



Invasive Species Early Detection and Rapid Response Plan

Cumberland Piedmont Network

Natural Resource Report NPS/CUPN/NRR—2014/795



ON THE COVER

Clockwise from left: garlic mustard (*Alliaria petiolata*), photograph by Jennifer Stingelin Keefer; winter creeper (*Euonymus fortunei*) at Chickamauga and Chattanooga National Military Park (CHCH), Photograph by: Joe Meiman; bush honeysuckle (*Lonicera* sp.), photograph by Jennifer Stingelin Keefer; Asian longhorned beetle (*Anoplophora glabripennis*), photograph by Jennifer Stingelin Keefer.

Invasive Species Early Detection and Rapid Response Plan

Cumberland Piedmont Network

Natural Resource Report NPS/CUPN/NRR—2014/795

Jennifer Stingelin Keefer¹, Kurt L. Helf², Teresa Leibfreid², and Margot W. Kaye³

¹The Pennsylvania State University
Department of Ecosystem Science and Management
309 Forest Resources Laboratory
University Park, Pennsylvania 16802

²National Park Service
Cumberland Piedmont Network
PO Box 8
Mammoth Cave, KY 42259

³The Pennsylvania State University
Department of Ecosystem Science and Management
303 Forest Resources Building
University Park, Pennsylvania 16802

April 2014

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are 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 Cumberland Piedmont Network (CUPN) website (<http://science.nature.nps.gov/im/units/cupn/>) and Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Keefer, J. S., K. L. Helf, T. Leibfreid and M. W. Kaye. 2014. Invasive species early detection and rapid response plan for the Cumberland Piedmont Network. Natural Resource Report NPS/CUPN/NRR—2014/795. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Tables	v
Standard Operating Procedures (SOPs)	vii
Appendices.....	vii
Executive Summary	ix
Acknowledgments.....	xi
Introduction.....	1
Background and History	1
Why Implement Invasive Species Early Detection?	2
Goals and Objectives	3
Parks Involved	4
Sampling Design.....	5
Prioritizing List of Target Species	5
Invasive Species Identification Field Guide	6
Opportunistic Sampling	7
Detection.....	10
Assessment	10
Rapid Response	10
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
Mapping.....	15
Data Entry, Verification, and Validation	16
Data Archival Procedures	16

Contents (continued)

	Page
Data Reporting.....	17
Revisions.....	17
Personnel Requirements and Training.....	19
Roles and Responsibilities	19
Training and Safety Procedures.....	19
Operational Requirements	21
Annual Workload and Field Schedule	21
Startup Costs and Budget Considerations.....	21
Facility and Equipment Needs.....	21
Interagency Cooperation and Education.....	22
Literature Cited	23

Figures

	Page
Figure 1. Emerald ash borer (<i>Agrilus planipennis</i>). Photo taken by Jennifer Stingelin Keefer.	2
Figure 2. Location of fourteen parks in the Cumberland Piedmont Network (CUPN).	4
Figure 3. Early Detection of Invasive Species Surveillance Monitoring Field Guide title page and species card example.	8
Figure 4. Park-specific high priority early detection species list card example.	9
Figure 5. Invasive Species Early Detection and Rapid Response system for the Cumberland Piedmont Network (CUPN).	11
Figure 6. Screenshot of NPSpecies Observation record.	15

Tables

	Page
Table 1. Annual sampling events planned for each monitoring crew in the Cumberland Piedmont Network (CUPN).	20
Table 2. Invasive Species Early Detection annual budget estimate for the Cumberland Piedmont Network (CUPN).	21
Table 3. Computer software required to perform invasive species early detection duties in the Cumberland Piedmont Network (CUPN).	22

Standard Operating Procedures (SOPs)

	Page
Standard Operating Procedure (SOP) #1: Updating Invasive Species Early Detection Lists	27
Standard Operating Procedure (SOP) #2: Species Card Development	31
Standard Operating Procedure (SOP) #3: Data Collection.....	35
Standard Operating Procedure (SOP) #4: Rapid Response Procedures	43
Standard Operating Procedure (SOP) #5: Data Management and Reporting.....	47
Standard Operating Procedure (SOP) #6: Training and Safety	57
Standard Operating Procedure (SOP) #7: Revising the Plan.....	73

Appendices

	Page
Appendix A: Cumberland Piedmont Network (CUPN) Invasive Species Prioritization Process	75
Appendix B: Contact lists for the Cumberland Piedmont Network (CUPN)	107
Appendix C: CUPN Invasive Species Early Detection Field Guide Copyright Restrictions by Photographer	113

Executive Summary

The Cumberland Piedmont Network (CUPN) Inventory and Monitoring Program was initiated in January 2001 to conduct biological inventories and examine the status and trends of ecosystem health for its cohort of 14 national parks, battlefields, monuments, and historic sites. The first phase of the monitoring program involved working with park managers to prioritize and select a core set of vital signs for long term monitoring. During this process, invasive plants and forest pests were ranked among the top priorities, due to concerns about the effects these organisms can have on park ecosystems (Leibfreid et al. 2005). The known ecological impacts of invasive pests include displacement 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 the CUPN's Vegetation Monitoring Protocol, it is also critical to detect new populations of invasive species early in their invasion of new and sensitive habitats. Only when invasions are detected early will the chance of eradication remain high.

Early detection efforts for invasive species in the CUPN include three main objectives to:

1. Develop and maintain an annually updated list of high priority invasive 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 CUPN field crews and other interested cooperators, resource managers, and volunteers.
3. Coordinate information exchange on invasive species with other national and regional level partners, by maintaining digital records in the NPS species database (NPSpecies) and providing exports to others in a timely and efficient manner.

The responsibility of implementing early detection objectives belongs to the CUPN-Network Program Manager. Accomplishments of these objectives will allow CUPN member park resource managers to assess each invasive species early detection record on an individual basis, and target limited management resources and coordination toward the highest priority risks.

Acknowledgments

This document uses text and ideas without citations from “Early detection of invasive species: surveillance, monitoring, and rapid response: Eastern Rivers and Mountains (ERMN) and Northeast Temperate Networks (NETN)” (Keefer et al. 2010), Invasive Exotic Plant Monitoring Protocol for the Heartland Network Inventory and Monitoring Program” (Young et al. 2007) and “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 all 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 Derek Puckett, United States Forest Service (USFS), Karan Rawlins and Rebekah Wallace, University of Georgia Center for Invasive Species and Ecosystem Health, Rickie White, Carl Nordman and Milo Pyne, NatureServe, and CUPN park resource managers and staff. All contributed their time and assistance in developing early detection species lists, working through 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 availability and/or disturbance regimes (Baker 1965). Invasive species negatively impact park resources and visitor enjoyment by altering landscapes and fire regimes, altering or 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, pers. comm., March 2, 2010). The Cumberland Piedmont Network (CUPN) is witnessing the destruction of the eastern hemlock (*Tsuga canadensis*) in two parks by the hemlock woolly adelgid (*Adelges tsugae*) and the imminent demise of ash species (*Fraxinus* spp.) caused by the advancing populations of the emerald ash borer (*Agrilus planipennis*) (Figure 1) near Cumberland Gap National Historical Park (CUGA).

National parks are clearly susceptible to invasions. Each park within the CUPN 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 Carl Sandburg Home National Historic Site are dealing with spreading invasive plants that were deliberately planted as part of historic landscaping (Irene Van Hoff, pers. comm., August 27, 2012) or that are encroaching from nearby homes where they were planted and escaped into the nearby habitats.

Why Implement Invasive Species Early Detection?

An early detection and rapid response plan for invasive species can assist park managers with the ability to 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, USOTA 1993, Atkinson 1997, Myers et al. 2000, Harris et al. 2001, Timmins and Braithwaite 2001, Rejmanek and Pitcairn 2002, FICMNEW 2003, Lodge et al. 2006). 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 eradication 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).



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

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 Weeds’ (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).

One way to help understand the benefits of early detection, is by assessing the costs of invasions 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 1900s (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 gray willow (*Salix cinerea*) in southern New England (USFS 2006), water hyacinth (*Eichhornia crassipes*) and parrot-feather watermilfoil (*Myriophyllum aquaticum*) in the Shawnee National Forest, Mississippi (Corey 2008), and black mangrove (*Lumnitzera racemosa*) in Matheson Hammock County Park, Miami-Dade County, Florida (ECISMA 2010).

Goals and Objectives

The goals of this plan are to assist park managers in identifying high priority invasive species and to quickly disseminate new occurrence information to all interested parties (e.g. NPS, public, private, etc.).

Early detection of invasive species in CUPN parks begins with opportunistic detection of invasive plant and forest pest species and focuses on educating all field crews and interested cooperators, resource managers, and volunteers on invasive species identification. This plan also provides a coherent framework for reporting and disseminating information on potential infestations.

The primary goal of this early detection plan 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 becomes widespread and/or established.

To achieve the plan's primary goal the following objectives are established for the CUPN I & M invasive species early detection efforts:

1. Develop and maintain an annually updated list of high priority invasive 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 CUPN field crews and other interested cooperators, resource managers, and volunteers.
3. Coordinate information exchange on invasive species with other national and regional level partners, by maintaining digital records in the NPS species database (NPSpecies) and providing exports to others in a timely and efficient manner.

Accomplishment of these objectives will allow CUPN member park resource managers to assess each invasive species early detection record on an individual basis, and target limited management resources and coordination toward the highest priority risks.

Parks Involved

The CUPN consists of 14 parks with diverse cultural and natural resources distributed across seven states and six different physiographic regions. Ecosystems encompassed by the CUPN parks include aquatic, terrestrial, and cave systems. Parks in the Network range in size from 220 acres to almost 53,000 acres, and include four Revolutionary War parks, four Civil War parks, three national historic sites, one national monument, one national preserve, and one national park.

The following parks are included in the CUPN's Invasive Species Early Detection and Rapid Response (Figure 2): Abraham Lincoln Birthplace National Historic Site (ABLI), Carl Sandburg Home National Historic Site (CARL), Chickamauga and Chattanooga National Military Park (CHCH), Cowpens National Battlefield (COWP), Cumberland Gap National Historical Park (CUGA), Fort Donelson National Battlefield (FODO), Guilford Courthouse National Military Park (GUCO), Kings Mountain National Military Park (KIMO), Little River Canyon National Preserve (LIRI), Mammoth Cave National Park (MACA), Ninety Six National Historical Site (NISI), Russell Cave National Monument (RUCA), Shiloh National Military Park (SHIL), and Stones River National Battlefield (STRI).

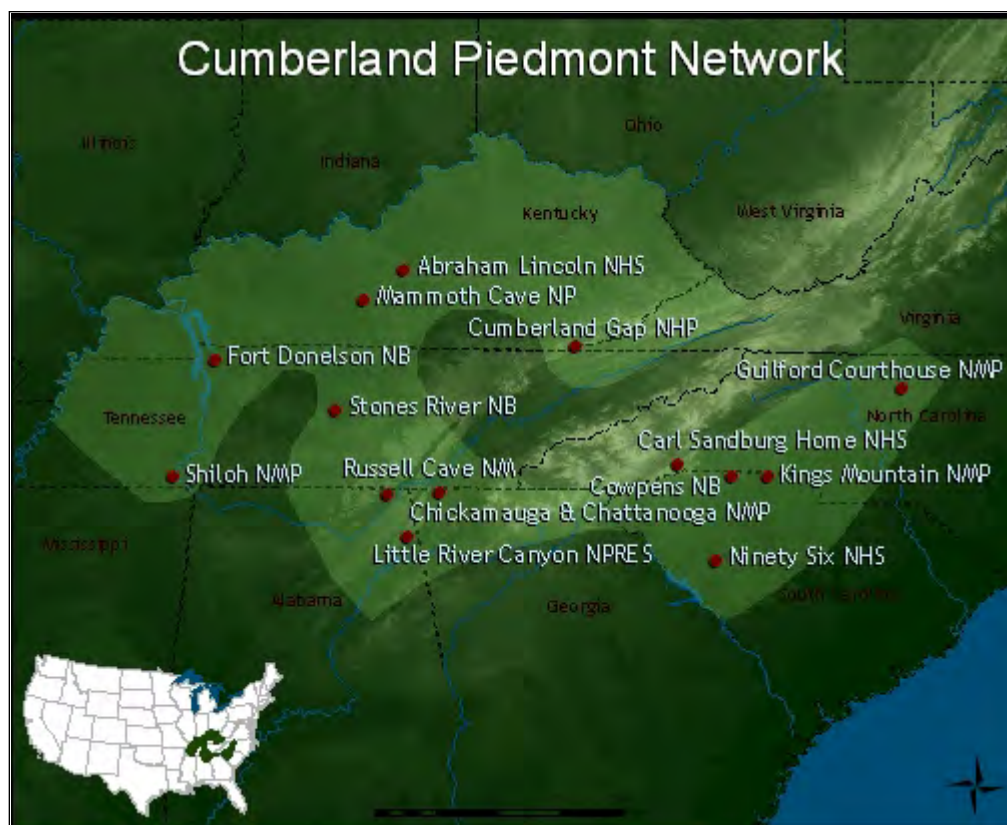


Figure 2. Location of fourteen parks in the Cumberland Piedmont Network (CUPN).

Sampling Design

Prioritizing List of Target Species

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 pest and 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). The North American Forest Commission Exotic Forest Pest Information System (NAFC-ExFor) supplies numerical scores in its expert-written pest reports which could easily form the basis of a ranked list of forest pests. Each of these systems provides a well-conceived model for ranking invasive plants and/or pests. 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](#) 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 plan.

The process of selecting an abbreviated list of target invasive species for each park in the CUPN consisted of four steps: 1) Review existing park datasets and literature and compile a list of all invasive species known or thought to occur in the parks; 2) Remove 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 plan will focus on terrestrial plants and insect pests. Aquatic plants and animals, as well as terrestrial animals and pathogens, may be added eventually, as time and resources permit.

See Appendix A for additional details on the CUPN 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 that 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 plan 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 highest 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 a high priority species is detected and eradicated, the species will likely remain on the park ISED list. However, if a high priority species is detected with a large population size 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 reason for removal of a widespread species from the high priority list is due to the need to focus efforts on those species at an early stage of invasion, where rapid response is most effective. In situations where high priority 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 for details on the process for creating new invasive species short lists of candidate species and questions to ask when prioritizing new species.

Invasive Species Identification Field Guide

To assist with the identification of target high priority invasive 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 originally developed by the Eastern Rivers and Mountains Network (ERMN) and adapted by the CUPN. Production of the CUPN "Early Detection of Invasive Species Surveillance Monitoring Field Guide" (NPS field guide) and 13 "new" species cards were completed in 2012. 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 CUPN Web site and available for download at <http://science.nature.nps.gov/im/units/cupn/monitor/invasiveplants/invasiveplants.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 plan, the word "Pest" represents non-plants. The NPS field guide title page and an early detection card example are presented in Figure 3.

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 4 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 high priority 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. Field forms can be viewed in SOP 2: Data Collection at the end of this document.

The primary directions and details regarding invasive species field guide species card creation can be found in SOP 6: Species Card Development.

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 CUPN, the networks' existing monitoring crews initially will be used for opportunistic encounters. Because these crews are already performing vital signs monitoring 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 trained also, for opportunistic encounters when they are out in the park. If time and resources permit, other individuals, such as park maintenance crews and local organizations, will be trained to aid in the effort.

National Park Service
U.S. Department of the Interior
Southeast Region



Cumberland Piedmont Network

Early Detection of Invasive Species Surveillance Monitoring Field Guide

Jennifer Stingelin Keefer

National Park Service
The Pennsylvania State University
309 Forest Resources Lab.
University Park, PA 16802

Jennifer_Stingelin_Keefer@partner.nps.org

U.S. Department of the Interior
National Park Service
Southeast Region
Inventory and Monitoring Program
Cumberland Piedmont Network
PO Box 8
Mammoth Cave, KY 42259

2012

JAPANESE CHAFF FLOWER [*Achyranthes japonica* (Miq.) Nakai] ACJA



Fig. 1 UGA 5443694

Native to eastern and southeastern Asia,¹ Japanese chaff flower (JCF), was first observed in 1981 on the banks of Tug Fork of the Big Sandy River at Warfield, Marrison County, Kentucky.^{1,3} Since this discovery, it has spread to 9 states.⁴ Although much is not known about this relatively new invader, an effective seed dispersal mechanism^{1,3} and competitive ability to shade-out native floodplain species,¹ are traits that have been observed since its initial discovery.

Habit: Erect,³ perennial herb (Fig. 1);^{2,5} to 15 dm (~5 ft).²
Reproduction: By seed; animal and water dispersed.

