir Farm National Historic Site.

Scientific Name	Common Name	ACAD	APPA	BOHA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<b>PESTS</b>												
<i>Adelges tsugae</i>	hemlock woolly adelgid						X	X				
<i>Pyrrhalta viburni</i>	viburnum leaf beetle	X										
<b>PLANTS</b>												
<i>Acer ginnala</i>	Amur maple				X							
<i>Acer palmatum</i>	Japanese maple						X					
<i>Acer platanoides</i>	Norway maple	X	X	X	X	X	X	X	X	X	X	
<i>Acer pseudoplatanus</i>	sycamore maple			X		X						
<i>Aegopodium podagraria</i>	bishop's goutweed	X				X			X			
<i>Ailanthus altissima</i>	tree of heaven		X	X		X	X	X		X	X	X
<i>Aira caryophyllea</i>	silver hairgrass										X	
<i>Akebia quinata</i>	five-leaf akebia					X	X	X				
<i>Albizia julibrissin</i>	mimosa											
<i>Alliaria petiolata</i>	garlic mustard	X	X	X	X	X	X	X		X	X	X
<i>Allium vineale</i>	wild garlic		X	X		X	X	X			X	
<i>Alnus glutinosa</i>	European alder				X							
<i>Amorpha fruticosa</i>	false indigo			X		X		X				
<i>Ampelopsis brevipedunculata</i>	Amur peppervine					X	X					
<i>Anthoxanthum odoratum</i>	sweet vernalgrass	X	X				X				X	
<i>Anthriscus sylvestris</i>	wild chervil				X							
<i>Aralia elata</i>	Japanese angelica tree						X					
<i>Artemisia vulgaris</i>	common wormwood	X		X								
<i>Barbarea vulgaris</i>	garden yellowrocket	X	X	X	X	X	X	X			X	X
<i>Berberis thunbergii</i>	Japanese barberry	X	X	X	X	X	X	X	X	X	X	X
<i>Berberis vulgaris</i>	common barberry	X	X	X	X	X	X	X	X		X	
<i>Bromus tectorum</i>	cheatgrass	X		X							X	
<i>Cardamine impatiens</i>	narrowleaf bittercress	X					X	X				X
<i>Carduus nutans</i>	nodding plumeless thistle						X					
<i>Celastrus orbiculatus</i>	Oriental bittersweet	X		X		X	X	X	X	X	X	X

Scientific Name	Common Name	ACAD	APPA	BOHA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed		X	X	X	X		X			X	
<i>Centaurea jacea</i>	brownray knapweed	X									X	
<i>Chelidonium majus</i>	celandine	X	X	X	X	X	X		X	X		X
<i>Cirsium arvense</i>	Canada thistle	X	X	X	X	X	X				X	
<i>Cirsium vulgare</i>	bull thistle	X	X	X	X	X	X			X	X	
<i>Convallaria majalis</i>	European lily of the valley		X	X		X		X		X	X	X
<i>Cynanchum louiseae</i> / <i>rossicum</i>	Louise's & European swallow-worts			X		X	X	X	X			X
<i>Cytisus scoparius</i>	Scotch broom					X						
<i>Datura stramonium</i>	jimsonweed			X								
<i>Daucus carota</i>	Queen Anne's lace	X	X	X	X	X	X	X	X	X	X	X
<i>Dipsacus fullonum</i>	Fuller's teasel		X			X				X		
<i>Elaeagnus umbellata</i>	autumn olive		X	X		X	X		X		X	X
<i>Epilobium hirsutum</i>	hairy willow-herb			X								
<i>Euonymus alatus</i>	burningbush		X	X	X	X	X	X		X		X
<i>Euphorbia cyparissias</i>	cypress spurge	X	X	X		X	X	X				
<i>Euphorbia esula</i>	leafy spurge			X			X			X		
<i>Forsythia</i> spp.	forsythia	X		X	X	X	X	X				
<i>Frangula alnus</i>	glossy buckthorn	X	X	X	X	X			X	X		
<i>Glechoma hederacea</i>	ground ivy	X		X	X	X	X	X	X		X	
<i>Glyceria maxima</i>	reed mannagrass									X		
<i>Hedera helix</i>	English ivy					X						
<i>Hemerocallis fulva</i>	orange daylily	X		X	X	X		X	X	X	X	X
<i>Heracleum mantegazzianum</i>	giant hogweed	X										
<i>Hesperis matronalis</i>	dame's rocket	X	X	X	X	X	X	X	X	X	X	X
<i>Humulus japonicus</i>	Japanese hops			X								
<i>Hypericum prolificum</i>	shrubby St. Johnswort	X										
<i>Impatiens glandulifera</i>	ornamental jewelweed	X										
<i>Iris pseudacoris</i>	paleyellow iris	X	X	X		X			X		X	
<i>Lepidium latifolium</i>	perennial pepperweed			X								
<i>Ligustrum obtusifolium</i>	border privet		X				X			X		
<i>Ligustrum vulgare</i>	European privet	X	X	X		X	X			X		
<i>Lonicera</i> spp.	bush honeysuckles							X				
<i>Lonicera japonica</i>	Japanese honeysuckle			X	X	X	X	X				X

Scientific Name	Common Name	ACAD	APPA	BOHA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<i>Lonicera maackii</i>	Amur honeysuckle						X					
<i>Lonicera morrowii</i>	Morrow's honeysuckle	X	X	X	X	X	X		X		X	X
<i>Lonicera tatarica</i>	Tatarian honeysuckle			X	X	X	X				X	
<i>Lonicera xylosteum</i>	dwarf honeysuckle	X		X	X							
<i>Lonicera X bella</i>	showy fly honeysuckle	X			X							X
<i>Luzula luzuloides</i>	oakforest woodrush	X										
<i>Lychnis flos-cuculi</i>	ragged robin		X									
<i>Lysimachia nummularia</i>	creeping jenny	X			X	X	X		X		X	X
<i>Lythrum salicaria</i>	purple loosestrife	X	X	X	X	X		X	X	X	X	
<i>Microstegium vimineum</i>	Japanese stiltgrass		X				X	X				X
<i>Morus alba</i>	white mulberry		X	X				X		X	X	
<i>Mycelis muralis</i>	wall lettuce	X										
<i>Myosotis scorpioides</i>	forget-me-not	X	X		X	X	X	X	X	X	X	
<i>Ornithogalum umbellatum</i>	star-of-Bethlehem					X	X					
<i>Pastinaca sativa</i>	wild parsnip		X	X								
<i>Paulownia tomentosa</i>	Princess tree						X					
<i>Phalaris arundinacea</i>	reed canarygrass	X	X	X	X	X			X	X	X	X
<i>Phellodendron amurense</i>	Amur corktree					X						
<i>Photinia villosa</i>	Oriental photinia						X					
<i>Phragmites australis</i>	common reed	X		X	X	X	X	X	X	X	X	
<i>Plantago lanceolata</i>	narrowleaf plantain	X	X	X	X	X	X	X	X	X	X	X
<i>Plantago major</i>	common plantain	X		X	X	X	X	X	X	X	X	X
<i>Poa compressa</i>	Canada bluegrass	X	X	X	X	X		X	X		X	
<i>Polygonum caespitosum</i>	Oriental lady's thumb		X			X	X					
<i>Polygonum cuspidatum</i>	Japanese knotweed	X		X	X	X	X	X	X	X	X	X
<i>Polygonum persicaria</i>	spotted lady's thumb	X	X	X		X	X			X	X	
<i>Populus alba</i>	white poplar	X	X	X		X						
<i>Potentilla recta</i>	sulphur cinquefoil	X	X	X	X	X	X		X	X	X	X
<i>Ranunculus ficaria</i>	lesser celandine		X									
<i>Ranunculus repens</i>	creeping buttercup	X		X		X	X			X	X	
<i>Rhamnus cathartica</i>	common buckthorn		X	X	X	X		X	X	X	X	?
<i>Robinia pseudoacacia</i>	black locust	X		X		X	X		X	X	X	
<i>Rosa multiflora</i>	multiflora rose	X	X	X		X	X	X	X	X	X	X
<i>Rosa rugosa</i>	rugosa rose	X		X		X						