Leaves: Simple, opposite, elliptic; apex acute or acuminate and margins entire^{2,3} (Figs. 2 & 3); pinnately to arcuately veined, pubescent.^{1,2,3}

Stems: Initially single stemmed, but older plants tend to have multiple stems arising from a single root crown; red base; pubescent;⁴ 4-angled;³ can become decumbent late in the season;⁴ dead, orange-colored stems remain erect



Fig. 2 UGA 5427471 Fig. 3 UGA 5427353

HERB

JAPANESE CHAFF FLOWER *Achyranthes japonica* (Miq.) Nakai



Fig. 4 UGA 5427352

through fall and winter.¹

Flowers: Late summer through early fall;¹ occur on erect spikes at end of stems and upper branches; small, lacking petals, and tightly clustered at end of spike;¹ diverge at nearly right-angles from spike¹ (Figs. 2 & 3).

Fruits/Seeds: slender, dry, with a single hard seed head;¹ spikes elongate as fruit forms and fruits lie flat against spike (deflexed), to 2 dm (~8 in)^{1,2} (Fig. 4); each fruit contains a pair of stiff spiny bracts that aid in seed dispersal.¹

Habitat: Densely shaded moist soils to sunny drier areas;¹ wooded, annually flooded riverbanks,^{1,2,3} edges of fields, ditches, and swales.¹

Similar Species: Pigweed species like (*Amaranthus retroflexus* L.)³ (PW) (Fig. 5), have reddish stem bases like JCF and similar flowers. However, all PW is alternately branched, not opposite like JCF.^{1,2} American lopseed (*Phytolacca leptostachya* L.)³ (AL) fruits are similar to the elongated JCF fruit,^{1,3} however, JCF fruit contains paired spiny bracts, are more dense along the stem, and are deflexed.¹ In addition, AL leaf margins are toothed, not smooth or toothless like JCF.



Fig. 5 UGA 5396512



Fig. 6 © Stephen L. Solheim

Figure 3. Early Detection of Invasive Species Surveillance Monitoring Field Guide title page and species card example.

ALABAMA Little River Canyon National Preserve LIRI Designated park contact: Mary Shew 4322 Little River Trail NE, Suite 100 Fort Payne, Alabama 35967 256-845-9605 Mary_Shew@nps.gov Please see other Species Lists for contact information when reporting early detection species in ALL OTHER parks. Pest <table border="0"> <tr> <td><i>Agrilus planipennis</i></td> <td>emerald ash borer</td> </tr> <tr> <td><i>Anoplophora glabripennis</i></td> <td>Asian longhorned beetle</td> </tr> <tr> <td><i>Lymantria dispar</i></td> <td>European gypsy moth</td> </tr> <tr> <td><i>Pityophthorus juglandis</i></td> <td>Thousand Cankers Disease</td> </tr> <tr> <td><i>Geosmithia sp.</i></td> <td></td> </tr> <tr> <td><i>Sirex noctilio</i></td> <td>sirex woodwasp</td> </tr> </table> Herb <table border="0"> <tr> <td><i>Alliaria petiolata</i></td> <td>garlic mustard</td> </tr> <tr> <td><i>Imperata cylindrica</i></td> <td>cogongrass</td> </tr> <tr> <td><i>Lythrum salicaria</i></td> <td>purple loosestrife</td> </tr> <tr> <td><i>Oplismenus hirtellus</i> ssp. <i>undulatifolius</i></td> <td>wavyleaf basketgrass</td> </tr> <tr> <td><i>Polygonum cuspidatum</i>/ <i>P. sachalinense</i></td> <td>Japanese/giant knotweed</td> </tr> </table> Vine <table border="0"> <tr> <td><i>Celastrus orbiculatus</i></td> <td>oriental bittersweet</td> </tr> <tr> <td><i>Lygodium japonicum</i></td> <td>Japanese climbing fern</td> </tr> <tr> <td><i>Polygonum perfoliatum</i></td> <td>mile-a-minute</td> </tr> <tr> <td><i>Wisteria floribunda</i>/ <i>W. sinensis</i></td> <td>Japanese/Chinese wisteria</td> </tr> </table> SPECIES	<i>Agrilus planipennis</i>	emerald ash borer	<i>Anoplophora glabripennis</i>	Asian longhorned beetle	<i>Lymantria dispar</i>	European gypsy moth	<i>Pityophthorus juglandis</i>	Thousand Cankers Disease	<i>Geosmithia sp.</i>		<i>Sirex noctilio</i>	sirex woodwasp	<i>Alliaria petiolata</i>	garlic mustard	<i>Imperata cylindrica</i>	cogongrass	<i>Lythrum salicaria</i>	purple loosestrife	<i>Oplismenus hirtellus</i> ssp. <i>undulatifolius</i>	wavyleaf basketgrass	<i>Polygonum cuspidatum</i> / <i>P. sachalinense</i>	Japanese/giant knotweed	<i>Celastrus orbiculatus</i>	oriental bittersweet	<i>Lygodium japonicum</i>	Japanese climbing fern	<i>Polygonum perfoliatum</i>	mile-a-minute	<i>Wisteria floribunda</i> / <i>W. sinensis</i>	Japanese/Chinese wisteria	ALABAMA: LIRI CONTINUED Shrub <table border="0"> <tr> <td><i>Elaeagnus umbellata</i></td> <td>autumn olive</td> </tr> <tr> <td><i>Lonicera</i> spp.</td> <td>bush honeysuckles</td> </tr> <tr> <td><i>Solanum viarum</i></td> <td>tropical soda apple</td> </tr> </table> Tree <table border="0"> <tr> <td><i>Triadica sebifera</i></td> <td>Chinese tallow</td> </tr> </table> Aquatic <table border="0"> <tr> <td><i>Hydrilla verticillata</i></td> <td>hydrilla</td> </tr> </table>	<i>Elaeagnus umbellata</i>	autumn olive	<i>Lonicera</i> spp.	bush honeysuckles	<i>Solanum viarum</i>	tropical soda apple	<i>Triadica sebifera</i>	Chinese tallow	<i>Hydrilla verticillata</i>	hydrilla
<i>Agrilus planipennis</i>	emerald ash borer																																								
<i>Anoplophora glabripennis</i>	Asian longhorned beetle																																								
<i>Lymantria dispar</i>	European gypsy moth																																								
<i>Pityophthorus juglandis</i>	Thousand Cankers Disease																																								
<i>Geosmithia sp.</i>																																									
<i>Sirex noctilio</i>	sirex woodwasp																																								
<i>Alliaria petiolata</i>	garlic mustard																																								
<i>Imperata cylindrica</i>	cogongrass																																								
<i>Lythrum salicaria</i>	purple loosestrife																																								
<i>Oplismenus hirtellus</i> ssp. <i>undulatifolius</i>	wavyleaf basketgrass																																								
<i>Polygonum cuspidatum</i> / <i>P. sachalinense</i>	Japanese/giant knotweed																																								
<i>Celastrus orbiculatus</i>	oriental bittersweet																																								
<i>Lygodium japonicum</i>	Japanese climbing fern																																								
<i>Polygonum perfoliatum</i>	mile-a-minute																																								
<i>Wisteria floribunda</i> / <i>W. sinensis</i>	Japanese/Chinese wisteria																																								
<i>Elaeagnus umbellata</i>	autumn olive																																								
<i>Lonicera</i> spp.	bush honeysuckles																																								
<i>Solanum viarum</i>	tropical soda apple																																								
<i>Triadica sebifera</i>	Chinese tallow																																								
<i>Hydrilla verticillata</i>	hydrilla																																								

Figure 4. Park-specific high priority 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 it is not feasible to conduct volunteer training and coordination at every park using CUPN staff, several parks have their own volunteer programs, and it is highly desirable to support these efforts into the future. New iPhone and Android Application technology developed by [The Bugwood Network](#) could potentially facilitate the use of volunteers for ISED in CUPN parks. Applications like

“IveGot1,” developed specifically for identifying and reporting invasive animals and plants in Florida, would eliminate the need for direct person-to-person reporting and expensive training materials. There are also a growing number of websites used for collecting species data from the general public (such as inaturalist.org) which could provide future opportunities for data gathering. The CUPN will work with park staff to assist in developing training aids for volunteers when feasible.

Detection

New detections of high priority invasive species are time-sensitive and should be immediately reported through the appropriate chain of command. The first step is the responsibility of the observer to promptly report an observation to the designated park and Network contacts using field forms designed for this purpose (SOP 3: Data Collection). Contact information for parks and the Network are listed in Appendix B, Table 1. The CUPN has two contacts: one for plants (currently the Network Program Manager), and one for pests (an Invertebrate Ecologist). If the observer is part of a CUPN field team, field forms, photographs, and/or specimens will be submitted to the appropriate Network contact. If the observer is not part of a CUPN field team, the above listed items will go directly to the park designated contact. It is then the responsibility of the designated park and Network contacts to share the information with each other and work together to contact other park and regional personnel, EPMTs, and outside agencies, as appropriate. Alerting the Network contact, 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 Network contact will follow-up with each designated park contact and may assist with alerting relevant outside agencies.

Assessment

Once a new species is detected, the first priority should be positive identification. If the pest or plant cannot be positively identified on the ground during the initial detection, the park and Network contacts will work together to immediately contact appropriate taxa experts or State and/or Federal agencies to aid in taxa identification (SOP 3: Data Collection). Only when a taxon is correctly identified can a rapid response commence.

Rapid Response

Rapid responses to invasions are effective and can prevent the spread and permanent establishment of invasive species. A conceptual model developed for the CUPN Early Detection of Invasive Species Rapid Response system depicts the flow of information once a high priority invasive species is detected (Figure 5). 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 4: 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.

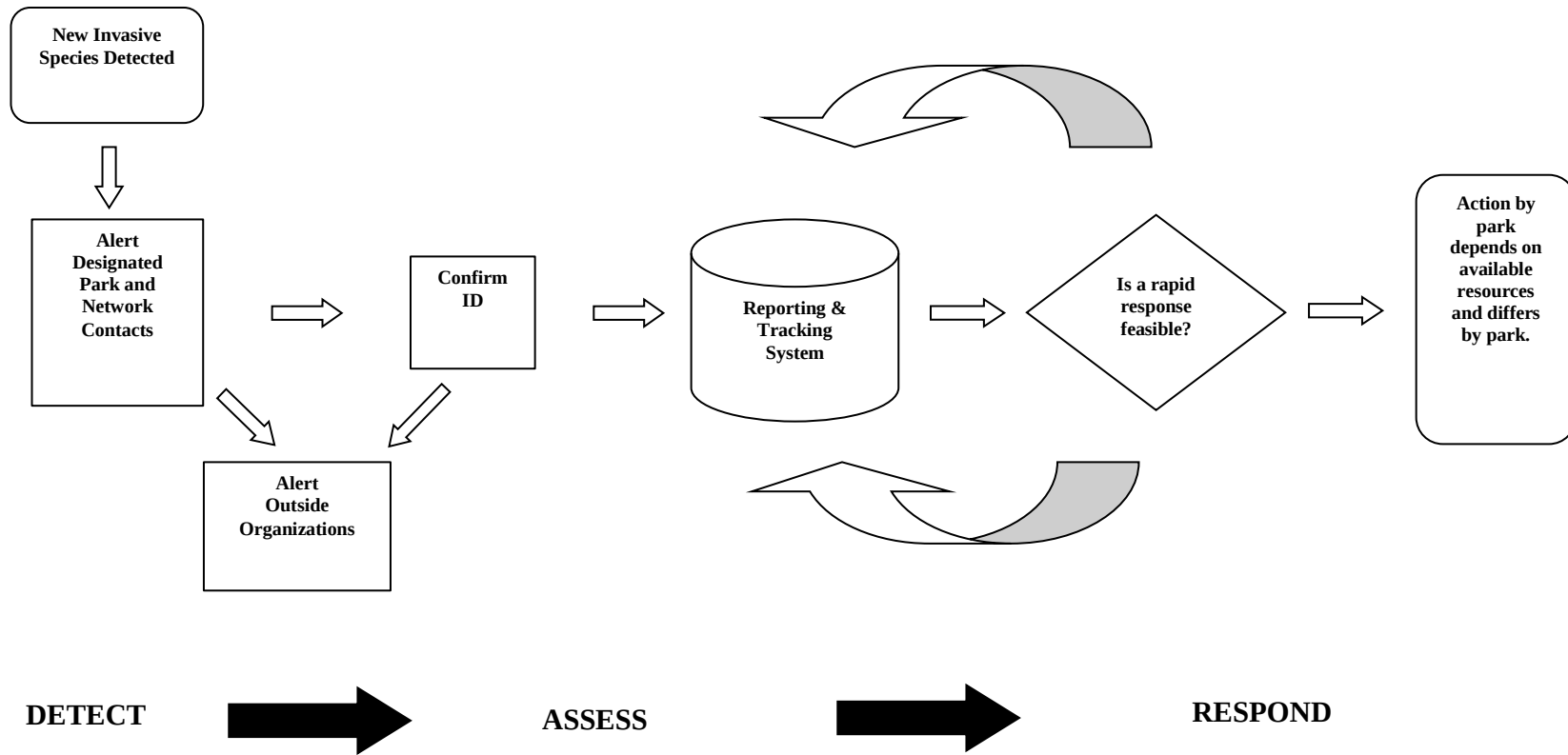


Figure 5. Invasive Species Early Detection and Rapid Response system for the Cumberland Piedmont Network (CUPN).

Field Methods

Field Season Preparations and Equipment Set-up

Prior to the commencement of a field season (see Table 1), the Network contacts are 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 plan is initially being carried out by existing network monitoring crews, additional equipment preparation and set-up will be minimal. Each CUPN 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 Invasive Species Coordinators:

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

In addition to the items above, volunteers and park personnel not involved with network monitoring should have the following list of supplies before performing invasive species surveillance monitoring (park approval is needed before collecting any specimens):

- Device capable of gathering coordinate data (GPS unit, cell phone, etc.)
- Device capable of taking digital photo (camera, cell phone, etc.)
- Biodegradable flagging (red or pink)
- Pencils (sharpened or with extra lead)
- Permanent markers
- 10x hand lens
- Sealable gallon-sized plastic bags for plant or pest samples
- Aspirator
- Several specimen vials containing ethyl alcohol
- Small, rectangular pieces of paper to label specimen and drop in vial

Gathering Field Data

The primary directions and details regarding field data gathering can be found in SOP 2: Data Collection. Generally, when a high priority exotic 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, 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, given the proper permitting, to confirm species identification, especially those that are likely to be identified incorrectly. Where possible, photographic specimens are preferred to avoid potential spread of invasive plant and pest material. However, in many cases, an actual specimen will be needed for proper identification. In those 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 species identity and will not be stored in a collection, unless requested by the park.

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

CHCH_ISED_JMeiman_*EuonymusFortunei*_LowerTruckTrail_05_20091217.jpg

Data Management and Reporting

Database

Species observation data will be recorded in the NPSpecies database which is part of the Integration of Resource Management Applications (IRMA) system that is used to store, manage, and discover information on species on National Park Service lands (Figure 6). This online database is maintained through the NPS-IM Program, and is accessible to all parks, as well as the general public. The CUPN invasive species coordinators are responsible for ensuring the data are entered, as soon as possible, after species identification is confirmed. When observations occur on the CUPN vegetation monitoring plots, species data will also be recorded in the CUPN Vegetation Monitoring Database, a Microsoft Access database developed using the Natural Resource Database Template (NRDT). The CUPN data manager is responsible for future development and maintenance of this application, including QA/QC, summarization and export routines (to NPSpecies and other data systems as needed). Refer to SOP #5: Data Management and Reporting for additional details.

Observation Profile	
Contact Data Steward Edit Profile	
Profile Definition	
Unique Observation Identifiers	
Code: 14038720 Unit: Cumberland Gap National Historical Park (CUGA) Scientific Name: Polygonum cuspidatum Lifecycle: Active Sensitivity: Non-Sensitive	
Event Information	Location Information Record Information
Documented Scientific Name: No Data	
Observer	
Date/Time of Observation	
Date Observed: 08/20/2013 End Date: No Data Time Observed: No Data	
Habitat	
General Habitat: Upland Specific Habitat: Broadleaf Forest Habitat Comments: Near perennial creek bed flowing into Yellow Creek	
Physical Description	
Count: No Data Age: No Data Sex: No Data Observation Method: Visual with Naked Eye Observation Method A small population was observed during forest monitoring fieldwork for the Cumberland Piedmont Network	

Figure 6. Screenshot of NPSpecies Observation record.

Mapping

To incorporate Network-level invasive species observations into regional efforts, we plan to use the [Early Detection and Distribution Mapping System \(EDDMapS\)](#). The EDDMapS was developed for the southeastern U.S. in 2005 ([Southeast Exotic Pest Plant Council](#)) and for the Mid-Atlantic states beginning in 2009 ([Mid-Atlantic Invasive Plant Council](#)). The Internet

application combines Google Maps, interactive county-level species introductions, and documents distribution over time in the southeastern states.

EDDMapS provides a convenient solution for the storage, display, and sharing of occurrence and distribution data on known and newly introduced invasive species and pests. 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 southeastern region are able to input location information on invasive species in nine states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) and Virginia (Mid-Atlantic region). 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 Invasive Plant Atlas of the MidSouth (IPAMS), would be beneficial to the network.