Scientific Name	Common Name	ACAD	APPA	BOHA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<i>Rubus phoenicolasius</i>	wine raspberry						X					
<i>Rumex acetosella</i>	common sheep sorrel	X	X	X	X	X	X	X	X	X	X	X
<i>Securigera varia</i>	crownvetch	X				X	X				X	
<i>Sedum sarmentosum</i>	stringy stonecrop					X						
<i>Senecio jacobaea</i>	tansy ragwort	X										
<i>Silphium perfoliatum</i>	cup plant					X						
<i>Solanum dulcamara</i>	bittersweet nightshade	X		X	X	X	X	X	X	X	X	X
<i>Spiraea japonica</i>	Japanese meadowsweet	X										
<i>Styrax obassa</i>	snowbell						X					
<i>Syringa reticulata</i>	Japanese tree lilac								X			
<i>Tussilago farfara</i>	coltsfoot	X	X	X	X	X			X		X	X
<i>Ulmus pumila</i>	Siberian elm			X								
<i>Urtica dioica ssp. dioica</i>	stinging nettle	X	X									
<i>Valeriana officinalis</i>	garden heliotrope	X					X	X			X	
<i>Verbascum blatteria</i>	moth mullein	X										
<i>Verbascum thapsus</i>	common mullein	X	X	X	X	X	X		X	X	X	X
<i>Viburnum opulus var. opulus</i>	European cranberrybush	X										
<i>Viburnum sieboldii</i>	Siebold's arrowwood						X					
<i>Vinca minor</i>	common periwinkle		X		X	X	X			X		X
<i>Wisteria floribunda</i>	Japanese wisteria						X					
<i>Wisteria sinensis</i>	Chinese wisteria					X						

**Appendix B, Table 3.** All invasive plant species known or thought to occur in Boston Harbor Islands National Recreation Area (BOHA), Northeast Temperate Network (NETN), by island and taxa category. The Graves, Green Island, Little Calf Island, Moon Island, Nixes Mate, and Shag Rocks are not included in this protocol due to accessibility issues and/or lack of habitat.

Scientific Name	Common Name	Bumpkin	Button	Calf	Deer	Gallops	Georges	Grape	Great Brewster	Hangman	Langlee	Little Brewster	Long	Lovells	Middle Brewster	Nut	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah	Sheep	Slate	Snake	Spectacle	Thompson	Webb SP	Worlds End	
<i>Acer platanoides</i>	Norway maple		X			X	X				X		X			X		X	X			X					X	X	X	
<i>Acer pseudoplatanus</i>	sycamore maple	X				X	X				X		X	X				X	X	X						X		X	X	
<i>Ailanthus altissima</i>	tree of heaven	X						X			X		X	X				X	X							X	X			
<i>Alliaria petiolata</i>	garlic mustard		X								X							X				X							X	
<i>Allium vineale</i>	wild garlic	X					X																					X		
<i>Amorpha fruticosa</i>	desert false indigo	X						X										X						X			X	X		
<i>Anthoxanthum odoratum</i>	sweet vernalgrass			X		X	X	X	X				X	X		X	X	X			X						X	X	X	
<i>Artemisia vulgaris</i>	common wormwood	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
<i>Barbarea vulgaris</i>	garden yellowrocket	X			X			X			X					X	X	X									X	X	X	
<i>Berberis thunbergii</i>	Japanese barberry	X									X							X		X							X	X	X	
<i>Berberis vulgaris</i>	European barberry	X						X					X					X		X			X							
<i>Bromus tectorum</i>	cheatgrass			X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X		
<i>Celastrus orbiculatus</i>	oriental bittersweet	X				X		X	X		X		X	X		X		X	X	X		X	X	X			X	X	X	
<i>Centaurea stoebe ssp. micranthos</i>	spotted knapweed												X															X		
<i>Chelidonium majus</i>	celandine													X							X								X	
<i>Cirsium arvense</i>	Canada thistle	X		X	X		X	X	X				X	X	X	X		X		X	X						X	X	X	
<i>Cirsium vulgare</i>	bull thistle	X		X	X	X	X	X					X	X	X	X		X	X			X	X		X	X	X	X	X	
<i>Convallaria majalis</i>	European lily of the valley										X								X	X							X		X	
<i>Cynanchum louiseae/rossicum</i>	Louise's & European swallow-worts													X					X								X		X	
<i>Datura stramonium</i>	jimsonweed				X	X	X	X	X	X			X	X	X			X						X	X	X				
<i>Daucus carota</i>	Queen Anne's lace	X			X		X	X	X				X				X	X	X		X						X	X	X	
<i>Elaeagnus angustifolia</i>	Russian olive						X																					X		
<i>Elaeagnus umbellata</i>	autumn olive	X						X								X											X	X	X	
<i>Epilobium hirsutum</i>	hairy willow-herb	X						X									X										X			
<i>Euonymus alatus</i>	burningbush																	X									X		X	
<i>Euphorbia cyparissias</i>	cypress spurge																	X								X				
<i>Euphorbia esula</i>	leafy spurge																											X		
<i>Forsythia viridissima</i>	forsythia																										X			
<i>Frangula alnus</i>	glossy buckthorn	X									X		X							X		X	X				X	X	X	
<i>Glechoma hederacea</i>	gill over the ground																												X	
<i>Hemerocallis fulva</i>	Orange daylily						X						X					X		X	X								X	
<i>Hesperis matronalis</i>	dame's rocket																	X												
<i>Humulus japonicus</i>	Japanese hop														X															
<i>Iris pseudacoris</i>	paleyellow iris													X																
<i>Lepidium latifolium</i>	perennial pepperweed	X		X		X	X	X	X				X	X				X	X					X	X	X	X	X		
<i>Ligustrum vulgare</i>	European privet					X												X											X	
<i>Lonicera spp.</i>	bush honeysuckles																												X	
<i>Lonicera japonica</i>	Japanese honeysuckle																	X			X							X	X	
<i>Lonicera morrowii</i>	Morrow's honeysuckle	X	X			X		X	X		X		X					X		X		X	X	X			X	X	X	
<i>Lonicera xylosteum</i>	dwarf honeysuckle																												X	

Scientific Name	Common Name	Bumpkin	Button	Calf	Deer	Gallops	Georges	Grape	Great Brewster	Hangman	Langlee	Little Brewster	Long	Lovells	Middle Brewster	Nut	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah	Sheep	Slate	Snake	Spectacle	Thompson	Webb SP	Worlds End	
<i>Lythrum salicaria</i>	purple loosestrife	X						X					X	X		X										X	X	X	X	
<i>Morus alba</i>	white mulberry										X								X											
<i>Onopordum acanthium</i>	Scotch cottonthistle			X		X								X	X		X													
<i>Pastinaca sativa</i>	wild parsnip																				X					X				
<i>Phalaris arundinacea</i>	reed canarygrass																X						X	X	X	X	X	X	X	
<i>Phragmites australis</i>	phragmites			X		X	X	X			X	X	X	X		X	X	X	X		X			X	X	X	X	X	X	
<i>Plantago lanceolata</i>	narrowleaf plantain						X	X			X	X				X	X	X			X					X	X	X	X	
<i>Plantago major</i>	common plantain						X	X			X	X				X	X	X							X	X	X	X	X	
<i>Poa compressa</i>	Canada bluegrass						X	X	X		X	X	X	X			X	X	X	X	X			X		X	X	X		
<i>Polygonum cuspidatum/sachalinense</i>	Japanese/giant knotweed																	X			X							X		
<i>Polygonum persicaria</i>	spotted ladythumb							X	X																X	X	X	X	X	
<i>Populus adenopoda</i>	Chinese aspen	X						X																						
<i>Populus alba</i>	white poplar					X	X		X		X	X						X			X								X	
<i>Potentilla recta</i>	sulphur cinquefoil	X			X		X		X				X				X	X			X							X	X	
<i>Pueraria montana var. lobata</i>	kudzu																	X												
<i>Ranunculus repens</i>	creeping buttercup																	X												
<i>Rhamnus cathartica</i>	common buckthorn	X	X								X		X								X		X					X	X	
<i>Robinia pseudoacacia</i>	black locust																	X		X						X		X	X	
<i>Rosa multiflora</i>	multiflora rose	X				X	X	X	X				X				X	X	X		X	X					X	X	X	X
<i>Rosa rugosa</i>	salt-spray rose	X	X	X		X	X	X	X		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Rumex acetosella</i>	common sheep sorrel	X		X	X	X	X	X	X		X	X	X	X			X	X	X	X	X			X			X	X	X	X
<i>Senecio jacobea</i>	fansy ragwort																													
<i>Solanum dulcamara</i>	bittersweet nightshade	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Tussilago farfara</i>	coltsfoot	X						X	X				X					X									X			
<i>Ulmus pumila</i>	Siberian elm														X		X	X	X		X					X	X			
<i>Verbascum blatteria</i>	moth mullein																									X				
<i>Verbascum thapsus</i>	common mullein	X	X			X	X	X	X		X		X	X	X	X	X	X	X	X	X		X	X		X	X	X	X	
<i>Vicia cracca</i>	bird vetch				X		X				X		X	X		X	X	X			X				X	X	X	X	X	



Although the numbers varied by park, approximately 50 common and well-established species were eliminated from NETN parks and approximately 20 were eliminated from BOHA. Examples include Queen Anne's lace (*Daucus carota*), dame's rocket (*Hesperis matronalis*), and sulphur cinquefoil (*Potentilla recta*). Both Queen Anne's lace and dame's rocket were present in every park and sulphur cinquefoil was present in every park with the exception of Roosevelt-Vanderbilt National Historic Sites (ROVA). Sufficient background data was not available for ROVA, but due to the general widespread distribution of sulphur cinquefoil, it is thought to occur there.

Once a list of species known or thought to occur in each park was created and all common and widespread species were removed, existing invasive species data from nearby parks, towns, counties, and states were reviewed and new invasive species threats not present in the parks were added to the candidate list. The following resources, among others, were utilized to complete a candidate list of early detection species lists for each park:

1. USDA PLANTS database <http://plants.usda.gov/>
2. The Biota of North America Program (BONAP) web-based U.S. County-Level Atlas of the Vascular Flora of North America <http://www.bonap.org/MapSwitchboard.html>
3. Early Detection and Distribution Mapping System (EDDMapS) <http://www.eddmaps.org/>
4. National Agricultural Pest Information System (NAPIS) <http://pest.ceris.purdue.edu/index.php>
5. Invasive Plant Atlas of New England (IPANE) <http://nbii-nin.ciesin.columbia.edu/ipane/>
6. iMapInvasives <http://www.imapinvasives.org/>
7. USGS Non-indigenous Aquatic Species (NAS) <http://nas.er.usgs.gov/>
8. Massachusetts Office of Coastal Zone Management Potential Invaders list (<http://www.mass.gov/czm/czm.htm>)
9. Invasive Species Watch List for Vermont <http://www.uvm.edu/mastergardener/invasives/invasivesdocuments/watchlist.pdf>
10. Vermont Department of Environmental Conservation (VDEC)
11. Connecticut Invasive Plant Working Group (CIPWG) <http://www.hort.uconn.edu/cipwg/>
12. Massachusetts Invasive Plants Advisory Group (MIPAG) <http://www.massnrc.org/mipag/>
13. New Hampshire Department of Agriculture, Markets and Food [http://www.nh.gov/agric/divisions/plant\\_industry/plants\\_insects.htm](http://www.nh.gov/agric/divisions/plant_industry/plants_insects.htm)
14. NatureServe Explorer <http://www.natureserve.org/explorer/>
15. Wayne Millington, NPS Northeast Region IPM Coordinator
16. Betsy Lyman, Northeast Exotic Plant Management Team (EPMT), Liaison
17. Northeast Aquatic Nuisance Species Panel (NEANS) <http://www.northeastans.org/>
18. Sea Grant: New York <http://nyis.info/Default.aspx>
19. Invasive Plant Council of New York State (IPC) <http://www.ipcnys.org/>
20. Central Jersey Invasive Species Strike Team (CJISST) <http://www.cjisst.org/index.html>
21. Leslie Mehrhoff, Director, Invasive Plant Atlas of New England (IPANE)
22. Communications with park personnel and contractors familiar with the parks.