The CUPN plans to share data on invasive species with the managers of EDDMapS, by exporting data from NPSpecies and/or the Vegetation Monitoring database. This will not only capture new high priority occurrences, but will also include all invasive species from these databases that were not previously recorded. Use of the EDDMapS, in conjunction with the CUPN website, 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 Southeast Region. To view the current CUPN website, visit:

Cumberland Piedmont Network Inventory and Monitoring Program.

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 plan. The CUPN data manager will oversee data entry, verification and validation, and will contact 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 CUPN office. Data forms and databases will be archived and backed up according to the network's data management plan (Moore 2005).

Data Reporting

The Invasive Species Coordinators will communicate with park contacts in late fall or winter to review associated park high priority exotic species lists, receive feedback, and make any necessary adjustments to the plan. They will also prepare summary reports when new invasive species are detected, using the format of a resource brief. Refer to SOP #5: Data Management and Reporting for examples of resource briefs. 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.

Revisions

Changes and revisions will be incorporated into this document as we learn more about invasive species early detection and rapid response. We will document these revisions in SOP# 7: Revising the Plan. Changes will also be tracked using the CUPN file naming convention and archived at the network level.

Personnel Requirements and Training

Roles and Responsibilities

The Cumberland Piedmont Network has designated two Invasive Species Early Detection coordinators, one for plants (Network Program Manager) and one for forest pests (Network Invertebrate Ecologist). The Invasive Species Coordinators serve as the project managers for this plan and work closely with existing monitoring crews, especially the CUPN Vegetation Monitoring crew leaders. The coordinators are responsible for plan development, refinement, overall quality assurance, website content, and coordination with outside agencies, private organizations, and regional mapping programs (e.g. EDDMaps). See Appendix B for a list of interagency contacts by state and taxa. Data management is the responsibility of the CUPN Coordinators working with the CUPN Data Manager. Occasional assistance will be needed from other network staff to assist with items such as GIS and website development. The Invasive Species Coordinators are also responsible for training field crews how to identify invasive plant and pest species and, on occasion, making site visits to confirm 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, GIS, and Web design skills are also helpful.

Training and Safety Procedures

The primary directions and details regarding training can be found in SOP #6: Training and Safety.

Training is essential for the proper identification of invasive pests and plants. The Invasive Species Coordinators 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 plan 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/park safety procedures, sign the Job Hazard Analysis (JHA), and read this entire ISED plan. All will engage in training exercises (i.e. test plot or site) designed to meet their individual monitoring protocol needs. Each CUPN monitoring crew will utilize their own respective monitoring protocol SOPs for training specifics. For example, for field season preparation and Global Positioning System (GPS) utilization, the CUPN vegetation monitoring crew will utilize SOP #1 Field Season Preparation and SOP #2. Using the GPS found in the CUPN Vegetation Monitoring Protocol (White et al. 2011).

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. In the future, as additional non-natural resource park personnel (i.e. interpretation and/or maintenance staff), and possibly volunteers, become involved, this plan will be modified to include specific training instructions geared towards these focus groups.

Table 1. Annual sampling events planned for each monitoring crew in the Cumberland Piedmont Network (CUPN).

Monitoring Protocol Crews	Parks	Field Season
Cave Aquatic Biota	MACA, RUCA, CUGA	July - October
Cave Bats/Cave Meteorology	CHCH, CUGA, MACA, RUCA	January – February and June - July (every other year)
Cave Crickets	MACA	June and December
Cave Woodrats	MACA	October - November
Ozone Foliar Injury	All parks	August ¹
Forest Vegetation	All parks	April – September ²
Water Quality	CHCH, CUGA, LIRI, MACA, RUCA, SHIL, STRI ABLI, KIMO CARL, COWP, FODO, GUCO, NISI	Monthly (2 years on – 5 years off) Bi-Monthly (every other year) Quarterly (every other year)

¹ Network sampling teams will rotate through 2 or 3 parks per year.

² Plot revisits usually take one week to complete and are on a five-year revisit schedule. Largest parks will have fieldwork every year (CHCH, CUGA, MACA). Medium and multi-unit parks will have fieldwork 4 years on and 1 year off (ABLI, FODO, LIRI). All other parks will have fieldwork 3 years on and 2 years off.

Operational Requirements

Annual Workload and Field Schedule

While early detection for high priority species can occur year-round, the majority of surveillance will commence with each monitoring field season. Table 1 lists annual sampling events for each monitoring crew. The Invasive Species Coordinators, with assistance from other CUPN staff, will be responsible for year-round data management, annual reporting, website updates, and communications with individual parks.

Startup Costs and Budget Considerations

This document was developed through a cooperative agreement with the Pennsylvania State University. The initial funding also covered data mining, development of 13 new field cards, and one session of training for vegetation monitoring field crews in May 2012. Future costs associated with this plan are detailed in Table 2. This estimate includes salary of existing staff, data management, travel costs, and supplies.

Table 2. Invasive Species Early Detection annual budget estimate for the Cumberland Piedmont Network (CUPN).

		%Budget	\$Amount	Estimate Basis
Salary	ISED Coordinators	60%	5,000	Approximately 3 weeks (1.5 weeks per coordinator, GS11-13)
	Data Management & Reporting	33%	2,800	1/3 budget rule estimate from IM program* (Interns,GS9-13)
Travel	ISED Coordinators	6%	500	Annual meeting/training (one or both coordinators)
Supplies		1%	100	Replacement costs/printing of cards.
TOTAL		100%	8,400	

* The I&M program requires that at least 30% of the cost of each protocol is dedicated to data management, analysis and reporting activities.

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. It is suggested that depending on the size of the infestation and whether the species is a pest, pathogen, or plant, the park manager contact EPMTs, and/or outside agencies to curb rapid response costs. Currently, qualified Exotic Plant Management Team (EPMT) crews may remove small infestations of plants if the population size is small and the complete removal of the plant is feasible. For cases of new pest detections, funds for rapid response treatment are available through USDA, but are contingent upon proper application procedures.

Facility and Equipment Needs

Minimally, the Invasive Species Coordinators 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 Cumberland Piedmont Network (CUPN).

Software Programs	Reason
Microsoft Office Access/Excel Word	General database management (NPSpecies, EDDMaps, etc.) 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	ISED Mapping

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). CUPN staff are already working closely with network parks, EPMT, and the Southeast Region Integrated Pest Management Coordinator. In addition, several of the network parks are cooperating with the United States Forest Service (USFS) and the Animal and Plant Health Inspection Service (APHIS), and universities with invasive species programs, such as Clemson University in South Carolina, for technical guidance and rapid response assistance. Local resource managers, plant/garden groups, and state exotic pest plant councils are also key resources for public outreach. 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.
- 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.
- 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 online February 24, 2009.
- Everglades Cooperative Invasive Species Management Area (ECISMA). 2010. The rapid response to *Lumnitzera racemosa* an Austral-Asian mangrove species. PowerPoint Presentation slide: 2010 Everglades invasive species summit. <http://www.evergladescisma.org/summit10/ECISMA.pdf>. Accessed online August 21, 2012.
- 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.
- 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].
- Harris, S., J. Brown, and S. Timmins. 2001. Weed surveillance—how often to search? *Science for Conservation* 175.
- 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.

- 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.treesearch.fs.fed.us/pubs/20715>.
- Keefer, J.S., M. Marshall, B. Mitchell, and M. Kaye. 2010. Early detection of invasive species: a US National Park Service approach. *in* E. Rindos, ed., *Plant Invasions: Policies, Politics, and Practices*, Proceedings of the 2010 Weeds Across Borders Conference, 1–4 June 2010, National Conservation Training Center, Shepherdstown, West Virginia. Bozeman, Montana: Montana State University, Center for Invasive Plant Management.
- Leibfreid, T.R., R.L. Woodman, and S.C. Thomas. 2005. Vital Signs Monitoring Plan for the Cumberland Piedmont Network and Mammoth Cave National Park Prototype Monitoring Program: July 2005. National Park Service, Mammoth Cave, Kentucky, USA. 125 pp. plus appendices.
- Lodge, D.M., S. L. Williams, H. MacIsaac, K. Hayes, B. Leung, S. Reichard, R. N. Mack, P. B. Moyle, M. Smith, D. A. Andow, J. T. Carlton, and A. McMichael. 2006. Biological invasions: recommendations for U.S. policy and management. *Ecol. Appl.* 16, 2035–2054.
- 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. diCasti, 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.
- 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/>]. 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.
- Moffitt, L. J. and Craig D. Osteen. 2006. Prioritizing Invasive Species Threats Under Uncertainty. *Agricultural and Resource Economics Review*. 35(1):41-51.
- Moore, W. J., R. Byrd, and T. Leibfreid. 2005. Data management plan for the Cumberland Piedmont Network and Mammoth Cave National Park Prototype monitoring program. USDI National Park Service. Mammoth Cave, KY. 81pp.

- 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.
- 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 Park Service. 2010. Natural Resource Database Template documentation. Natural Resource Program Center, Office of Inventory, Monitoring, and Evaluation, Fort Collins, CO. http://science.nature.nps.gov/im/datamgmt/standards/data_standards_summary_20100610.pdf.
- National Research Council. 2002. Predicting invasions of non-indigenous plants and plant pests. National Academy of Sciences. Washington, DC.
- 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.

- United States Congress Office of Technology Assessment (USOTA). 1993. Harmful non-indigenous species in the United States. U.S. Government Printing Office. Washington, DC.
- United States Forest Service (USFS). 2006. A forest health program success story-- From obscurity to notoriety: large gray willow. USFS Northeastern Area.
http://www.na.fs.fed.us/ss/06/fh/gray_willow_access.pdf. Accessed online August 21, 2012.
- United States Presidential Executive Order (USPEO). 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.
- 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.
- Webb, B. (n.d.). Early Detection & Spot Removal Team of The Nature Conservancy's Southern Lake Champlain Valley Program. Retrieved online 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.
- White, R., C. Nordman, L. Smart, T. Leibfreid, B. Moore, R. Smyth, and T. Govus. 2011. Draft vegetation monitoring protocol for the Cumberland Piedmont Network, Version 1.1. Natural Resource Report NPS/CUPN/NRR—2011. National Park Service. Fort Collins, CO.
- 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

CUPN

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

Every year, invasive species early detection (ISED) lists for each park 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 a high priority exotic species is detected and eradicated, the species will likely remain on the park ISED list. However, if a high priority exotic 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 (see Appendix B Contact List) 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 MidSouth (IPAMS), 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, and check websites maintained by groups such as state exotic pest plant councils. 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 considered when prioritizing each new invasive species:

- 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).

- 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?
- Does the species have the potential to become naturalized in the park?
- Does the species have the potential to establish in minimally managed habitats?
- 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. Another example would be a species dependent on alkaline soils will not be a big threat in park with only acidic soils.
- Is the species a significant threat to park resources and communities of ecological significance (rare, threatened or endangered species, bogs, river scour communities, cliff communities etc.)?
- Does the species negatively affect forest crop production, commercial agriculture or human health?
- 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.
- 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?
- What is the known cold hardiness/agricultural zone of the species?
- 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?
- Does the park have specific management actions in mind? Didymo might be impossible to currently control, but species tracking and spread prevention via public education might be important to the park.
- 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. For invasive plants, the state exotic plant councils provide rankings based on severity of threat within the state, as well as "watch" lists. The USDA Forest Service Southern Region's "Regional forester's list and ranking structure: invasive exotic plant species of management concern (2001)" guides invasive management on National Forest lands. It is also important to remember that this process is not a formal ranking system, based upon the number of questions answered with "yes". Outcomes can vary depending on who is involved in the prioritization process and how much weight is placed on the answer to each question listed above.

After completing the species prioritization process, each park species list must be updated (as needed) to document revisions to the candidate and final list of early detection species.

Literature Cited

- 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.

Standard Operating Procedure (SOP) #2: Species Card Development

CUPN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #2 Species Card Development

This SOP provides specific instructions regarding the development of new species cards for inclusion in the CUPN “Early Detection of Invasive Species Surveillance Monitoring Field Guide” [National Park Service (NPS) field guide]. Prior to the publishing of this plan, 13 NPS species cards were completed in 2012 (Table 1).

SOP #2, Table 1. Thirteen invasive species early detection cards developed in 2012.

Taxa Category	Scientific Name	Common Name
Pests	<i>Lymantria dispar</i>	European gypsy moth
	<i>Tomicus piniperda</i>	Common pine shoot beetle
Aquatics	<i>Alternanthera philoxeroides</i>	alligatorweed
	<i>Hydrilla verticillata</i>	Hydrilla
Plants	<i>Achyranthes japonica</i>	Japanese chaff flower
	<i>Phragmites australis</i>	Phragmites/common reed
	<i>Euonymus fortunei</i>	Winter creeper
	<i>Lygodium japonicum</i>	Japanese climbing fern
	<i>Wisteria floribunda</i> /W. <i>sinensis</i>	Japanese/Chinese wisteria
	<i>Lonicera</i> spp.	bush honeysuckles
	<i>Solanum viarum</i>	tropical soda apple
	<i>Melia azedarach</i>	Chinaberrytree
	<i>Triadica sebifera</i>	Chinese tallow

Background Research

Prior to card development, research should be conducted to find specific information about each species and common look-alike species. In-house reference materials, journal articles and Web sites are usually sufficient; however, a trip to the library or discussion with a taxa expert is sometimes necessary. Once information is obtained, images of each species and look-alike species must be found and appropriate permissions granted before commencing card production. It is important to concentrate on images that focus on distinguishing features. Generally, plant photos should depict the overall habit and/or form of the species (plants), fruits, seeds, buds, or other distinguishing characteristics. For example, when creating a card for *Solanum viarum* (tropical soda apple), a photo of thorns projecting from the upper leaf surface veins and petiole was included. Pest species photos should depict different life stages of the pest if necessary, close-ups of distinguishing features, and host damage. For example, when creating the card for *Lymantria dispar* (European gypsy moth), photos of both male and female moths, mature larva (caterpillar) and pupae were included. The [Bugwood Network and Forestry Images Archive and Database Systems](#) is a good place to start. Other image sources include, but are not limited to [CalPhotos](#), [Discover Life](#), and [Missouri Plants](#). Photos can be retrieved anywhere, however, it is

imperative that Web site photo use instructions are adhered to or specific photographers are individually contacted to ask for photo use permission. Most individuals have no problem granting permission for photos used for educational or non-profit purposes. JPEG or TIFF files can be used; however, TIFF files have been used in the past because they do not degrade in quality each time the photo is edited. A list of photos used to create the initial thirteen ISED cards as well as photo-us permissions is listed in Appendix C.

Species Card Development

The United States Forest Service's (USFS) 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. When creating a new species card, blank front or "Master Text Top Ring" and back or "Master Text Bottom Ring" master template copies must be inserted into the existing field guide. When creating new citation pages, a blank front or "Master Citation Top Ring" page needs to be inserted. The "Master Text Bottom Ring" template can be used as a blank back citation page. All pages are inserted alphabetically by scientific name and by the color-coded taxonomic category or life form, in the case of plants. Once all of the appropriate pages are inserted, the color-coded squares (lower right-hand corner of front species card) and bar (top of front citation page) need to be updated. This can be done by "Overriding All Master Page Items" and choosing the appropriate colors and text (color-coded squares only).

Once the new blank templates are in place, species information and photographs can now be placed on the card. For each citation, footnotes are used in the text and appropriately cited on the citation card. Photographs are cited with the photographer name and copyright date (if available) or Bugwood identification number and are appropriately cited beneath all reference citations on the citation card.

Once all new cards are completed, updates must be made to the species list at the front of the field guide. If future species cards are developed in groups, field guide "Supplements" can be printed and distributed to all field guide holders. For future reference, specific master templates for species and citation cards are available in the master CUPN Invasive Species Field Guide InDesign® file.

Printing

The following are printing specifications for the CUPN "Early Detection of Invasive Species Surveillance Monitoring Field Guide:"

There are a total of 43 pages (86 back and front).

1. Pages starting with title page (pg. 1) and ending with Hydrilla (pg. 23) (includes back of card) should be printed on Xerox Polyester 10 mil paper or a cardstock with lamination. The United States Department of Agriculture (USDA) Forest Service uses white poly vinyl chloride, but this type of paper is extremely expensive.
2. Text citation pages starting with *Adelges tsugae* (hemlock woolly adelgid) (p. 24) and ending with *Hydrilla verticillata* (*Hydrilla*) (pg. 43) should be printed on white heavy cardstock.

3. Round the corners.
4. Print head-to-foot.
5. Size of trimmed page: 3 X 8
6. Punch 2 round holes at the top of the publication. Center of each hole should be approximately 1" from each side of the card and 3/8" down from the top of the card. Ensure the holes are no more than 1" from the top and do not cut off any text. (Match holes to printed sample enclosed).