Approximately 20 invasive species currently absent from NETN parks and approximately 30 invasive species currently absent from BOHA, were added to the candidate list. For example, IPANE and the Connecticut Invasive Plant Working Group (CIPWG) list Japanese sand sedge (*Carex kobomugi*) and Chinese silvergrass (*Miscanthus sinensis*) on their "Non-native Invasive

and Potentially Invasive Vascular Plant” lists. Japanese sand sedge has popped-up at locations in Massachusetts and Rhode Island and Chinese silvergrass has also been observed in both states as well as Connecticut. Both these species have the potential to spread into the NETN parks.

Once a good invasive species candidate list was constructed, each candidate species was then researched and prioritized. During this process, each park natural resource manager, the Regional Integrative Pest Management Coordinator and Exotic Plant Management Team Liaison was consulted for input. In the case of BOHA, the NETN coordinator, BOHA Natural Resource Manager, Invasive Species Early Detection Coordinator (ISED) and Les Mehrhoff, former Director of IPANE, participated in a conference call to prioritize species for each island. Initially, due to time constraints, species were marked as “priority” and “low priority.” The following questions were asked during the species prioritization process:

1. Does the species have an invasive history? “A species is likely to become invasive in a new habitat if it has a prior history of invasion elsewhere” (Rejmanek 2000, National Research Council 2002).
2. What is the species current distribution and have there been any recent outbreaks? What is the species proximity to the park? If aquatic, does it occur up or downstream of the park?
3. Does the species have the potential to become naturalized in the park?
4. Does species have the potential to establish in minimally managed habitats?
5. What is the species’ habitat suitability (i.e. wetland or upland forest)? A wetland species is not as high a threat to a park that does not contain wetland habitat.
6. Are there host species present (pests and diseases only)?
7. Is the species a significant threat to park resources and communities of ecological significance (bogs, river scour communities, cliff communities etc.)?
8. Does the species negatively affect forest crop production, commercial agriculture or human health?
9. Does the species possess reproductive strategies and dispersal mechanisms that enable it to disperse rapidly and widely? A species that reproduces by seed and is dispersed by animals is more likely to be a threat than a species that reproduces only by vegetative means.
10. Does the species have a competitive ability? For example, if the species is a plant, does it have an advantage over native plants when acquiring resources like water, light, and nutrients?
11. If the species already exists in the park, have there been any disturbances or changes in the park landscape that would alter or enhance the species’ invasibility?
12. What are the individual parks desires? For example, didymo might be impossible to currently control, but species tracking and spread prevention via public education might be important to the park.
13. What is the NatureServe Explorer Invasive Species Impact Rank (I-Rank) if available? I-Rank was only be used for guidance during the prioritization process. “Species for which I-Rank information is currently available do not represent a random sample of species exotic in the United States; available assessments may be biased toward those species with higher-than-average impact.” (NatureServe 2009).

Although numbers vary by park, a total of 29 early detection species, 11 low priority species, and 11 questionable species were designated for the NETN parks and 18 early detection, 4 low priority, and zero questionable species were designated for BOHA. For example, wavyleaf

basketgrass (*Oplismenus hirtellus* ssp. *undulatifolius*) was recently reported as a new threat in Maryland by the Anacostia Watershed Society and the Maryland Department of Natural Resources. The species has since jumped as far as Shenandoah National Park in Virginia and regional invasive species experts are concerned about its potential spread. Wavyleaf basketgrass invasive traits include an effective seed dispersal mechanism, shade tolerance, and a seasonal advantage of staying green longer than native plants (Kydé and Marose n.d., Peterson et al., 1999). Visitors to parks on the east coast are potential long-distance vectors for this species. If this species spreads, it has the potential to become an aggressive invader in eastern forests. Low priority species are species that were reviewed, but dropped-out during the 2009 final prioritization process. These species will be considered in the future as possible early detection list additions. Species designated as questionable are species that will most likely be added to the next year's early detection list, but a general confirmation from the park regarding species absence is needed before the addition is made.

See Tables 4 and 5 for a list of Invasive early detection candidate species and October 2009 final invasive early detection species for the NETN by park and taxa category. These tables will be updated on an annual basis to reflect new invasive early detection species inclusions, eliminations, and changing priorities.



**Appendix B, Table 4.** Invasive early detection candidate species and October 2009 final invasive early detection species for the Northeast Temperate Network by park and taxa category. This list contains the remaining subset of species from the initial literature search and data review and the species obtained from nearby parks, towns, counties, and states.

Scientific Name	Common Name	ACAD	APPA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
PESTS											
<i>Adelges tsugae</i>	hemlock woolly adelgid	ED	?	ED	ED	P	P	ED		ED	ED
<i>Agrilus planipennis</i>	emerald ash borer	ED		ED	ED	ED	ED	ED	ED	ED	ED
<i>Anoplophora glabripennis</i>	Asian long-horned beetle			ED	ED	ED	ED	ED	ED	ED	ED
<i>Pyrrhalta viburni</i>	viburnum leaf beetle	P	?				ED		ED		ED
<i>Sirex noctilio</i>	Sirex woodwasp			ED	ED	ED	ED	ED		ED	ED
PLANTS											
<i>Acer ginnala</i>	amur maple	P		P/ED	P						
<i>Acer palmatum</i>	Japanese maple				P	P					
<i>Acer platanoides</i>	Norway maple	P/ED	P	P/ED	P	P	P	P	P	P	
<i>Acer pseudoplatanus</i>	sycamore maple				P						
<i>Actinidia arguta</i>	hardy kiwi					P					
<i>Aegopodium podagraria</i>	goutweed	P			P			P			
<i>Ailanthus altissima</i>	tree of heaven	?	P	ED	P	P	P	ED	P	P	P
<i>Akebia quinata</i>	chocolate vine				P	P	P				?
<i>Albizia julibrissin</i>	mimosa										
<i>Alliaria petiolata</i>	garlic mustard	P/ED	P	P	P	P	P	ED	P	P	P
<i>Alnus glutinosa</i>	European alder			P/ED							
<i>Ampelopsis brevipedunculata</i>	Amur peppervine				P	P			ED	ED	ED
<i>Anthriscus sylvestris</i>	wild chervil			ED			P				
<i>Aralia elata</i>	Japanese aralia					ED	ED				
<i>Berberis thunbergii</i>	Japanese barberry	P/ED	P	P	P	P	P	P	P	P	P
<i>Berberis vulgaris</i>	common barberry	P	P	P	P	P	P			P	
<i>Cardamine impatiens</i>	narrowleaf bittercress	P/ED		ED	ED	ED	P	ED	ED	ED	P
<i>Carduus nutans</i>	nodding plumeless thistle					P					
<i>Carex kobomugi</i>	Japanese sand sedge										
<i>Celastrus orbiculatus</i>	oriental bittersweet	P/ED		ED	P	P	P	P	P	P	P
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed		P		P	P	P			P	
<i>Chelidonium majus</i>	celandine	P	P	P	P	P	P	P	P	P	P
<i>Cirsium arvense</i>	Canada thistle	P	P	P	P	P				P	
<i>Cirsium palustre</i>	marsh thistle										
<i>Cirsium vulgare</i>	bull thistle	P	P	P	P	P	P		P	P	
<i>Commelina communis</i>	Asiatic dayflower				P	P	P			P	P
<i>Cynanchum louiseae</i> / <i>C. rossicum</i>	Louise's & European swallow-worts		P	P	P	P	P	P	ED	ED	P
<i>Dioscorea oppositifolia</i>	Chinese yam										
<i>Elaeagnus umbellata</i>	autumn olive			P	P	P		P	?	P	P/ED
<i>Euonymus alatus</i>	winged burning bush	ED	P	P	P	P	P	ED	P	ED	P
<i>Eupatorium serotinum</i>	lateflowering thoroughwort										
<i>Forsythia</i> spp.	forsythia	P		P	P	P	P				
<i>Frangula alnus</i>	glossy buckthorn	P/ED	P	P	P	ED		P	P		ED
<i>Hedera helix</i>	English ivy				P			L			
<i>Heracleum mantegazzium</i>	giant hogweed	P		ED	ED	ED	ED	ED	L	ED	ED
<i>Humulus japonicus</i>	Japanese hop				ED	?	ED	ED	L	ED	ED
<i>Impatiens glandulifera</i>	ornamental jewelweed	P									

Scientific Name	Common Name	ACAD	APPA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<i>Iris pseudacorus</i>	paleyellow iris	P	P		P		P	P		P	
<i>Kochia scoparia</i>	common kochia										
<i>Lepidium latifolium</i>	perennial pepperweed	?		?	?	?	?	?	ED	?	?
<i>Lespedeza cuneata</i>	Chinese lespedeza										
<i>Ligustrum obtusifolium/L. vulgare</i>	border/European privets	P/ED	P		P	P	P		P	ED	ED
<i>Lonicera</i> spp.	bush honeysuckles	P/ED					P	ED	ED		
<i>Lonicera japonica</i>	Japanese honeysuckle	?			P	P	P		ED		P
<i>Lonicera maackii</i>	amur honeysuckle			P		P				ED	
<i>Lonicera morrowii</i>	Morrow's honeysuckle	P	P	P	P	P		P		P	P
<i>Lonicera tatarica</i>	Tatarian honeysuckle			P	P	P				P	
<i>Lonicera X bella</i>	Bell's honeysuckle	P		P							P
<i>Lonicera xylosteum</i>	European fly-honeysuckle	P		P							
<i>Luzula luzuloides</i>	oakforest woodrush	P/ED									
<i>Lythrum salicaria</i>	purple loosestrife	P	P	P	P	L	P	P	P	P	ED
<i>Microstegium vimineum</i>	Japanese stiltgrass	?	P	ED	ED	P	P	ED	ED	ED	P
<i>Miscanthus sinensis</i>	Chinese silvergrass					L					
<i>Morus alba</i>	white mulberry		P				P		P	P	
<i>Mycelis muralis</i>	wall lettuce	P									
<i>Oplismenus hirtellus ssp. undulatifolius</i>	wavyleaf basketgrass	ED		ED	ED	ED	ED	ED	ED	ED	ED
<i>Ornithogalum umbellatum</i>	star-of-bethlehem				P	P					
<i>Paulownia tomentosa</i>	Princess tree					P			L	L	
<i>Perilla frutescens</i>	beefsteakplant										
<i>Phellodendron amurense</i>	Amur corktree				P	?	?				
<i>Photinia villosa</i>	Oriental photinia					P	?				
<i>Phragmites australis</i>	phragmites	P			P	P	P	ED	P	P	
<i>Polygonum cuspidatum/sachalinense</i>	Japanese/giant knotweed	P/ED		P/ED	P	P	P	P	P	P	P
<i>Polygonum perfoliatum</i>	mile-a-minute	?		ED	ED	ED	ED	ED	ED	ED	ED
<i>Populus alba</i>	white poplar	P	P		P						
<i>Pueraria montana var. lobata</i>	kudzu				ED	ED	ED		ED	ED	ED
<i>Pyrus calleryana</i>	Bradford pear										
<i>Pyrus pyrifolia</i>	Chinese pear										
<i>Ranunculus ficaria</i>	lesser celandine		P		ED	ED	ED	ED			
<i>Ranunculus repens</i>	creeping buttercup	P			P	P			P	P	
<i>Rhamnus cathartica</i>	common buckthorn	?	P	P	P	ED	P	P	P	P	ED
<i>Robinia pseudoacacia</i>	black locust	P		P	P	P	P	P	P	P	P
<i>Rosa multiflora</i>	multiflora rose	P/ED	P	ED	P	P	P	P	P	P	P
<i>Rosa rugosa</i>	Japanese rose	P			P						
<i>Rubus phoenicolasius</i>	wine raspberry					P	ED		L	ED	P
<i>Securigera varia</i>	crown-vetch	P			P	P				P	
<i>Sedum sarmentosum</i>	stringy stonecrop				P		P				
<i>Senecio jacobaea</i>	tansy ragwort	P									
<i>Silphium perfoliatum</i>	cup plant				P						
<i>Sorghum halepense</i>	Johnsongrass										
<i>Spiraea japonica</i>	Japanese spiraea	P									
<i>Styrax obassia</i>	fragrant snowbell					P	?				
<i>Syringa reticulata</i>	Japanese tree lilac			P				P			

Scientific Name	Common Name	ACAD	APPA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
<i>Viburnum dilataum</i>	linden arrowwood					?	?				
<i>Viburnum sieboldii</i>	Siebold viburnum					P	?				
<i>Vinca minor</i>	common periwinkle		P	P	P	P	P		P	P	P
<i>Wisteria floribunda/W. sinensis</i>	Japanese/Chinese wisteria				P	P	P				ED

ED=October 2009 final early detection species; P=already present within park; P/ED=present within park in small numbers, but early detection is still warranted to prevent spread to other areas of park; L=low priority (species was reviewed, but dropped-out during 2009 final prioritization process); ?=considering adding to the 2010 early detection list, but waiting to receive confirmation regarding species absence. Parks include: Acadia National Park (ACAD); Appalachian National Scenic Trail (APPA); Marsh-Billings-Rockefeller National Historical Park (MABI); Minute Man National Historical Park (MIMA); Morristown National Historical Park (MORR); Roosevelt-Vanderbilt National Historic Sites (ROVA); Saint-Gaudens National Historic Site (SAGA); Saugus Iron Works National Historic Site (SAIR); Saratoga National Historical Park (SARA); and Weir Farm National Historic Site (WEFA)

**Appendix B, Table 5.** Invasive early detection candidate species and October 2009 final invasive early detection species for Boston Harbor Islands National Recreation Area (BOHA), Northeast Temperate Network (NETN), by island and taxa category. This list contains the remaining subset of species from the initial literature search and data review and the species obtained from nearby parks, towns, counties and states.