The following are printing specifications for the CUPN pest and plant reporting forms:

1. All pages should be printed on Rite-in-the-Rain waterproof paper.
2. Round the corners.
3. Print head-to-foot.
4. Size of trimmed page: 3 3/4" X 8"
5. Punch 2 round holes at the top of the publication. Center of each hole should be approximately 1" from each side of the card and 3/8" down from the top of the card. Ensure the holes are no more than 1/2" from the top and do not cut off any text. (Match holes to printed sample enclosed).

The following are printing specifications for the CUPN park species lists:

1. All pages should be printed on Xerox Polyester 10 mil paper or a cardstock with lamination.
2. Round the corners.
3. Print head-to-foot.
4. Size of trimmed page: 3 3/4" X 8"
5. Punch 2 round holes at the top of the publication. Center of each hole should be approximately 1" from each side of the card and 3/8" down from the top of the card. Ensure the holes are no more than 1/2" from the top and do not cut off any text. (Match holes to printed sample enclosed).

Standard Operating Procedure (SOP) #3: Data Collection

CUPN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #3 Data Collection

Once a new early detection plant species is observed, it is imperative that an Early Detection Pest or Plant Reporting form as well as accompanying photos and/or specimens be completed and submitted to the designated park contact and/or Invasive Species Coordinator. 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) Park
 - f) Species name (scientific or common)
 - g) GPS coordinates [Universal Transverse Mercator (UTM) coordinates, UTM zone or Decimal Degrees (DD)], Datum, and Coordinate error (meters)
 - h) How were the coordinates obtained (e.g. phone, GPS unit etc.)?
 - i) Specific location of the species including road names, trails, signs etc.
 - j) Habitat (e.g. forest edge, wetlands: bog, edge: lake, right-of-way).
 - k) Host species involved (pests only)
 - l) DBH (diameter at breast height) if tree species (pests only)
 - m) Host species stem count (pests only) or stem count (plants 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) Infested area - estimation of the area that only contains the species of interest (in square feet, square meters, acres or hectares) (plants only).
 - p) Gross area – estimation of the general area of infestation, but may include areas that are not occupied by the species of interest (in square feet, square meters, acres or hectares) (plants only).
 - q) Canopy closure (check one) (plants only):
 - i) Trace (<1%)
 - ii) Low (1-5%)
 - iii) Moderate (5.1 – 25%)
 - iv) High (25.1 – 100%)

- r) Abundance/Density (check one) (plants only):
 - i) Single
 - ii) Scattered
 - iii) Scattered dense patches
 - iv) Dense monoculture
 - v) Linearly scattered
 - s) Description of the plant (check all that apply):
 - i) In flower
 - ii) In fruit
 - iii) Seedlings/Rosettes
 - iv) Seeds
 - v) Dormant/Dead
 - vi) Bolting
 - vii) Unknown
 - t) Certainty of identity:
 - i) Extremely Confident
 - ii) Moderately confident
 - iii) Not very confident
 - u) Additional comments (habitat, vigor, number of individuals present, site accessibility etc.).
 - v) Specimen collected: Yes/No
 - w) Photograph taken: Yes/No
- 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) Send or deliver card and photographic evidence to the designated park contact or the appropriate Invasive Species Coordinator. Original forms should always be sent back to the appropriate network office for data entry and archival purposes.

Specimen Preservation

Plants

If collection of a plant specimen is warranted by a trained botanist possessing or named in a collecting permit, 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.

Identify the plant or pest as soon as possible. See Tables 1 and 2 for a list of qualified botanists and entomologists, respectively, available to assist in their identification.

Specimen Preservation

Pests

Pest specimens may be temporarily stored for almost a week in a refrigerator provided they are kept in a tightly closed container with a moist cotton ball to prevent drying out. For longer periods they may be stored in an airtight container in a deep freeze.

- a) Line the container with tissue to protect the specimens from contact with condensation.
- b) When removing the specimens from the freezer, allow them to reach room temperature before opening container to prevent possible loss of diagnostic appendages due to breakage and wetting due to condensation.

Pest specimens should be preserved in liquid for shipping.

- a) Soft bodied insects should be placed in 70% ethyl alcohol solution in an appropriate size vial and labeled with the collector's contact information, collection date and location.
- b) If ethyl alcohol is unavailable, isopropyl alcohol may be used as a substitute.
- c) Hard bodied insects can also be temporarily preserved in alcohol for Shipping to the PI.
- d) Do not send liquid preserved insect specimens via the U.S. Postal Service but instead use Federal Express.

SOP Figures 1 and 2 show examples of a pest and plant reporting forms for the Cumberland Piedmont Network (CUPN). See Appendix C for State and Federal contact information for reporting new plant/pest discovery information.

SOP #3, Table 1. Qualified botanists/ecologists available to assist in plant identification.

Name	Contact Information
Tom Govus, Botanist	Consultant 3711 Big Creek Road Ellijay, GA 30536 Email: tgovus@ellijay.com
Carl Nordman, Botanist	NatureServe 601A Foster Street Durham, NC 27701 Email: Carl_Nordman@natureserve.org
Milo Pyne, Southeast Regional Ecologist	NatureServe 601A Foster Street Durham, NC 27701 Email: Milo_Pyne@natureserve.org
Rickie White, Plant Ecologist	NatureServe 601A Foster Street Durham, NC 27701 Email: Rickie_White@natureserve.org
Al Schotz, Botanist/Community Ecologist	Alabama Natural Heritage Program 1090 South Donahue Drive Auburn University, AL 36849 Phone: (334)-844-5019 Email: ars0002@auburn.edu
Dan Spaulding, Curator	Anniston Museum of Natural History 800 Museum Drive Anniston, AL 36206 Email: d.spaulding@annistonmusem.org
John Nelson, Chief Curator	University of South Carolina A.C. Moore Herbarium 715 Sumter Street, Coker Life Sciences Building, rm 208 Columbia, SC 29208 Email: plantman@herbarium.org
Deborah White, Botanist	Kentucky State Nature Preserves Commission 801 Schenkel Lane, Frankfort, KY 40601 Phone: (502)-573-2886 Email: deborah.white@ky.gov
Roger McCoy, Botanist	Natural Heritage Inventory Coordinator TN Division of Natural Areas 401 Church St. Floor 7 Nashville, Tennessee 37243-0447 phone: 615-532-0437 Email: roger.mccoy@state.tn.us
Johnny Townsend, Botanist	Virginia Natural Heritage Program 217 Governor Street, Third Floor Richmond, VA 23219 Email: John.townsend@dcr.virginia.gov Phone: (804) 225-4855

SOP #3, Table 2. Federal and State entomologists/taxonomists available to assist in pest identification.

Name	Contact Information
Forrest Oliveria, USDA Plant Pathologist, Pineville, LA Field Office	Initial USDA Forest Service Contact, serving Alabama and Mississippi 2500 Shreveport Highway Pineville, LA 71360 Phone: (318) 473-7294 Email: foliveria@fs.fed.us
Bill Carothers, USDA Field Office Representative, Asheville, NC	Initial USDA Forest Service Contact, serving Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia 200 W.T. Weaver Blvd. Asheville, NC 28804 Phone: (828) 257-4321 Email: wcarothers@fs.fed.us
Dennis Barclift, Plant Pest Administrator	Alabama Department of Agriculture & Industries Division of Plant Industry 1445 Federal Drive Montgomery, AL 36107 Phone: (334) 240-7225 Email: dennis.barclift@agi.alabama.gov
Mike Evans, State Plant Regulatory Official	Georgia Department of Agriculture Plant Protection Section 1190 Experiment Street 180 E Green Street Redding Building, Room 213 Griffin, GA 30223 Phone: (770) 228-7215 Email: Mike.Evans@agr.georgia.gov
John Obrycki, Professor and Chair	University of Kentucky, Department of Entomology Lexington, KY 40546 Phone: (859) 257-7450 Email: john.obrycki@uky.edu
Phillip Wilson, Plant Pest Administrator	North Carolina Department of Agriculture & Consumer Services, Plant Protection Section 1060 Mail Service Center Raleigh, NC 27699-1060 Phone: (919) 707-3753 Email: Phillip.Wilson@ncagr.gov
Christel Harden, State Plant Regulatory Official	Clemson University, Department of Plant Industry 511 Westinghouse Road Pendleton, SC 29670 Phone: (864) 646-2135 Email: charden@clemson.edu

SOP #3, Table 2 (Continued). Federal and State contacts available to assist in pest identification.

Name	Contact Information
Gray Haun, State Plant Regulatory Official	Tennessee Department of Agriculture, Division of Regulatory Services Ellington Agricultural Center 440 Hogan Road Nashville, TN 37220 Phone: (615) 837-5103 Email: walker.haun@state.tn.us
Larry Nichols, Office of Plant Industry Services	Virginia Department of Agriculture and Consumer Services 102 Governor Street, Room LL55 Richmond, VA 23219 Phone: (804) 786-3515 Email: Larry.Nichols@vdacs.virginia.gov

EARLY DETECTION PEST SPECIES REPORTING FORM DIRECTIONS 1) Fill out this form. 2) Flag location 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). If possible, include a common item (e.g. coin) for scale. 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 Kurt Helf at the CUPN office: PO Box 8 Mammoth Cave, KY 42259 Phone: 270-758-2163 Fax: 270-758-2609 Kurt_Helf@nps.gov GENERAL INFORMATION Name(s): _____ Email: _____ Phone: _____ Date: _____ SPECIES INFORMATION Park: _____ State & County: _____ Species name: _____ GPS Coordinates (UTMs or DD's--circle): Y (Northing): _____ X (Easting): _____ UTM Zone: 16 or 17 (circle) Datum: _____ Error (meters): _____ How were the coordinates obtained (e.g. phone, GPS unit etc.)? _____ Over	EARLY DETECTION PEST SPECIES REPORTING FORM SPECIES INFORMATION (cont.) Location Description (be as specific as possible): _____ Habitat (eg. forest edge, mixed forest, open field): _____ Host Species Involved: _____ DBH (if tree species): _____ Host Species Stem Count: _____ Type of Evidence Present (circle): 1. Crown dieback 2. Foliar injury (chlorosis, necrosis, other discoloration) 3. Sawdust 4. Exit holes 5. Other _____ Specimen Collected (circle one)? Yes No Photograph Taken (circle one)? Yes No Certainty of Identity (circle one): Extremely confident Moderately confident Not very confident Other Comments (eg. site accessibility): _____
--	---

SOP #3, 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 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). If possible, include a common item (e.g. dollar bill) for scale.
- 4) ASAP, send card and/or information on card and photos to designated park contact (see Species List pages) and Teresa Leibfreid at the CUPN office:

PO Box 8
Mammoth Cave, KY 42259
Phone: 270-758-2135
Fax: 270-758-2609
Teresa_Leibfreid@nps.gov

GENERAL INFORMATION

Name(s): _____

Email: _____

Phone: _____

Date: _____

SPECIES INFORMATION

Park: _____

State & County: _____

Species name: _____

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

Y (Northing): _____

X (Easting): _____

UTM Zone: 16 or 17 (circle)

Datum: _____

Error (meters): _____

How were the coordinates obtained (e.g. phone, GPS unit etc.)? _____

Over

EARLY DETECTION PLANT SPECIES REPORTING FORM

SPECIES INFORMATION (cont.)

Location Description (be as specific as possible):

Infested Area (choose one):

_____ Sq. ft. _____ Sq. m. _____ Acres _____ Hectares

Gross Area (choose one):

_____ Sq. ft. _____ Sq. m. _____ Acres _____ Hectares

Habitat (eg. forest edge, mixed forest, open field)

Canopy Closure (check one):

___ Trace (<1%) ___ Low (1-5%) ___ Moderate (5.1 - 25%) ___ High (25.1 - 100%)

Abundance/Density:

___ Single ___ Scattered ___ Scattered dense patches
___ Dense monoculture ___ Linearly scattered

Stem Count : _____

Plant Description (check all that apply):

___ In Flower ___ In Fruit ___ Seedlings/Rosettes ___ Seeds
___ Dormant/Dead ___ Bolting ___ Unknown

Certainty of Identity (circle one):

Extremely confident
Moderately confident
Not very confident

Other Comments (eg. site accessibility):

SOP #3, Figure 2. Early Detection of Invasive Species Surveillance Monitoring and Rapid Response plant species reporting form.

Standard Operating Procedure (SOP) #4: Rapid Response Procedures

CUPN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #4 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:

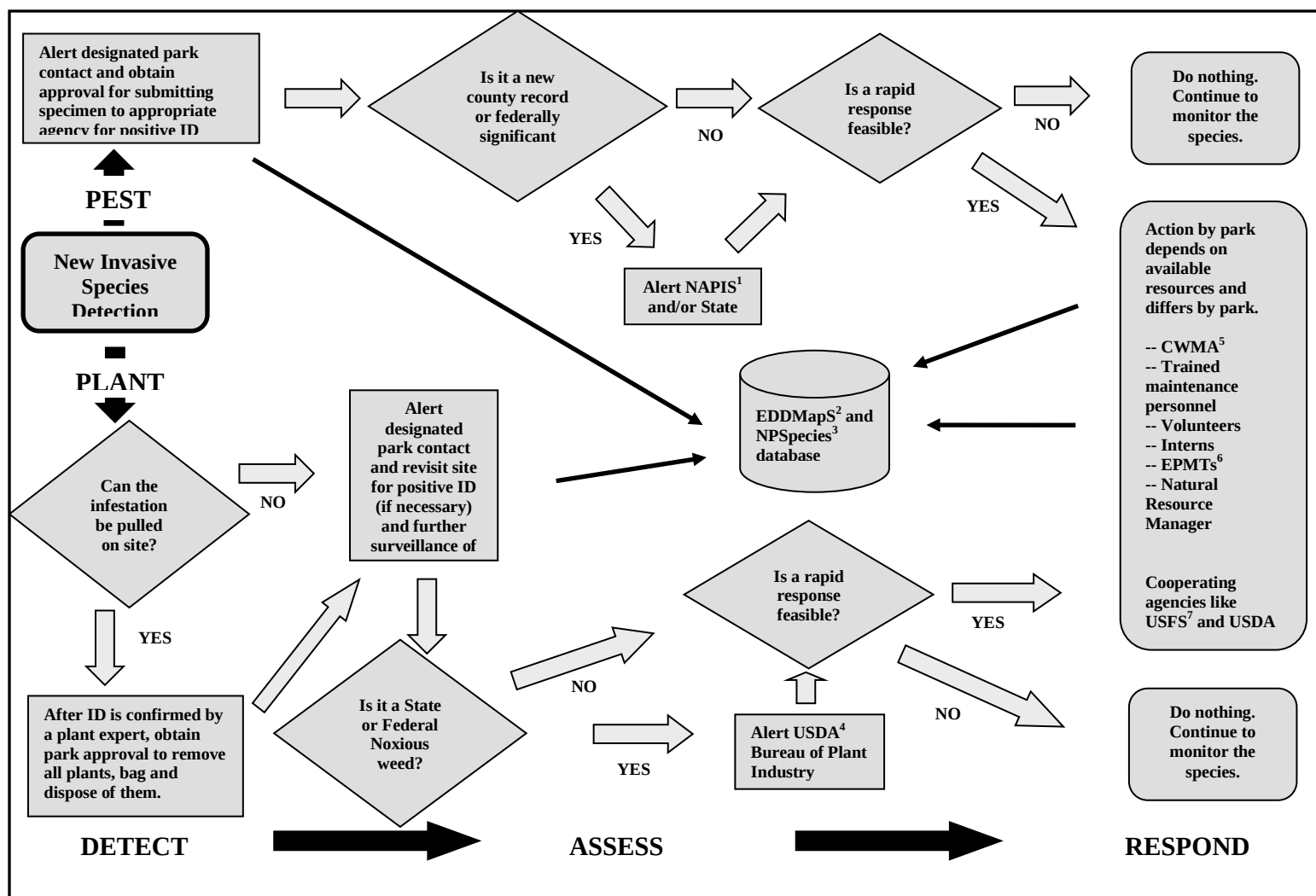
- Has the species been positively identified? If not, the site must be re-visited. Photographs or specimens must be examined by an expert.
- Is it a new county record and is it considered a significant threat? A pest species such as *Agrilus planipennis* (emerald ash borer) would be a good candidate for this category.
- 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.
- If the observer is confident in his/her identification, is highly skilled in plant/pest identification, and has Park approval, can the population be eradicated on-site (in the case of 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 (with Park's approval).
- If a rapid response is required, whom 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 (Appendix B, Table 1). It is the DPC's responsibility to alert other park staff, and coordinate with the Network (if needed) to contact the appropriate agencies. If it is an invasive plant, the Southeast Exotic Plant Management Team should also be notified.

Figure 1 depicts the Invasive Species Early Detection and Rapid Response system for the Cumberland Piedmont Network (CUPN).