Due to the large number of islands present within BOHA, volunteer early detection began in 2009 at 12 islands. These twelve islands are highlighted in the table below. Islands that are not currently being surveyed are not highlighted. Early detection lists will be created for the remainder of the islands as time and resources permits. The Graves, Green Island, Little Calf Island, Moon Island, Nixes Mate, and Shag Rocks are not included in this protocol due to accessibility issues and/or lack of habitat.

Scientific Name	Common Name	Bumpkin	Button	Calf	Deer	Gallops	Georges	Grape	Great Brewster	Hangman	Langlee	Little Brewster	Long	Lovells	Middle Brewster	Nut	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah	Sheep	Slate	Snake	Spectacle	Thompson	Webb SP	Worlds End
PESTS																													
<i>Adelges tsuga</i>	hemlock woolly adelgid																												L
<i>Agilus planipennis</i>	emerald ash borer	ED												ED				ED										ED	ED
<i>Anoplophora glabripennis</i>	Asian long-horned beetle	ED					ED	ED						ED				ED								ED	ED	ED	ED
<i>Pyrrhalta viburni</i>	viburnum leaf beetle	ED						ED										ED									ED	ED	ED
PLANTS																													
<i>Acer ginnala</i>	Amur maple																												
<i>Acer platanoides</i>	Norway maple		P			P	P				P		P			P		P	P	P		P					P	P	P
<i>Acer pseudoplatanus</i>	sycamore maple	P				P	P				P		P	P				P	P	P						P		P	P
<i>Aegopodium podagraria</i>	goutweed																												
<i>Ailanthus altissima</i>	tree of heaven	P		ED			ED	P	ED		P	ED	P	P				P	P							P	P	ED	ED
<i>Aira caryophyllea</i>	silver hairgrass																												
<i>Akebia quinata</i>	five-leaf akebia																												
<i>Albizia julibrissin</i>	mimosa																												
<i>Alliaria petiolata</i>	garlic mustard	ED	P	ED			ED	ED	ED		P	ED		ED				P								ED	ED	ED	P
<i>Allium vineale</i>	wild garlic	P					P																					P	
<i>Amorpha fruticosa</i>	desert false indigo	P						P										P							P		P	P	
<i>Ampelopsis brevipedunculata</i>	Amur peppervine	ED		ED			ED	ED	ED			ED		ED				ED								ED	ED	ED	ED
<i>Anthoxanthum odoratum</i>	sweet vernalgrass			P		P	P	P	P				P	P		P	P	P				P					P	P	P
<i>Berberis thunbergii</i>	Japanese barberry	P		ED			ED	ED	ED		P	ED		ED				P		P						ED	P	P	P
<i>Berberis vulgaris</i>	European barberry	P						P					P					P		P				P					
<i>Butomus umbellatus</i>	flowering rush																												
<i>Cardamine impatiens</i>	narrowleaf bittercress	ED		ED			ED	ED	ED			ED		ED				ED								ED	ED	ED	ED
<i>Celastrus orbiculatus</i>	oriental bittersweet	P				P		P	P		P		P	P		P		P	P	P		P	P	P			P	P	P
<i>Centaurea stoebe ssp. micranthos</i>	spotted knapweed												P															P	
<i>Chelidonium majus</i>	celandine													P				P											P
<i>Cynanchum louiseae/rossicum</i>	Louise's & European swallow-worts	ED		ED			ED	ED	ED			ED		P				ED	P							ED	P	ED	P
<i>Cytisus scoparius</i>	Scotch broom																												
<i>Datura stramonium</i>	jimsonweed				P	P	P	P	P	P			P	P	P			P							P	P	P		
<i>Elaeagnus angustifolia</i>	Russian olive						P																					P	
<i>Elaeagnus umbellata</i>	autumn olive	P						P								P											P	P	P
<i>Elsholtzia ciliata</i>	crested late-summer mint																												
<i>Epilobium hirsutum</i>	hairy willow-herb	P						P									P										P		
<i>Euonymus alatus</i>	burningbush			ED			ED	ED	ED			ED		ED				P								ED	P	ED	P
<i>Euphorbia cyparissias</i>	cypress spurge																	P								P			
<i>Euphorbia esula</i>	leafy spurge																											P	



Scientific Name	Common Name	Bumpkin	Button	Calf	Deer	Gallops	Georges	Grape	Great Brewster	Hangman	Langlee	Little Brewster	Long	Lovells	Middle Brewster	Nut	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah	Sheep	Slate	Snake	Spectacle	Thompson	Webb SP	Worlds End
<i>Forsythia viridissima</i>	forsythia																										P		
<i>Frangula alnus</i>	glossy buckthorn	P									P	P								P		P		P			P	P	P
<i>Froelichia gracilis</i>	slender snake cotton																												
<i>Geranium thunbergii</i>	Thunberg's geranium																												
<i>Glaucium flavum</i>	yellow hornpoppy																												
<i>Glechoma hederacea</i>	gill over the ground																												P
<i>Glyceria maxima</i>	reed mannagrass																												
<i>Hemerocallis fulva</i>	Orange daylily						P					P						P		P	P								P
<i>Heracleum mantegazzianum</i>	giant hogweed	L		L			L	L	L			L		L				L								L	L	L	L
<i>Hesperis matronalis</i>	dame's rocket																	P											
<i>Humulus japonicus</i>	Japanese hop														P														
<i>Hypericum prolificum</i>	shrubby St. Johnswort																												
<i>Impatiens glandulifera</i>	ornamental jewelweed	L		L			L	L	L			L		L				L								L	L	L	L
<i>Iris pseudacoris</i>	paleyellow iris													P															
<i>Kochia scoparia</i>	common kochia																												
<i>Lepidium latifolium</i>	perennial pepperweed	P		P		P	P	P	P			ED	P	P				P	P						P	P	P	P	ED
<i>Ligustrum spp. (obtusifolium/vulgare)</i>	border/European privets					P												P											P
<i>Lonicera spp.</i>	bush honeysuckles																												P
<i>Lonicera japonica</i>	Japanese honeysuckle	ED		ED			ED	ED	ED			ED		ED				P			P					ED	ED	P	P
<i>Lonicera maackii</i>	Amur honeysuckle																												
<i>Lonicera morrowii</i>	Morrow's honeysuckle	P	P			P		P	P		P		P					P		P		P	P	P			P	P	P
<i>Lonicera tatarica</i>	Tatarian honeysuckle																												
<i>Lonicera xylosteum</i>	dwarf honeysuckle																												P
<i>Lythrum salicaria</i>	purple loosestrife	P						P				P	P		P											P	P	P	P
<i>Microstegium vimineum</i>	Japanese stiltgrass	ED		ED			ED	ED	ED			ED		ED				ED								ED	ED	ED	ED
<i>Morus alba</i>	white mulberry										P									P									
<i>Onopordum acanthium</i>	Scotch cottonthistle			P		P								P	P		P												
<i>Oplismenus hirtellus ssp. undulatifolius</i>	wavyleaf basketgrass	ED		ED			ED	ED	ED			ED		ED				ED								ED	ED	ED	ED
<i>Phalaris arundinacea</i>	reed canarygrass																P							P	P	P	P	P	P
<i>Phragmites australis</i>	phragmites			P		P	P		P			P	P	P		P		P	P		P			P	P	P	P	P	P
<i>Polygonum caespitosum</i>	Oriental lady's thumb																												
<i>Polygonum cuspidatum/sachalinense</i>	Japanese/giant knotweed	ED		ED			ED	ED	ED			ED		ED				P			P					ED	ED	P	ED
<i>Polygonum perfoliatum</i>	mile-a-minute	ED		ED			ED	ED	ED			ED		ED				ED								ED	ED	ED	ED
<i>Polygonum persicaria</i>	spotted lady's thumb							P	P																	P	P	P	P
<i>Populus adenopoda</i>	Chinese aspen	P						P																					
<i>Populus alba</i>	white poplar	ED		ED		P	P	ED	P		P	ED	P	P				P			P					ED	ED	ED	P
<i>Potentilla recta</i>	sulphur cinquefoil	P			P		P		P				P				P	P			P							P	P
<i>Pueraria montana var. lobata</i>	kudzu	ED		ED			ED	ED	ED			ED		ED				P								ED	ED	ED	ED
<i>Ranunculus ficaria</i>	lesser celandine	L		L			L	L	L			L		L				L								L	L	L	L
<i>Ranunculus repens</i>	creeping buttercup																	P											
<i>Rhamnus cathartica</i>	common buckthorn	P	P								P		P								P			P				P	P
<i>Robinia pseudoacacia</i>	black locust																	P		P							P		P

Scientific Name	Common Name	Bumpkin	Button	Calf	Deer	Gallops	Georges	Grape	Great Brewster	Hangman	Langlee	Little Brewster	Long	Lovells	Middle Brewster	Nut	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah	Sheep	Slate	Snake	Spectacle	Thompson	Webb SP	Worlds End
<i>Rosa multiflora</i>	multiflora rose	P				P	P	P	P				P				P	P	P		P	P					P	P	P
<i>Rubus phoenicolasius</i>	wineberry																												
<i>Salvinia molesta</i>	salvinia																												
<i>Senecio jacobea</i>	tansy ragwort	L		L			L	L	L			L		L				L								L	P	L	L
<i>Silphium perfoliatum</i>	cup plant																												
<i>Tussilago farfara</i>	coltsfoot	P						P	P				P					P									P		
<i>Ulmus pumila</i>	Siberian elm														P		P	P	P		P					P	P		
<i>Valeriana officinalis</i>	garden heliotrope																												
<i>Verbascum blatteria</i>	moth mullein																									P			
<i>Veronica beccabunga</i>	European speedwell																												

ED=October 2009 final early detection species; P=already present within park; P/ED=present within park in small numbers, but early detection is still warranted to prevent spread to other areas of park; L=low priority (species was reviewed, but dropped-out during 2009 final prioritization process; ?=considering adding to 2010 early detection list, but waiting to receive confirmation regarding species absence.

## References

- Causton, C. E., S. B. Peck, B. J. Sinclair, L. Roque-Albelo, C. J. Hodgson, and B. Landry. 2006. Alien Insects: Threats and Implications for Conservation of Galapagos Islands. *Annals of the Entomological Society of America*. 99(1):121-143.
- Floyd, J. 2008. New Pest Response Guidelines: Temperate Terrestrial Gastropods. USDA–APHIS–PPQ–Emergency and Domestic Programs, Riverdale, Maryland. [http://www.aphis.usda.gov/import\_export/plants/manuals/emergency/index.shtml]
- Hiebert, R.D., and J. Stubbendieck. 1993. Handbook for Ranking Exotic Plants for Management and Control. U. S. Department of the Interior, Natural Resources Report NPS/NRMWRO/NRR-93/08. National Park Service, Natural Resources Publication Office, Denver, CO.
- Invasive Plant Atlas of New England (IPANE). 2009. *IPANE Evaluation of Species*. [http://nbiin.ciesin.columbia.edu/ipane/aboutproject/SpeciesEvaluationProtocols.htm]. (Accessed February 17, 2009).
- Kyde, Kerrie L. and Betty H. Marose. nd. Wavyleaf Basketgrass in Maryland: An Early Detection Rapid Response Program in Progress. Poster. Maryland Department of Natural Resources. [http://dnr.maryland.gov/wildlife/download/wlbg\_poster011108.pdf](Accessed April 16, 2009).
- Mehrhoff, L. J. 2000. *Criteria for Including a Species as a Non-Native Invasive Species or a Potentially Invasive Species In Connecticut*. Retrieved February 17, 2009 from the Connecticut Invasive Plant Working Group (CIPWG) Web Site: [http://www.hort.uconn.edu/cipwg/].
- Moffitt, L. J. and Craig D. Osteen. 2006. Prioritizing Invasive Species Threats Under Uncertainty. *Agricultural and Resource Economics Review*. 35(1):41-51.
- Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virginia.
- National Research Council. 2002. Predicting Invasions of Non-indigenous Plants and Plant Pests. National Academy of Sciences. Washington, D.C., 198 pp.
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available [http://www.natureserve.org/explorer]. (Accessed: November 24, 2009 ).
- Peterson, Paul M., Edward E. Terrell, Edward C. Uebel, Charles A. Davis, Hildemar Scholz, and Robert J. Soreng. 1999. *Oplismenus hirtellus* Subspecies *undulatifolius*, a new record in North America. *Castanea*. 64(2):201-202.
- Rejmánek, M. 2000. Invasive plants: approaches and predictions. *Austral Ecology* 25:497-506.