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 lack funding and resources to perform invasive species rapid response on their own, cooperation with EPMTs and outside agencies will likely be necessary. In addition, in some cases, "no response" may be the appropriate action. Eradication or control of certain infestations may not be feasible due to location, 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 CUPN and enable them to respond more quickly to new invasive species occurrences. For example, Mammoth Cave National Park (MACA) uses volunteers to assist with invasive plant removal and have been actively involved in controlling new populations of garlic mustard within

the park (Brice Leech, pers. comm., April 1, 2012). Carl Sandburg Home National Historic Site (CARL) is fortunate to have a tractor operator and a small boom sprayer to respond to pasture invasions (Irene Van Hoff, pers. comm., September 6, 2012) and Cumberland Gap National Historical Park (CUGA) would potentially utilize the Resource Management Specialist, a Biological Science Technician, and interns (when available) to rapidly respond to new species detections (Jenny Beeler, pers. comm., September 12, 2012).



SOP #4, Figure 1. Invasive Species Early Detection and Rapid Response system for the Cumberland Piedmont Network (CUPN).

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

Standard Operating Procedure (SOP) #5: Data Management and Reporting

CUPN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #5 Data Management and Reporting

Introduction

This SOP describes tasks to be performed for data management and reporting. The ISED coordinators will be responsible for completion of all data management and reporting activities. There are four main data management/reporting components to manage in ISED monitoring:

1. **Data origination:** There are several potential sources of data (including CUPN field crews, park staff/volunteers, and Exotic Plant Management Team) that will involve different formats (emails, phone calls, field forms). Data from all sources/formats will be transcribed to the ISED field forms and entered into the NPSpecies database (SOP #5 - Figures 1). Hardcopy field forms will be scanned after QA/QC is completed and stored on the CUPN server.
2. **Data distribution:** Species data will be available to parks and others through the online site for Integrated Resource Management Applications (<https://irma.nps.gov>). Invasive plant data will also be entered/distributed to EDDMapS according to procedures defined by that program (<http://www.eddmaps.org/>). Pest data will also be provided to the appropriate state and federal contacts and incorporated into EDDMapS (if/when system expands to include all state pests in addition to invasive plants).
3. **Voucher and Archival Data:** Specimens, photographic vouchers, and archival material will be entered into the Interior Collection Management System (ICMS), according to procedures established in the NPS museum handbook. This task will be performed by the curatorial specialist for CUPN, who will work with each park to update their collections/ICMS records.
4. **Reporting:** Summary reports will be produced in the format of one-two page Resource Briefs (SOP #5 - Figures 2-4). The content will vary depending on highlighted species/parks for the year.

Observation Profile	
Contact Data Steward Edit Profile	
Profile Definition	
▲ Unique Observation Identifiers	
Code: 14038720 Unit: Cumberland Gap National Historical Park (CUGA) Scientific Name: Polygonum cuspidatum Lifecycle: Active ⓘ Sensitivity: Non-Sensitive	
Event Information Location Information Record Information	
Documented Scientific Name: No Data	
▼ Observer	
▲ Date/Time of Observation	
Date Observed: 08/20/2013 End Date: No Data Time Observed: No Data	
▲ Habitat	
General Habitat: Upland Specific Habitat: Broadleaf Forest Habitat Comments: Near perennial creek bed flowing into Yellow Creek	
▲ Physical Description	
Count: No Data Age: No Data Sex: No Data Observation Method: Visual with Naked Eye Observation Method A small population was observed during forest monitoring fieldwork for the Cumberland Piedmont Network	

SOP #5 Figure 1. Screenshot of NPSpecies Observation record.

Invasive Species Early Detection PROGRAM BRIEF

National Park Service - Southeast Region
U.S. Department of the Interior

Cumberland Piedmont Network
Inventory & Monitoring Program



Abraham Lincoln NHS - Carl Sandburg Home NHS - Chickamauga & Chattanooga NMP
- Cowpens NB - Cumberland Gap NHP - Fort Donelson NB - Guilford Courthouse NMP
- Kings Mountain NMP - Little River Canyon NPRES - Mammoth Cave NP - Ninety Six
NHS - Russell Cave NM - Shiloh NMP - Stones River NB

IMPORTANCE

An "invasive species" is an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. The known ecological impacts of invasive species include



Emerald ash borer (*Agrilus plannipennis*)

loss of threatened and endangered species, altered structure and composition of terrestrial and aquatic communities, and reduction in overall species diversity. Early detection followed by rapid management response can 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. Only when invasions are caught early will the chance of eradication remain high.

"Damages associated with alien invasive species effects and their control amount to approximately \$120 billion per year."

— Pimental et al., 2005

WHAT WE ARE DOING

In May 2012, the Cumberland Piedmont Network (CUPN) vegetation monitoring crews began searching for priority invasive plants and pests during routine monitoring activities at CUPN parks. Knowledgeable monitoring crew members provide additional "eyes and ears" to detect incipient species occurrences while in the parks. Park natural resource managers, Exotic Plant Management Teams, and other National Park Service scientists also participate. If you work in the parks and would like to get involved, please contact one of the Invasive Species Early Detection (ISED) Coordinators.

"Every person working or recreating in a national park has the potential to serve as an early detector."

— Williams et al. 2007

WHAT WE ARE FINDING

As of December 2012, one new invasive plant occurrence was documented at one CUPN park. Although not on an early detection list, Oriental false hawksbeard (*Youngia japonica*), was seen in several roadside locations at Chickamauga and Chattanooga National Military Park (CHCH). In addition, there was one false alarm that tested the rapid response portion of the protocol. Japanese dodder (*Cuscuta japonica*), a Federal noxious weed, was reported in September 2012 at Kings Mountain National Military Park (KIMO). The detection was immediately referred to local botanists and then to Clemson University department of Plant Industry. A subsequent site visit by a Clemson University scientist, followed by laboratory specimen identification, confirmed the species as compact dodder (*C. compacta*), a native parasitic vine. Although this detection was a false alarm, it was a great example of how the rapid response portion of the protocol is working.

Pimental, 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.

Williams, A. E., S. O'Neill, F. 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/SPAN/NRR-2007/00N, National Park Service Pacific West Regional Office, Oakland, California.

CONTACT INFORMATION

Teresa Leibfreid (plants) and Kurt Helf (pests), ISED Coordinators

Teresa_Leibfreid@nps.gov, Kurt_Helf@nps.gov

<http://science.nature.nps.gov/im/units/cupn/>

Invasive Species Early Detection 2012 RESOURCE BRIEF

National Park Service - Southeast Region
U.S. Department of the Interior

Cumberland Piedmont Network
Inventory & Monitoring Program



Kings Mountain National Military Park

SPECIES SPOTLIGHT: JAPANESE DODDER

Native to Asia, Japanese dodder (*Cuscuta japonica*), is an invasive, annual, parasitic vine that kills host seedlings and makes host species more susceptible to disease. (Figure 1)



Figure 1 Photo by: Barry Rice

It penetrates the vascular tissue of its host for water and nutrients and reattaches to the host plant as it grows. It looks like a tangled, yellow-to-orange mass of spaghetti. The branched stems are fleshy, circular, pale yellow with red spots and striations. Leaves are minute and scale-like. Flowers are abundant and pale yellow. This species is extremely difficult to distinguish from native dodders. Japanese dodder was first discovered in residential areas of Houston near Hobby Airport in 2001 after being introduced to and eradicated from several southern states in the 1970s. It is now present in Florida, South Carolina, Texas and California.

"Traditional Asian medicines use Japanese dodder seeds for a range of diseases, including high blood pressure, infertility and urinary problems."

—Contorsi 2011

WHAT WE ARE DOING

In May 2012, the Cumberland Piedmont Network (CUPN) vegetation monitoring crew began searching for priority invasive plants and pests during routine monitoring activities at CUPN parks. Knowledgeable monitoring crew members provide additional "eyes and ears" to detect incipient species occurrences while in the parks. Park natural resource managers, Exotic Plant Management Teams, and other National Park Service scientists also participate.

A host is "any organism in which another spends part or all of its life, and from which it derives nourishment or gets protection..."

— Eleanor Lawrence

WHAT WE ARE FINDING

Although no new invasive early detection species were detected during surveillance monitoring at Kings Mountain National Military Park (KIMO) in 2012, there was one false alarm that tested the rapid response portion of the protocol. Japanese dodder, a Federal noxious weed, was reported to one of the CUPN Invasive Species Early Detection Coordinators (SEDC) by a National Park Service employee in September 2012. The detection was immediately referred to local botanists and then to Clemson University department of Plant Industry. A subsequent site visit by Clemson University scientist, Sherry Aultmann, followed by laboratory specimen identification, confirmed the species as compact dodder, a native parasitic vine. Although this detection was a false alarm, it was a great example of how the rapid response portion of the Early Detection of Invasive Species: Surveillance, Monitoring, and Rapid Response protocol is working.

Contorsi, J. Sept. 29, 2011. Partial use of Japanese dodder seeds. Retrieved December 10, 2012 from <http://www.thefarmers.org/articles/545125-partial-use-of-japanese-dodder-seeds>.
Lawrence, C. 1982. *Handbook of Biological Terrestrial Invertebrates*. Longman Singapore Publishers (Print).
Texas Invasives.org. Invasive database: *Cuscuta japonica*. Retrieved December 7, 2012 from http://www.invasives.org/invasives/invasive_databases.php?invdb=CJA.
Barry Rice, barr@nps.gov, Bug-nodding
Barry Moore, barry.moore@nps.gov, Urban Forestry Division, Bug-nodding

CONTACT INFORMATION

Theresa Leibert (plants) and Kurt Heit (pests), SED Coordinators
Theresa_Leibert@nps.gov, Kurt_Heit@nps.gov
<http://nature.nps.gov/inv/units/cupn/>



Monitoring of Native and Exotic Invasive Forest Pests and Pathogens

Importance

Monitoring native and exotic invasive insect forest pests and pathogens (IFP) is an important addition to the Cumberland Piedmont Network's (CUPN) suite of monitoring protocols. IFPs pose a serious, and likely permanent, threat to CUPN's 14 mostly forested park units. In the short-term, i.e., years, IFPs can alter forest light regimes, microclimate, and nutrient cycling. In the long-term, i.e., decades, they can alter tree species composition and so their effects may ramify through the entire forest ecosystem and beyond.

The environmental and economic damage caused by IFPs are a cause of deep concern among many public and private institutions. Indeed, new and established IFPs are monitored by numerous federal and state agencies, universities, and non-governmental organizations. These entities gather extensive data on IFPs' current range, model future outbreaks, and monitor the major pathways through which they enter and move about within the United States. Thus, CUPN will use these existing data as a cost-effective way to monitor IFPs among its 14 park units.

CUPN's IFP monitoring efforts will combine data mining with collection of field data from its 14 park units. Data mining efforts will utilize web-based tools to efficiently monitor/gather existing data administered by external sources. Gaps in existing data, such as park-specific sources of IFP transport (e.g., roadways), will be filled by limited collection of field data during vegetation monitoring events at each CUPN park unit. In addition, as a further cost-saving measure future collection of additional field data may also utilize trained volunteers. These disparate data will then be synthesized and results delivered as annual reports to resource management officials at all 14 CUPN parks.

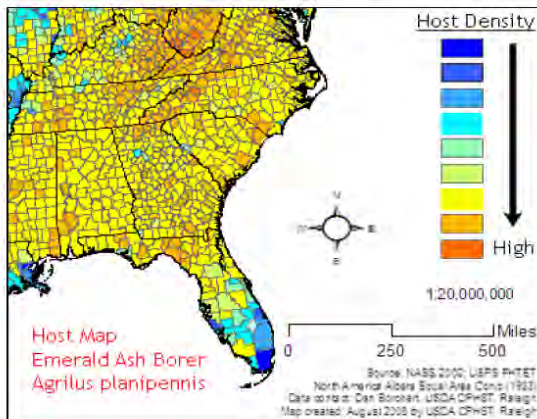


Figure 1. Relative risk by density to host trees in CUPN states from Emerald Ash Borer infestation (Total Acreage Per County)



Figure 2. Presence/absence of Hemlock Woolly Adelgid infestations outside and inside Cumberland Gap National Historic Park. Map provided by Songlin Fei, University of Kentucky Department of Forestry

In addition to annual reports, frequent updates will be posted on the CUPN Forest Pest website as they are received. Urgent updates, such as detection of rapidly spreading new forest pests or virulent pathogens, will be emailed to respective park officials.

Monitoring Objectives

- Web-based mining of state and county level data on presence/absence of new and established IFPs.
- Estimate current infestation levels (e.g., number and percent of infested trees) and distribution of IFPs in conjunction with vegetation monitoring protocol at CUPN park units.

Potential Measures

- Relative risk to host trees at state and county level (Figure 1).
- Presence/absence of new and established IFPs at CUPN park units.
- Stand density of tree species infested by IFPs at CUPN park units.
- Infestation level and distribution trends of selected IFPs at CUPN park units.
- Number/percent of trees infested by IFPs at CUPN park units.

Management Applications

- Access up to date information on new and established IFPs for better informed management decisions.
- Access up to date information on new and established IFPs for public education efforts.
- Access up to date treatment options, regulations, and cooperating officials.
- Plan targeted treatment using data on IFP distribution inside and outside CUPN park units (Figure 2).
- Guidance on prioritizing mitigation efforts among potentially numerous IFP infestations.

Contact

Dr. Kurt Lewis Helf at Kurt_Helf@nps.gov

Network website: <http://science.nature.nps.gov/im/units/cupn/index.cfm>

Resource website: http://science.nature.nps.gov/im/units/cupn/monitor/forestpest/forest_pests.cfm

April 2009

Cumberland Piedmont Network

Forest Pest Information Request

Chickamauga/Chattanooga National Military Park

Inventory & Monitoring
National Park Service
U.S. Department of the Interior



European Gypsy Moth (*Lymantria dispar*)

Distribution and host species

The European Gypsy Moth has been an important pest of hardwoods since its introduction in 1869. Established populations exist from Maine to Wisconsin and generally in a southeasterly line from Illinois to northeastern North Carolina. Many CUPN park units are vulnerable to gypsy moth outbreaks because oak, their preferred host, typically the most abundant tree genera in southeastern forest canopies (Figure 1). Oaks are the preferred host species for feeding caterpillars, but they also eat apple, sweetgum, basswood, gray and white birch, poplar, willow and hundreds of other trees and shrubs. Older larvae will also feed on a number of conifers such as hemlock, pines, spruces and southern white cedar.

Biology, potential effects of infestation, and dispersal

Adults emerge in July and August and do not feed. Females deposit egg masses (100 to 800 eggs), covered with irritating buff-colored hairs, under rocks and on tree trunks, limbs, houses, outdoor furniture, vehicles, and other sheltered places. Larvae emerge in late April or early May from overwintering eggs and feed through June and into early July.

When gypsy moth larvae densities reach high levels, partial or complete defoliation of the forest canopy can occur. The effects of defoliation depend primarily on the amount of foliage removed, the condition of the tree at the time it is defoliated, the number of consecutive defoliations, available soil moisture, and host species. If less than half of their crown is defoliated, most hardwoods will experience only a slight loss in radial growth. Healthy trees can usually withstand one or two consecutive defoliations of more than half and re-foliate by midsummer. Trees weakened by other stressors (e.g., drought) are frequently killed after a single significant defoliation. Weakened trees are also vulnerable to disease organisms, e.g. *Armillaria* fungus can attack their roots, or other insects, e.g., the two-lined chestnut borer can attack their trunk and branches.

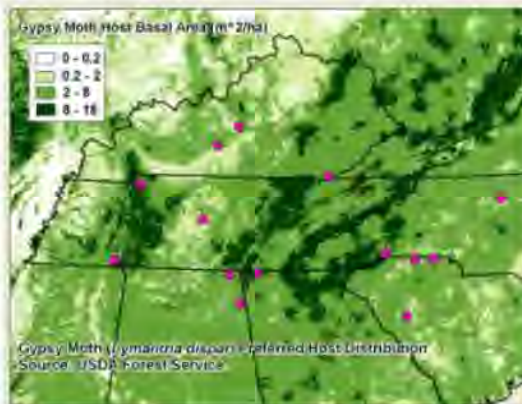


Figure 1. Distribution of oak (*Quercus* spp.), the gypsy moth's preferred host species, by basal area (in 2ha) which is closely correlated with foliage cover. Dots indicate CUPN park locations



Figure 2. Female European Gypsy Moths over egg mass. Because females are flightless, passive dispersion of egg masses on items that are moved long distances, e.g., mobile homes, significantly increases their ability to spread. Hannes Lattre, Bugwood.org

On their own, gypsy moths spread about 13 miles per year. Artificial dispersion significantly increases the spread by the insect hitchhiking on transported items such as nursery stock, vehicles, forest products, and outdoor household articles (Figure 2). Federal and state regulations require that items moving from infested to uninfested areas must be carefully inspected and certified to be free of gypsy moth life stages; it is the only forest pest under Federal Domestic Quarantine (7 CFR 301.45).