Warner, P.J., C. C. Bossard, M.L. Brooks, J. M. DiTomaso, J. A. Hall, A. M. Howald, D. W. Johnson, J. M. Randall, C. L. Roye, and A. E. Stanton. 2003. Criteria for Categorizing Invasive Non-native Plants that Threaten Wildlands. California Exotic Pest Plant Council and Southwest Vegetation Management Association.

## Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be increased incrementally by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

### Revision History Log

Version #	Date	Revised by	Changes	Justification
-----------	------	------------	---------	---------------

**Appendix C.** Interagency contact list by state and taxa for the Eastern Rivers and Mountains Network (ERMN).

In the event that a state or federal noxious weed or Animal Plant and Health Inspection Service--Plant Protection and Quarantine (APHIS-PPQ) plant pest is discovered in the ERMN, the following agencies must be contacted to report the new discovery (Table 1).

**Appendix C, Table 1.** State and federal contact information for reporting new noxious weed and plant pest occurrences.

Agency and Contact	State	Taxa
Pennsylvania Department of Agriculture Bureau of Plant Industry Melissa Bravo, (717) 787-7204, <a href="mailto:mbravo@state.pa.us">mbravo@state.pa.us</a>	PA	Noxious Weed Giant hogweed
Animal Plant and Health Inspection Service Plant Protection and Quarantine (APHIS-PPQ) Mike O'Connor, (609) 259-8650, <a href="mailto:michael.r.oconor@aphis.usda.gov">michael.r.oconor@aphis.usda.gov</a> Darryl Jewett, (607) 566-2212, <a href="mailto:darryl.k.jewett@aphis.usda.gov">mailto:darryl.k.jewett@aphis.usda.gov</a> Rachel Nyce, (717) 241-0133, <a href="mailto:rachel.s.nyce@aphis.usda.gov">rachel.s.nyce@aphis.usda.gov</a> Rachel Braud, (304) 372-8590, <a href="mailto:rachel.a.braud@aphis.usda.gov">rachel.a.braud@aphis.usda.gov</a>	NJ NY PA WV	Plant Pests Asian longhorned beetle emerald ash borer sirex woodwasp
Department of Agriculture Saul Vaiciunas, (609) 633-7976, <a href="mailto:saul.vaiciunas@ag.state.nj.us">saul.vaiciunas@ag.state.nj.us</a> Ken Carnes, (518) 457-2087, <a href="mailto:kennoth.carnes@agmkt.state.ny.us">mailto:kennoth.carnes@agmkt.state.ny.us</a> Nancy Richwine, (717) 772-5223, <a href="mailto:nrichwine@state.pa.us">nrichwine@state.pa.us</a> Sherri Hutchinson, (304) 558-2212, <a href="mailto:nichole.k.campbell@aphis.usda.gov">mailto:nichole.k.campbell@aphis.usda.gov</a>	NJ NY PA WV	Viburnum leaf beetle *Before reporting this species, check the National Agricultural Pest Information System (NAPIS) web site to determine if this species has already been reported for the county of observation. <a href="http://pest.ceris.purdue.edu/index.php">http://pest.ceris.purdue.edu/index.php</a>



**Appendix D.** Interagency contact list by state and taxa for the Northeast Temperate Network (NETN).

In the event that a state or federal noxious weed or Animal Plant and Health Inspection Service--Plant Protection and Quarantine (APHIS-PPQ) plant pest is discovered in the NETN, the following agencies must be contacted to report the new discovery (Table 1).

**Appendix D, Table 1.** State and federal contact information for reporting new noxious weed and plant pest occurrences.

Agency and Contact	State	Taxa
Department of Agriculture Bureau of Plant Industry  Douglas Cygan, #(603) 271-3488, <a href="mailto:dcygan@agr.state.nh.us">dcygan@agr.state.nh.us</a> Timothy Schmalz, (802)241-3544, <a href="mailto:tim.schmalz@state.vt.us">tim.schmalz@state.vt.us</a>	NH VT	State and Federal Invasive and Noxious Plants: <a href="http://plants.usda.gov/java/noxComposite">http://plants.usda.gov/java/noxComposite</a>
Animal Plant and Health Inspection Service Plant Protection and Quarantine (APHIS-PPQ)  Nichole Campbell, #(203) 269-4277, <a href="mailto:nichole.k.campbell@aphis.usda.gov">mailto:nichole.k.campbell@aphis.usda.gov</a> John Crowe, #(207) 848-5199, <a href="mailto:john.f.crowe@aphis.usda.gov">mailto:john.f.crowe@aphis.usda.gov</a> Mike O'Connor, #(609) 259-8650, <a href="mailto:michael.r.oconor@aphis.usda.gov">michael.r.oconor@aphis.usda.gov</a> Darryl Jewett, #(607) 566-2212, <a href="mailto:darryl.k.jewett@aphis.usda.gov">mailto:darryl.k.jewett@aphis.usda.gov</a>	CT, MA ME, NH, VT NJ NY	Plant Pests Asian longhorned beetle emerald ash borer sirex woodwasp
Department of Agriculture Division of Plant Industry  Rose Hiskes, #(203) 974-8600, <a href="mailto:rose.hiskes@po.state.ct.us">rose.hiskes@po.state.ct.us</a> Jennifer Forman Orth, #(617) 626-1735, <a href="mailto:jennifer.forman-orth@state.ma.us">mailto:jennifer.forman-orth@state.ma.us</a> Karen Coluzzi, #(207) 287-7551, <a href="mailto:karen.l.coluzzi@maine.gov">mailto:karen.l.coluzzi@maine.gov</a> John Weaver, #(603) 271-7384, <a href="mailto:jweaver@agr.state.nh.us">mailto:jweaver@agr.state.nh.us</a> Saul Vaiciunas, #(609) 633-7976, <a href="mailto:saul.vaiciunas@ag.state.nj.us">saul.vaiciunas@ag.state.nj.us</a> Ken Carnes, #(518) 457-2087, <a href="mailto:kennoth.carnes@agmkt.state.ny.us">kennoth.carnes@agmkt.state.ny.us</a> Emilie Inoue, #(802) 241-3544, <a href="mailto:emilie.inoue@state.vt.us">mailto:emilie.inoue@state.vt.us</a>	CT MA ME NH NJ NY VT	Viburnum leaf beetle Before reporting this species, check the National Agricultural Pest Information System (NAPIS) web site to determine if this species has already been reported for the county of observation. <a href="http://pest.ceris.purdue.edu/index.php">http://pest.ceris.purdue.edu/index.php</a>





The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 962/102272, May 2010

**National Park Service**  
**U.S. Department of the Interior**



---

**Natural Resource Program Center**  
1201 Oakridge Drive, Suite 150  
Fort Collins, CO 80525

[www.nature.nps.gov](http://www.nature.nps.gov)

EXPERIENCE YOUR AMERICA™