Management Approaches

Prevention/Early Detection:

- Monitor CUPN forest pest website for information on local/regional forest pest detections and outbreaks (see links below).
- Establish and maintain communication with appropriate USFS personnel before detection.
- Educate public using multiple media, e.g., leaflet at: <http://www.na.fs.fed.us/SPFO/pubs/fidls/gypsymoth/gypsy.htm>
- Consider silvicultural practices before and after outbreak.
- Inspections and embargoes of items that act as dispersal agents.

Rapid Response:

- Conduct park-based planning and prepare advance proposal package, including biological evaluation, FS 3400-2 form, and NEPA and NHPA Clearance, to apply for Forest Health Protection Project funding (if necessary).
- For low density outbreaks use mass trapping and mating disruption. High density outbreaks likely require use of biological and/or chemical pesticides Gypchek, Thuricide, Confirm, Mimic, and Dimilin. Such applications may require aircraft.
- Comprehensive USDA gypsy moth IPM manual at: www.aphis.usda.gov/import_export/plants/manual/domestic/downloadads/gypsy_moth.pdf

For further information visit resource website (see links below) or contact: Dr. Kurt Lewis Helf at Kurt_Helf@nps.gov

Network website: <http://science.nature.nps.gov/im/units/cupn/index.cfm>

Resource website: http://science.nature.nps.gov/im/units/cupn/monitor/forestpest/forest_pests.cfm

February 2010

SOP #5 Figure 4. Example of a Cumberland Piedmont Network (CUPN) resource brief: Chickamauga and Chattanooga National Military Park (CHCH).

Data Entry, Verification, Validation

Opportunistic monitoring by CUPN will occur year round, on a variable schedule, depending on other vital signs monitoring schedules. Immediately upon returning from the field, ISED forms will be checked for completeness and accuracy by the appropriate Invasive Species Coordinator. Following completion of the review and confirmation of species identity, data will be entered into the NPS species database (NPSpecies) located on the website for Integrated Resource Management Applications (IRMA). Data verification and validation will occur after data entry, to ensure that values from hardcopy were correctly entered and are valid. A validity check will ensure that species information is accurate and locational coordinates occur within the park area. After verification and validation, the data forms will be scanned and copied to the project's Validated Data folder. The CUPN curatorial specialist will handle any voucher specimens and data entry into Interior Collection Management System (ICMS), and the CUPN GIS specialist will process any needed GIS layers with metadata.

Database Administration

Data Maintenance

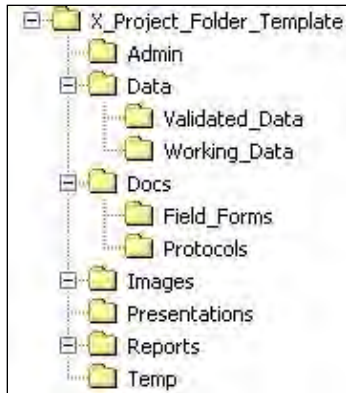
Datasets are rarely static. They often change through additions, corrections, and improvements made following the archiving of a dataset. There are three main caveats to this process:

1. Only make changes that improve or update the data while maintaining data integrity.
2. Once archived, document any changes made to the dataset.
3. Be prepared to recover from mistakes made during editing.

Any editing of archived data is accomplished jointly by the project leader and a data manager. Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions.

Data Organization

CUPN established a template directory structure in their Data Management Plan (Moore 2005). In SOP 5. Data Management and Reporting of this plan, each monitoring project is composed of seven folders and four subfolders (Figure 5). Project files which are being modified, considered draft, and/or certain files currently in use (e.g., a copy of the field data form) should reside within this directory. A similar directory structure will contain archived files (\CUPN_Archive\). Both the working and archive directories will be accessible via the MACA Local Area Network, with access permissions maintained by the data manager(s) and/or MACA Information Technology Staff.



SOP #5, Figure 5. Cumberland Piedmont Network (CUPN) project directory structure.

Data Security and Integrity

As many different users may be accessing the data, it is imperative that the data remain secure. To address this need, data managers have created user groups within the local area network operating system that will have different security levels. Generally, three levels of users will be given different sets of permissions. CUPN data managers will have all permissions, including insert, delete, and modify for all folders in the folder structure. Project leaders/program coordinators, will have the same permissions as program data managers except for read-only permission to the shared data tables and archived data. Those entering the data will have insert and modify permission to the observation data and read-only permission to the lookup and shared data tables.

Version Control

Prior to any major changes of a dataset, a copy is stored with the appropriate version number. This allows for the tracking of changes over time. With proper controls and communication, versioning ensures that only the most current version is used in any analysis. Frequent users of the data are notified of the updates, and provided with a copy of the most recent archived version.

Data Logs and Backups

Once the data are archived, any changes made to the data must be documented in an edit log. From this point forward, original field data forms should not be altered. Field forms can be reconciled to the database through the use of the edit log. Secure data archiving is essential for protecting data files from corruption. Once a dataset has passed the specified QA/QC procedures, an electronic version of the dataset will be maintained in a read-only format on the program server. Incremental or differential tape backups of all project databases are regularly conducted. Backup copies of the data are maintained in a secure alternate location.

Data Availability

In addition to the “standardized” data dissemination strategies noted in Chapter IX of the CUPN Data Management Plan (DMP)(Moore et al. 2005), data will be made available for research and management applications on request (per the framework established in the DMP). Data requests should be directed to the CUPN Program Manager.

Literature Cited

- Moore, W. J., R. Byrd, and T. Leibfreid. 2005. Data management plan for the Cumberland Piedmont Network and Mammoth Cave National Park Prototype monitoring program. USDI National Park Service. Mammoth Cave, KY. 81pp.
- NPS, Washington Support Office, Inventory and Monitoring Program. 2010. Natural Resource Database Template Revised Documentation. National Park Service. Fort Collins, CO.

Standard Operating Procedure (SOP) #6: Training and Safety

CUPN Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Standard Operating Procedure (SOP) #6 Training and Safety

Training is essential for the proper identification of invasive pests and plants. Invasive Species Early Detection Coordinators must ensure that monitoring crew members and other observers have a clear understanding of the major identifying characteristics of early detection species, as well as characteristics of common look-alike species.

Monitoring Crews and Park Personnel that have Knowledge of Basic Plant Identification Skills

Each Cumberland Piedmont Network (CUPN) monitoring crew will utilize their designated monitoring procedures for training specifics and safety. Because the majority of effort will be performed by vegetation monitoring crews with plant identification skills, additional training will be minimal. For example, for field season preparation the CUPN vegetation monitoring crew will utilize the “Field Season Preparation SOP” (White et al. 2011). For safety, that field crew will follow the JHA for vegetation monitoring, which is also included in this document for use by ISED efforts (SOP 6, Table 1).

Training materials for monitoring field crews and individuals with knowledge of basic plant identification include:

- National Park Service (NPS) Early Detection Field Guide
 - ✓ Park early detection species cards
 - ✓ Plant and pest reporting forms
- United States Forest Service (USFS) field guides
- Other early detection species photographs and supplemental texts or presentations

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 Invasive Species Coordinators. For example, the vegetation monitoring crew will receive ISED training during their annual refresher training in April/May. Crews deficient in plant and pest identification skills will receive additional training on a case-by-case basis.

Each crew should receive a basic overview of:

1. The plan and why it was developed
2. The park species list cards
3. The NPS and USFS field guides and how they are used together. This should include explanation of how to “build” a specific park field guide by viewing a park species list card and pulling specific species from each field guide.

4. Each species in the field guide. This should include unique identifying characteristics and look-alike species.
5. Reporting forms and specimen collection procedures
6. Reporting procedures
7. Job Safety Analysis (SOP 6, Table 1).

Volunteers and Park Personnel that Lack Plant/Pest Identification Skills

In the future, as additional non-natural resource park personnel (i.e. interpretation and/or maintenance staff), and possibly volunteers, become involved, it will be necessary to provide more in-depth training geared towards these focus groups. A training model will be developed based on other successful early detection of invasive species volunteer programs. The Invasive Plant Atlas of New England (IPANE) has been successfully training volunteers since its establishment in 2001 (Mehrhoff et al. 2005) and training documents are available on-line for reference (www.eddmaps.org/ipane/volunteers/volunteers.htm). The following general training materials are recommended for future volunteer trainings:

1. Training manual
 - a. What is an invasive species?
 - b. Why are we interested in detecting them?
 - c. General plan overview and why it was developed.
 - d. Who to report to?
 - e. How to report?
 - f. What is needed in the field?
2. Waiver of liability
3. Job Safety Analysis (SOP 6, Table 1).
4. Short-list of early detection species (10 to 15 max.) for each park or designated volunteer search area.
5. Reporting forms or iPhone application reporting instructions.
6. PowerPoint presentation providing multiple slides/photographs of each species. This should include the basics of leaf and stem morphology and general plant identification. For example:
 - a. compound vs. simple
 - b. palmately lobed vs. pinnately lobed
 - c. alternate vs. opposite
7. The NPS and USFS field guides and how they are used together. This should include explanation of how to “build” a specific park field guide by viewing a park species list card and pulling specific species from each field guide.

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
Emergency Preparedness	Not knowing emergency procedures. Not having emergency supplies.	• Know who to contact and how to reach them in the event of a life-threatening or non-life-threatening emergency. • Have current CPR and first aid certification, and know the certification status of co-workers. • Keep a well-maintained first aid kit in each vehicle and with each field team.	
Hiking to/from site	Falling or tripping due to stream crossings, wading, wet areas, poor footing, uneven terrain, loose/rolling rocks and heavy pack.	• Use caution at all times. Walk carefully, watching footing. • Wear appropriate boots for conditions, especially stream wading. Stay aware of your feet. Address blisters and hot spots promptly. • Avoid carrying excessive weight or unbalanced loads. • When walking on a steep slope, lean upslope. Ensure that stems and vines are alive and can support your weight before relying on them. • Use extreme caution traversing wet rocks, streams, steep slopes or blowdown areas. • Proceed cautiously, test footing carefully, and use a sturdy pole or walking stick for balance.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
	Cut, scratched, or bruised by thick vegetation; Eye or ear injuries	• Shield your eyes and face with your hands, glasses, or hat when moving through tall thick brush. • Keep your head and eyes pointed somewhat downward so your head hits obstacles before your eyes. • Wear pants and long-sleeved shirts to protect bare skin. • Look before you grab vegetation to avoid grasping thorny stems. • Do not follow closely behind other people to avoid having branches snap back at you.	
	Cuts from broken glass	• Broken glass is often found on the river bed and adjacent to streams. • Wear sturdy shoes at all times and look out for broken glass and other sharp debris. • Use a walking stick to feel your way through dense vegetation.	
	High stream velocity	• Know safe wading limits. • Wear emergency personal flotation device when applicable.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		• Check weather forecast before the work day begins to anticipate rising water levels.	
	Slippery riverbed	• Wear wading boots. • Check surfaces before weighting each foot. • Use walking stick/wading rod to stabilize.	
	Encounters with strangers	• Report uncomfortable encounters with strangers to a supervisor/park ranger as soon as possible. • Report apparent illegal activities to a park ranger. • Avoid confrontation with other people in the park. • Do not cross into private property without first obtaining permission from the landowner.	
Boating to/from site	Entrapment; overturning; falling overboard	• Check river gauges and weather forecasts to ensure that flow levels are low enough for safe crossing. • Have personal flotation devices, a throw rope and helmets. • Avoid submerged trees, undercut rocks and large boulders to prevent entrapment, overturning.	
Working outdoors	Being struck by falling	• Listen to the weather forecast each morning (park radio	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
during storms	trees or branches Being struck by lightning	and/or internet). • Plan or adjust field work to avoid being out in thunderstorms. • Postpone work if safety will be compromised by storm conditions. If you see or hear a thunderstorm coming, retreat from high ground and exposed areas. Go inside a sturdy building or vehicle, if possible. • If you can't get inside and if you feel your hair stand on end, lightning is about to strike. • Make yourself the smallest target possible and minimize contact with the ground. • Crouch down on your pack on the balls of your feet and keep your feet close together. Place your hands on your knees and lower your head. • During a thunderstorm members of the crew should stay separated by at least ten feet.	
Poisonous plants, especially poison ivy	Contamination/toxicity from contact with poisonous plants	• Learn to identify poison ivy in its many growth forms. • Wear long sleeves and pants.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		• Be aware of poison ivy and avoid coming in direct contact with it. • Thoroughly wash hands, equipment, and clothes with Tecnu or similar specialized soap after working in areas with poison ivy.	
Working in bear territory	Black bear encounter	• Avoid working solo, if possible. • Be especially alert near dawn or dusk. • Be especially aware of mother bears with cubs. Never approach cubs or come between a mother bear and cubs. • Face the animal but do not make eye contact, continually make noise -- do not freeze or remain silent. • Appear larger by standing tall, waving arms or jacket over your head. • Slowly back away – don't approach a bear. • Never run from a bear. • If bear charges, throw things and shout loudly. • If bear attacks, fight back aggressively.	
Bee, wasp, or yellow-	Multiple stings from	• Be alert to hives in brush, ground holes, or hollow logs.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
jacket stings	disturbing or stepping into nest areas	Watch for insects traveling in and out of one location. • If you or anyone you are working with is known to have allergic reactions to be stings, tell the rest of the crew and your supervisor. Make sure you carry emergency medication with you at all times, and that your co-workers know where you keep it. • Wear long sleeve shirts and pants, tuck in shirt. Bright colors and metal objects may attract bees or wasps. • If you are stung, a cold compress may bring relief. • If stinger is left behind, scrape it off of skin. • Do not use tweezers as this squeezes the venom sack, worsening the injury. • If the victim develops hives, asthmatic breathing, tissue swelling or a drop in blood pressure, seek medical help immediately.	
Bites from mosquitoes, no- see-ums, and chiggers	Itchy reactions to multiple bites	• Wear long sleeves and pants. • Avoid sitting on the ground or on logs, especially in dry sunny grassy areas. • Use insect repellants. Do not apply Permethrin, Permanone,	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		or greater than 30% DEET directly to skin, only to clothing. • Carry after-bite medication to reduce skin irritation.	
Poisonous snakes	Being bitten by a poisonous snake	• Wear snake gaiters when in known snake habitat. • Be alert for snakes in thick vegetation and rocky habitats. • Look before putting hands or feet in places out of immediate view. • Treat all bites as if envenomation has occurred. • Seek medical attention immediately and/or call 911 for help. • Keep the person calm and move as little as possible to reduce spread of the venom • Immobilize the bitten area and keep it at or below the level of the heart. • Remove rings, watches, shoes, etc. before swelling begins in earnest. • Monitor the person's vital signs -- temperature, pulse, rate of breathing, and blood pressure -- if possible. If there are signs of <u>shock</u> (such as paleness), lay the person flat, raise the feet	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		about a foot, and cover the person with a blanket. • Do NOT use tourniquets or suction devices. • Do NOT cut the area around the bite. • Do NOT apply ice or flush the wound with water. • Do NOT give the person stimulants or pain medications unless a doctor tells you to do so. • Do NOT give the person anything by mouth.	
Ticks	Contracting diseases transmitted from ticks	• Use tick avoidance precautions, including pre-treating clothing with permethrin, tucking pants into socks and shirt into pants. • Avoid sitting directly on the ground, especially in leaf litter, and check packs for ticks before putting them on. • Wear clothes (including pants and long-sleeved shirts) that are light colored and check for ticks on clothing periodically throughout the day. • Conduct a thorough tick check every evening after completing field work. • Know how to identify tick life forms, and the signs and symptoms of tick-borne diseases.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
Working in heat, humidity, or cold	Heat exhaustion, sunburn, dehydration, hypothermia	• Evaluate the weather forecast each morning and plan field work accordingly. • Carry and drink plenty of water. • Take extra breaks during extreme weather events. • Adjust the work routine to minimize exposure to extreme heat and humidity. • Take adequate garments for all possible weather conditions. • Choose clothing that will keep you warm even if it gets wet.	
Hazard Trees	Being struck by falling trees or branches.	• Look up. Be alert for widow-makers, storm damaged trees with large broken limbs, and unstable standing dead trees. • Do not spend extended time in an area with hazard trees. • Do not attempt to tag or measure unstable snags.	
High water stream crossings	Injuries from falling and/or drowning	• Thoroughly investigate area to find safest crossings. • Wear appropriate foot gear for stream crossings. • It is safer to wade through high water, rather than rock hop across a stream trying to keep your boots dry. • Unbuckle your pack and be prepared to jettison gear should you lose your balance/fall in.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		• Use wading rod/walking stick for balance	
	Illness from Giardia, E. Coli or other bacteria	• Do not drink from any stream, river, etc. unless water has been properly filtered or treated. • Have up-to-date vaccinations. • Be aware of possible contaminations before entering field. • Wear gloves and waders to protect open wounds from exposure.	
Carrying a pack and other equipment	Injuries from improper packing, adjustment, and lifting of backpacks. Injuries from improper carrying of gear.	• Learn how to properly pack, adjust, lift, and carry a pack. • When hand-carrying gear, keep one hand free. • If carrying long equipment, be aware of other people and never swing around quickly. Avoid allowing a long piece of equipment to project up and behind you, where you cannot see it.	
General operation of a vehicle	Injuries from vehicle accident; Damage to vehicle	• Perform pre-operational check of vehicle (oil, tire pressure, tire condition, fluids, wipers, brakes, lights, gas, etc.). Report all needed repairs to the crew leader or supervisor promptly. • Do not use the vehicle if it is unsafe. • Wear seat belts with shoulder harnesses whenever	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment			
Recommended or Optional Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Tasks	Potential Hazards	Recommended Action or Procedure	
		vehicle is in motion. (E.O. 13043 4-16-97) • Do not use cell phones or text while driving. • Only NPS employees, volunteers, or authorized cooperators and contractors are allowed to <u>operate or ride in</u> a government vehicle. • Ensure full visibility from all windows and mirrors. • Clean windshield regularly. • Always ride inside the vehicle. • Properly store and secure all tools, equipment, and cargo so that they will not shift during sudden starts or stops. • Plan your travel before you start. Know your route. • Practice defensive driving; be alert to potential hazards. • Obey all traffic laws and speed limits. • Adjust speed to changing weather or traffic conditions • Allow adequate following/stopping distance. • Avoid distractions such as eating or adjusting navigation/GPS units while driving. • Be alert for pedestrians or bicyclists using roadways.	

SOP #6 Table 1. Job Hazard Analysis for Vegetation Monitoring.

JOB HAZARD ANALYSIS		Name of Job: Vegetation Monitoring	New: X Revised: Reviewed:
Job Title: Field Crew Members	Division: Southeast Region Inventory&Monitoring Division, Cumberland Piedmont Network	Job Hazard Analysis: General Field Work Travel to, from and within parks	Analysis By:
Required Personnel	Mode of communication (radio/cell phone), sturdy hiking boots, long pants (preferably treated with permethrin), food, water, insect repellent, first aid kit. Personal flotation device if in boat.		
Protective Equipment	Hat, long sleeve shirt, rain gear, sunscreen, poison ivy treatment, bee sting kit (required if allergic to insect stings), walking stick (if steep terrain), waders or water boots.		
Recommended or Optional Equipment			
Tasks	Potential Hazards	Recommended Action or Procedure	
		• Be watchful for wildlife crossing roads, especially at early morning, dusk, and after dark. • Do NOT drive if fatigued. Stay alert! • Do NOT exceed the 12 hour limit for driving/work hours.	
Driving on gravel, dirt, or un-maintained roads	Injuries from vehicle accident; Damage to vehicle	• Maintain a slow and safe speed for changing road conditions, such as loose gravel, large potholes, washed out road, fallen trees or rocks, etc. • Be alert on narrow roads for oncoming vehicles and log trucks. • Be prepared to slow down, pull over, or stop with little notice. • Many roads require 4-wheel drive and/or high-clearance vehicles for safe passage. Use the appropriate vehicle for the terrain. • Do not exceed the capacity of your vehicle or driving ability. • When in doubt, turn around or back out. • Use spotters to assist in navigating obstacles and assessing water depth at stream crossings.	

Literature Cited

- Mehrhoff, L. J., C. J. Matlack, and J. A. Silander. "The IPANE Project: an introduction to New England's Early Detection Network." PowerPoint presentation. 30 August 2005.
<http://www.csrees.usda.gov/funding/integrated/pdfs/ipane.pdf> (accessed online 11/15/2012).
- White, R., C. Nordman, L. Smart, T. Leibfreid, B. Moore, R. Smyth, and T. Govus. 2011. Draft Vegetation Monitoring Protocol for the Cumberland Piedmont Network, Version 1.1. Natural Resource Report NPS/CUPN/NRR—2011/. National Park Service. Fort Collins, Colorado.

Standard Operating Procedure (SOP) #7: Revising the Plan

CUPN
Early Detection of Invasive Species
Surveillance Monitoring and Rapid Response
Standard Operating Procedure (SOP) #7
Revising the Plan

Version 1.0 (December 30, 2012)

Revision History Log

Prev. Version #	Revision Date	Revised by	Changes Made	Justificati on	New Version

This Standard Operating Procedure explains how to make changes to the Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Plan and accompanying SOPs, and how to track these changes. Any changes in the Early Detection of Invasive Species Surveillance Monitoring and Rapid Response document will adhere to the guidelines contained in this SOP. Observers asked to edit the document need to follow this outlined procedure in order to eliminate confusion in how data are collected and analyzed. All observers should be familiar with this SOP in order to identify and use the most current methodologies, and should see the revision history log attached to each SOP.

Procedures:

1. Early Detection of Invasive Species Surveillance Monitoring and Rapid Response Plan for the Cumberland Piedmont Network and accompanying SOPs has attempted to incorporate the most sound methodologies for collecting and analyzing data. However, all protocols regardless of how sound, require editing as new and different information becomes available. Required edits should be made in a timely manner and appropriate reviews undertaken.
2. All edits require review for clarity and technical soundness. Oversight of the revision process for all SOPs is the responsibility of the Invasive Species Coordinators. When a potential modification to a protocol is identified, the CUPN Program Manager, will decide whether the change should be considered “small” or “significant.” Small changes or additions to existing methods will be reviewed in-house by Cumberland Piedmont Network staff. However, if a substantial change, such as a change in methods is sought, then an outside review may be required. The need will be determined by the Southeast

Regional Inventory & Monitoring Division Chief. Regional and National staff of the National Park Service, or others with familiarity in ecological research and data analysis will be utilized as reviewers. Experts in invasive species early detection and management will also be consulted.

3. Edits and protocol versioning will be documented in the Revision History Log that accompanies the Narrative and each SOP. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02, ...etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...etc.). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.
4. The data manager will be consulted regarding changes to protocols. Changes to this protocol could have significant implications for data management depending on their nature and magnitude. Immediately after the changes to the Narrative or SOP(s) have been made, the data manager will be informed, so the new version number can be incorporated in the metadata of the project database.
5. Post new versions on the Internet and in the “Narratives” or “SOP” subfolder for the project. Forward a notice to any key individuals (such as park contacts) with older versions of the plan. Archive a copy of each previous version in the MACA curatorial facility.

Appendix A: Cumberland Piedmont Network (CUPN) 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 pest and 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). The North American Forest Commission Exotic Forest Pest Information System (NAFC-ExFor) supplies numerical scores in its expert-written pest reports which could easily form the basis of a ranked list of forest pests. Each of these systems provides a well-conceived model for ranking invasive plants and/or pests. 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](#) 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 Plan 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 plan, 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 plan.

The process for selecting a short list of invasive species for each park in the CUPN 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 CUPN parks across seven 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 non-native and 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 Cumberland Piedmont Network (CUPN).

Resources	CUPN Parks
Consultations with park Natural Resource Managers, 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
NPSpecies - The National Park Service Biodiversity Database. Secure online version. https://science1.nature.nps.gov/npspecies/web/main/start . • Mckinney LE and Others. 1991. The flora of Mammoth Cave National Park. Published Report-48792. • Seymour WR and Campbell J. An Annotated Checklist of the Recorded Vascular Flora of Mammoth Cave National Park. Published Report-147269 • Remaley T and Johnson K. 1997. Small Parks Exotic Plant Project 1996-97 Summary Report. Unpublished Report-2166638. • Rogers J and Johnson K. NRPP Project # 214: Summary Report for fiscal year 2000: Exotic Plant Management Activities, Appalachian Cluster Small Parks. Unpublished Report-2166393.	All Parks
Vegetation Classification and Mapping Report data	All Parks
Cumberland Piedmont Network Vegetation Monitoring Trip Reports. July 18-20, 2011 and July 11-14, and 25, 2011, respectively.	NISI, STRI
Completed park-specific Natural Resource Condition Assessments	ABLI, COWP, CUGA, FODO, KIMO, LIRI, NISI
Park state data submitted by members of the Cooperative Agricultural Pest Survey (CAPS) and found in the National Agricultural Pest Information System (NAPIS)	All Parks
Consult the North American Forest Commission Exotic Forest Pest Information System (NAFC-ExFor) and rank list of forest pests based on numerical scores in its expert-written pest reports.	All Parks

Appendix A, Table 2. Non-native and invasive forest pests and plant species known or thought to occur in the Cumberland Piedmont Network-CUPN (based on download from NPSpecies for non-native plants, with additions from parks, CUPN staff).

* Nomenclature follows the PLANTS Database developed by the Natural Resource Conservation Service in cooperation with the Biota of North American Program (United States Department of Agriculture, Natural Resources Conservation Service, <http://plants.usda.gov>, 6 August 2012); To avoid confusion, some synonyms are listed as well as multiple common names; X = present in park; PP= probably present in park; U= unconfirmed if present in park; H = historic occurrence in park; Parks include: Abraham Lincoln Birthplace National Historic Site (ABLI), Carl Sandburg Home National Historic Site (CARL), Chickamauga and Chattanooga National Military Park (CHCH), Cowpens National Battlefield (COWP), Cumberland Gap National Historical Park (CUGA), Fort Donelson National Battlefield (FODO), Guilford Courthouse National Military Park (GUCO), Kings Mountain National Military Park (KIMO), Little River Canyon National Preserve (LIRI), Mammoth Cave National Park (MACA), Ninety Six National Historical Site (NISI), Russell Cave National Monument (RUCA), Shiloh National Military Park (SHIL), and Stones River National Battlefield (STRI).

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
PESTS															
<i>Adelges tsugae</i>	hemlock woolly adelgid		X			X									
<i>Lymantria dispar</i>	European gypsy moth			X											
AQUATIC PLANTS															
<i>Egeria densa</i>	Brazilian elodea			U									U		
<i>Hydrilla verticillata</i>	Florida elodea			U											
<i>Myriophyllum aquaticum</i>	brazilian watermilfoil		X	U										X	
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil		X				U						U		
<i>Najas minor</i>	brittle waternymph			U			U		PP	U			U		
<i>Nasturtium officinale</i>	watercress			U		X	U			U	U		U		U
<i>Nelumbo nucifera</i>	sacred lotus			U											
<i>Potamogeton crispus</i>	curly pondweed			U			U			U			U		
PLANTS															
<i>Abelia X grandiflora</i>	glossy abelia				X										
<i>Abutilon theophrasti</i>	velvetleaf				X	U	U				X				X
<i>Acer palmatum</i>	Japanese maple		X					X							
<i>Acer platanoides</i>	Norway maple						X								
<i>Achillea millefolium</i>	common yarrow	X	X	X	X	X	X	X	U	X	X	X	X	X	X
<i>Acinos arvensis</i>	basil thyme					U									
<i>Adonis annua</i>	blooddrops												U		

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Aegilops cylindrica</i>	jointed goatgrass														U
<i>Aegopodium podagraria</i>	bishop's goutweed			U											
<i>Aesculus hippocastanum</i>	horse chestnut		X												
<i>Agrostemma githago</i>	common corncockle					U	U		U						U
<i>Agrostis gigantea</i>	redtop					U	X				X			U	U
<i>Ailanthus altissima</i>	tree of heaven		X	X	X	X	U	X	X	X	X		X	X	X
<i>Aira elegans</i>	annual silver hairgrass						X		X			X		X	
<i>Ajuga reptans</i>	common bugle				X								X		
<i>Akebia quinata</i>	chocolate vine							X							
<i>Albizia julibrissin</i>	silk tree			X	X	X	X	X	X	X	X	X	X	X	X
<i>Alcea rosea</i>	hollyhock						U								
<i>Alliaria petiolata</i>	garlic mustard			X		X					X				X
<i>Allium ampeloprasum</i>	broadleaf wild leek										U				
<i>Allium oleraceum</i>	field garlic	X													X
<i>Allium sativum</i>	cultivated garlic						X				X				X
<i>Allium vineale</i>	wild garlic	X	X	X	X	X	X	X	X		X	X			X
<i>Alnus glutinosa</i>	European alder										PP				
<i>Alopecurus arundinaceus</i>	creeping meadow foxtail					U									
<i>Alopecurus myosuroides</i>	slender meadow foxtail								U						
<i>Alternanthera philoxeroides</i>	alligatorweed			U			U			X			U	U	
<i>Ampelopsis brevipedunculata</i>	Amur peppervine		X												
<i>Anagallis arvensis</i>	scarlet pimpernel					U	U				X	X		U	
<i>Anthemis arvensis</i>	corn chamomile	X		U		U									X
<i>Anthemis cotula</i>	stinking chamomile			U		U	X		U	X	X		U		X
<i>Anthoxanthum odoratum</i>	sweet vernalgrass		X	X	X	X		X	PP	X	X	X		X	
<i>Anthriscus caucalis</i>	bur chervil														U
<i>Aphanes microcarpa</i>	slender parsley piert								X					U	
<i>Arabidopsis thaliana</i>	mouseear cress	U	X	X	X		X		U	X	X	X		X	X

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Arctium minus</i>	lesser burdock		X	X		U	U				X				X
<i>Arenaria serpyllifolia</i>	thymeleaf sandwort		X	X		U	X			X	U			X	U
<i>Armoracia rusticana</i>	horseradish						U								
<i>Arrhenatherum elatius</i>	tall oatgrass					U					U				
<i>Artemisia annua</i>	sweet sagewort			U		U	X				X				U
<i>Artemisia vulgaris</i>	common wormwood	X	X		X	U	U	X			U				X
<i>Arthraxon hispidus</i>	small carpgrass		X	X		U	X	X	X	X	X			X	
<i>Aruncus dioicus</i>	bride's feathers			X		X			X	X	X				
<i>Arundo donax</i>	giant reed				X		U				X				U
<i>Asparagus officinalis</i>	garden asparagus	U	X	X	X	U	U				X	X		X	X
<i>Asplenium scolopendrium</i>	Hart's tonguefern												U		
<i>Aucuba japonica</i>	Japanese laurel							X							
<i>Avena fatua</i>	wild oat										U				
<i>Avena sativa</i>	common oat			U		X	U		U	U					X
<i>Barbarea verna</i>	early yellowrocket		X	X		X			U	X	U	X			U
<i>Barbarea vulgaris</i>	garden yellowrocket		X	X		X	X				X				U
<i>Belamcanda chinensis</i>	blackberry lily	U			X	X	X				X	X	U	X	X
<i>Bellis perennis</i>	lawndaisy					U									
<i>Berberis thunbergii</i>	Japanese barberry	X	X	X		X	X	X			X				
<i>Betula pendula</i>	European white birch				X										
<i>Brassica napus</i>	rape	U		X		X					U				
<i>Brassica nigra</i>	black mustard										X				
<i>Brassica rapa</i>	field mustard					X	X				X				X
<i>Briza minor</i>	little quakinggrass									U		X			
<i>Bromus arvensis</i>	field brome														X
<i>Bromus catharticus</i>	rescuegrass		X						U			X			
<i>Bromus commutatus</i> (= <i>B. racemosus</i>)	meadow brome	X		X	X	U	X		PP		X	X		X	X
<i>Bromus japonicus</i> (= <i>B. arvensis</i>)	Japanese brome	X		U	X	X	X		X		X	X		X	X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Bromus racemosus</i>	bald brome					U					X			X	
<i>Bromus secalinus</i>	rye brome					U			X						U
<i>Bromus sterilis</i>	poverty brome										X			U	X
<i>Bromus tectorum</i>	cheatgrass					U	X		U	X	X		U	U	X
<i>Broussonetia papyrifera</i>	paper mulberry				X		U	X	U				U	X	
<i>Buglossoides arvensis</i>	corn gromwell	X		X		U	U		U		X				X
<i>Bupleurum rotundifolium</i>	hare's ear														X
<i>Buxus sempervirens</i>	common box		X	X											
<i>Calamintha nepeta</i>	lesser calamint			X		U									X
<i>Calystegia sepium</i>	hedge false bindweed	X	X	X	X	X	X		U	X	X		X	X	X
<i>Camelina microcarpa</i>	littlepod false flax														U
<i>Cannabis sativa</i>	marijuana			X											
<i>Capsella bursa-pastoris</i>	shepard's purse			X	X	X	X		PP	X	X			U	X
<i>Cardamine hirsuta</i>	hairy bittercress	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Cardiospermum halicababum</i>	balloon vine														X
<i>Carduus nutans</i>	nodding plumeless thistle	X				X	X				X				X
<i>Castanea mollissima</i>	Chinese chestnut			X					X						X
<i>Castanea sativa</i>	European chestnut												U		
<i>Catharanthus roseus</i>	Madagascar periwinkle				X										
<i>Celastrus orbiculatus</i>	Oriental bittersweet	X	X	X		X		X			X				
<i>Centaurea cyanus</i>	garden cornflower				X		U	X	U						X
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	X				X					X				U
<i>Centaurium pulchellum</i>	branched centaury										X				
<i>Cerastium brachypetalum</i>	gray chickweed		X	X			X		U		U			U	U
<i>Cerastium fontanum</i>	<i>common mouse-ear chickweed</i>	X	X		X	X	X		U		X				U
<i>Cerastium glomeratum</i>	sticky chickweed	U		X	X	U	X		X	X	X		X	U	U
<i>Cerastium semidecandrum</i>	fivestamen chickweed									X			X		
<i>Chaenomeles japonica</i>	Maule's quince							X							

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Chaenomeles speciosa</i>	flowering quince		X		X	X	X							X	
<i>Chaenorhinum minus</i>	dwarf snapdragon														U
<i>Chenopodium album</i>	lambquarters		X		X	X	X		U	X	X		X	X	X
<i>Chenopodium ambrosioides</i>	Mexican tea		X	U	X	X	X		U		X		X	X	X
<i>Chenopodium murale</i>	nettleleaf goosefoot														U
<i>Chenopodium pumilio</i>	clammy goosefoot			U											
<i>Cichorium intybus</i>	chicory			U		X	U	X	U		X				X
<i>Cirsium arvense</i>	Canada thistle				X	U									
<i>Cirsium vulgare</i>	bull thistle	X	X	U	X	X	U			X	X	X			X
<i>Clematis terniflora</i>	sweet autumn virginsbower			X		X	X	X			X		X		X
<i>Cleome hassleriana</i>	pink queen						U				X			U	
<i>Cnicus benedictus</i>	blessed thistle								U						
<i>Commelina communis</i>	Asiatic dayflower	X	X	X	X	X	X	X	X	X	X		X		X
<i>Conium maculatum</i>	poison hemlock		X			U					X				X
<i>Conringia orientalis</i>	hare's ear mustard			X											U
<i>Consolida ajacis</i>	doubtful knight's-spur				X		U		U	X					X
<i>Convallaria majalis</i>	European lily of the valley						U								
<i>Convolvulus arvensis</i>	field bindweed				X	X		X			X				U
<i>Coronopus didymus</i>	lesser swinecress			U					U						
<i>Cosmos bipinnatus</i>	garden cosmos						U							U	
<i>Cotinus coggygria</i>	European smoketree												X		
<i>Crepis pulchra</i>	smallflower hawksbeard								U						X
<i>Crotalaria spectabilis</i>	showy rattlebox									X					
<i>Cruciata pedemontana</i>	piedmont bedstraw				X	U	X		X	X				X	X
<i>Cunninghamia lanceolata</i>	Chinese fir							X							
<i>Cyclospermum leptophyllum</i>	marsh parsley								U					U	X
<i>Cymbalaria muralis</i>	Kenilworth ivy		X	X											
<i>Cynodon dactylon</i>	Bermudagrass	X	X	X	X	U	X	X	U	X	X	X	X	X	X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Cynoglossum officinale</i>	gypsyflower					U									
<i>Cyperus difformis</i>	variable flatsedge												U		
<i>Cyperus iria</i>	ricefield flatsedge			U	X		U		U	X				X	
<i>Cyperus rotundus</i>	nutgrass								U						U
<i>Cytisus scoparius</i>	Scotch broom				X										
<i>Dactylis glomerata</i>	orchardgrass	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Dactyloctenium aegyptium</i>	Egyptian grass								U						
<i>Datura stramonium</i>	jimsonweed			U	X	U	X				X		X	X	U
<i>Daucus carota</i>	Queen Anne's lace	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Descurainia sophia</i>	herb sophia														U
<i>Deutzia X magnifica</i>				X											
<i>Dianthus armeria</i>	Deptford pink	X		X	X	X	X	X	U	U	X			U	X
<i>Dianthus barbatus</i>	sweetwilliam														U
<i>Digitaria ischaemum</i>	smooth crabgrass	X		X	X	U	X		X	X	X		U	X	X
<i>Digitaria violascens</i>	violet crabgrass									X	U				
<i>Dioscorea oppositifolia</i>	Chinese yam		X	X		X	X	X	X	X	X		X	X	X
<i>Diplotaxis tenuifolia</i>	perennial wallrocket										X				
<i>Dipsacus fullonum</i>	Fuller's teasel	X				X	U				X				X
<i>Draba verna</i>	spring draba	X	X	X	X	U	X		U	X	X			X	X
<i>Duchesnea indica</i>	Indian strawberry	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Echinochloa colona</i>	jungle rice								U		U				U
<i>Echinochloa crus-galli</i>	barnyardgrass		X	X		X	X		U	X	X	X	X	U	U
<i>Echinochloa frumentacea</i>	billion-dollar grass						U								
<i>Echium vulgare</i>	common viper's bugloss					U					U				U
<i>Elaeagnus angustifolia</i>	Russian olive				X			X							
<i>Elaeagnus pungens</i>	thorny olive			X				X				X			
<i>Elaeagnus umbellata</i>	autumn olive	X	X	X	X	X	X	X	PP		X	X			
<i>Eleusine indica</i>	Indian goosegrass		X	X	X	X	X		U		X		X	X	X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Elymus repens</i>	quackgrass					U									
<i>Eragrostis cilianensis</i>	stinkgrass		X	U		U	X				X				U
<i>Eragrostis curvula</i>	weeping lovegrass					U	U							U	X
<i>Eragrostis minor</i>	little lovegrass					U	U				U				U
<i>Eremochloa ophiuroides</i>	centipede grass				X				X					X	
<i>Erodium cicutarium</i>	redstem stork's bill				X				U	X					
<i>Erysimum repandum</i>	spreading wallflower	U								U					X
<i>Euonymus alatus</i>	burningbush	X	X	X	X	X	X	X			X				X
<i>Euonymus bungeanus</i>	winterberry euonymus			X											
<i>Euonymus fortunei</i>	winter creeper	X	X	X	X	U	X	X							X
<i>Euonymus obovatus</i>	running strawberry bush	X													
<i>Euphorbia cyparissias</i>	cypress spurge										U				
<i>Euphorbia davidii</i>	David's spurge			U											
<i>Euphorbia helioscopia</i>	madwoman's milk														U
<i>Facelis retusa</i>	annual trampweed				X				U			X			
<i>Fagopyrum esculentum</i>	buckwheat					U	U								
<i>Festuca brevipila</i> (=F. <i>trachyphylla</i>)	hard fescue	X													X
<i>Ficus carica</i>	edible fig				X										U
<i>Foeniculum vulgare</i>	sweet fennel								U						U
<i>Forsythia viridissima</i>	greenstem forsythia			X		X	X								X
<i>Forsythia X intermedia</i> / <i>Forsythia hybrida</i>	showy forsythia							X	PP						
<i>Frangula alnus</i>	glossy buckthorn						X								
<i>Galeopsis ladanum</i>	red hempnettle														X
<i>Galinsoga quadriradiata</i>	shaggy soldier	X	X	X		X	U				X		X		X
<i>Galium divaricatum</i>	Lamarck's bedstraw														U
<i>Galium mollugo</i>	false baby's breath					U							X		U
<i>Geranium columbinum</i>	longstalk cranesbill					U									
<i>Geranium dissectum</i>	cutleaf geranium	X		X		U	X				X				X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Geranium molle</i>	dovefoot geranium			X		U	U				X				X
<i>Geranium pusillum</i>	small geranium		X												
<i>Ginkgo biloba</i>	maidenhair tree		X	X		X								X	X
<i>Gladiolus communis</i>	cornflag										U			U	
<i>Gladiolus X gandavensis</i>							U								
<i>Glechoma hederacea</i>	ground ivy	X	X	X		X	X	X			X		X		X
<i>Glycine max</i>	soybean														X
<i>Hedera helix</i>	English ivy	X	X	X	X	X	X	X	X	X	X			X	X
<i>Heliotropium amplexicaule</i>	clasping heliotrope									U					
<i>Heliotropium indicum</i>	India heliotrope						X			X				X	U
<i>Hemerocallis fulva</i>	orange daylily	X		X	X	X	X	X	U		X		X	X	X
<i>Hemerocallis lilioasphodelus</i>	yellow daylily		X												
<i>Hesperis matronalis</i>	dames rocket			X		X									
<i>Hibiscus syriacus</i>	rose of Sharon			X	X	X	X	X				X		X	X
<i>Hibiscus trionum</i>	flower of an hour					U					U				
<i>Hieracium aurantiacum</i>	orange hawkweed										X				
<i>Hieracium caespitosum</i>	meadow hawkweed					X									
<i>Hieracium pilosella</i>	mouseear hawkweed										X				
<i>Holcus lanatus</i>	common velvetgrass					U	X	X	U	X	X			X	
<i>Holosteum umbellatum</i>	jagged chickweed			X		U	X		U		X				X
<i>Hordeum vulgare</i>	common barley			U			U								U
<i>Hosta ventricosa</i>	blue plantain lily		X												
<i>Humulus japonicus</i>	Japanese hop								U						
<i>Humulus lupulus</i>	common hop					U									
<i>Hypericum calycinum</i>	Aaron's beard		X		X										
<i>Hypericum formosum</i>											X				
<i>Hypericum perforatum</i>	common St Johnswort						U	X			X			X	X
<i>Hypochaeris brasiliensis</i>	Brazilian cat's ear								U						

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Hypochaeris radicata</i>	hairy cat's ear		X	X	X	U	U		X		U			X	
<i>Ilex cornuta</i>	Chinese holly			X				X							
<i>Ilex crenata</i>	Japanese holly		X					X							
<i>Ipomoea coccinea</i>	redstar		X	U	X	U	U		U	X	X				
<i>Ipomoea hederacea</i>	ivy/leaf morning-glory			X	X	X	X		U	X	X			X	X
<i>Ipomoea purga</i>	jalap											X			
<i>Ipomoea purpurea</i>	tall morning-glory	X	X	X	X	X			U	X	X	X	X		X
<i>Ipomoea wrightii</i>	Wright's morning-glory														U
<i>Iris germanica</i>	German iris						X	X	U						
<i>Iris pseudacorus</i>	pale/yellow iris					U									
<i>Jasminum nudiflorum</i>	winter jasmine							X							
<i>Juncus capitatus</i>	leafybract dwarf rush												U		
<i>Kickxia elatine</i>	sharp/leaf cancerwort						X								
<i>Kummerowia stipulacea</i>	Korean clover			X	X	X	X		U		X			X	X
<i>Kummerowia striata</i>	Japanese clover	X		X	X	X	X	X	X	X	X	X	X	X	X
<i>Lactuca saligna</i>	willow/leaf lettuce					X	U		U		X				X
<i>Lactuca serriola</i>	prickly lettuce			X		U	X		U	X	U			X	X
<i>Lagerstroemia indica</i>	crapemyrtle			X	X		U							X	
<i>Lamium album</i>	white deadnettle													X	
<i>Lamium amplexicaule</i>	henbit deadnettle	X		X	X	X	X	X	X	X	X	X	X	X	X
<i>Lamium purpureum</i>	purple deadnettle			X	X	X	X		PP	X	X		X	U	X
<i>Lapsana communis</i>	common nipplewort					U									
<i>Larix occidentalis</i>	western larch														X
<i>Lathyrus hirsutus</i>	Caley pea				X		U			X				U	
<i>Lathyrus latifolius</i>	perennial pea		X	X	X	X	X				U			X	X
<i>Lathyrus sylvestris</i>	flat pea										U				
<i>Leonurus cardiaca</i>	common motherwort			U		U	U								
<i>Lepidium campestre</i>	field pepperweed	U		X		X	X				X				X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Lepidium ruderales</i>	roadside pepperweed										X	X			
<i>Lespedeza bicolor</i>	shrub lespedeza				X	U	X	X	U		U		U		
<i>Lespedeza cuneata</i>	sericea lespedeza	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Lespedeza thunbergii</i>	Thunberg's lespedeza					U									
<i>Leucanthemum vulgare</i>	oxeye daisy	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Leucojum aestivum</i>	summer snowflake						X								
<i>Ligustrum amurense</i>	Amur privet					X					U				
<i>Ligustrum japonicum</i>	Japanese privet				X			X					X		
<i>Ligustrum lucidum</i>	glossy privet							X							
<i>Ligustrum obtusifolium</i>	border privet					U									
<i>Ligustrum sempervirens</i>	privet						X								
<i>Ligustrum sinense</i>	Chinese privet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Ligustrum vulgare</i>	European privet		X	X	X	U	X	X	X	X	PP	X	X		X
<i>Linaria vulgaris</i>	butter and eggs			X		U				X	X				
<i>Linum usitatissimum</i>	common flax					X			U						
<i>Liriope spicata</i>	creeping liriope							X							X
<i>Lithospermum officinale</i>	European stoneseed										X				
<i>Lolium perenne</i>	perennial ryegrass		X		X	X	X	X	X	X	X	X	X		X
<i>Lolium temulentum</i>	Darnel ryegrass														U
<i>Lonicera fragrantissima</i>	sweet breath of spring			X	X			X							
<i>Lonicera japonica</i>	Japanese honeysuckle	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Lonicera maackii</i>	Amur honeysuckle	X		X		X									X
<i>Lonicera morrowii</i>	Morrow's honeysuckle		X												
<i>Lonicera spp</i> (<i>L. fragrantissima</i> , <i>L. maackii</i> , <i>L. morrowii</i> , <i>L. standishii</i> , <i>L. tatarica</i> , <i>L. xbella</i>)	bush honeysuckles					X		X			PP				
<i>Lonicera standishii</i>	Standish's honeysuckle														X
<i>Lotus corniculatus</i>	bird's-foot trefoil					X									U
<i>Ludwigia grandiflora</i> (= <i>L. uruguayensis</i>)	large-flower primrose-willow						U								

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Lunaria annua</i>	annual honesty			X				X							
<i>Lycium barbarum</i>	matrimony vine			U			U								
<i>Lycoris radiata</i>	red spider lily						U		U						
<i>Lysimachia nummularia</i>	creeping jenny			X		U	X		PP		X				X
<i>Macrothelypteris torresiana</i>	swordfern			X								X			
<i>Mahonia bealei</i>	Beale's barberry		X	X				X					U		X
<i>Malus pumila</i>	paradise apple	X	X		X	X	X	X		X				X	
<i>Malus sylvestris</i>	European crab apple		X				X								
<i>Malva moschata</i>	musk mallow					U									
<i>Malva neglecta</i>	common mallow					X									X
<i>Malva sylvestris</i>	high mallow						U		U						
<i>Marrubium vulgare</i>	horehound			U		X	U								X
<i>Medicago Arabica</i>	spotted medick								U						
<i>Medicago lupulina</i>	black medic		X	X		X	X		U	X	X		X		X
<i>Medicago orbicularis</i>	blackdisk medick														U
<i>Medicago sativa</i>	alfalfa	X		U		U	X		U	X	X				U
<i>Melia azedarach</i>	Chinaberrytree				X			X	U	X		X			
<i>Melilotus officinalis</i> (= <i>M. albus</i>)	sweetclover	X		X	X	X	X	X	X		X		X	X	X
<i>Melissa officinalis</i>	common balm										X				
<i>Mentha spicata</i>	spearmint		X				U								U
<i>Mentha suaveolens</i>	apple mint					U									
<i>Mentha X piperita</i>	peppermint		X	U		U	X				X			U	U
<i>Mercurialis annua</i>	annual mercury			X					U						
<i>Microstegium vimineum</i>	Nepalese browntop, Japanese stiltgrass	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Microthlaspi perfoliatum</i>	claspleaf pennycress					U					U				
<i>Mirabilis jalapa</i>	marvel of Peru			X					U						
<i>Miscanthus sinensis</i>	Chinese silvergrass		X		X	X					X				
<i>Morus alba</i>	white mulberry	X	X	X	X		X	X	U				X		X

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Mosla dianthera</i>	miniature beefsteakplant			X							X				
<i>Murdannia keisak</i>	wartremoving herb		X	X		U			PP	X		X			
<i>Muscari botryoides</i>	common grape hyacinth						X				X				X
<i>Muscari comosum</i>	tassel grape hyacinth														U
<i>Muscari neglectum</i>	starch grape hyacinth			U	X		U		X	X				X	X
<i>Myosotis arvensis</i>	field forget-me-not					X					X		X		
<i>Myosotis scorpioides</i>	true forget-me-not					U									
<i>Nandina domestica</i>	sacred bamboo			X	X			X					U		X
<i>Narcissus poeticus</i>	poet's narcissus			X		U	X				X				X
<i>Narcissus pseudonarcissus</i>	daffodil			X	X	X	X		X		X			X	X
<i>Narcissus X incomparabilis</i>	nonesuch daffodil			X											
<i>Nepeta cataria</i>	catnip			X		U									X
<i>Nicandra physalodes</i>	apple of Peru					U	U			X					
<i>Ornithogalum umbellatum</i>	Sleepydick, star-of-Bethlehem	X		U			X	X		U	X	X		X	X
<i>Osmanthus heterophyllus</i>	holly osmanthus							X							
<i>Papaver dubium</i>	blindeyes														U
<i>Papaver somniferum</i>	opium poppy										U				
<i>Paspalum dilatatum</i>	dallisgrass			X	X	X	X		X	X	X	X	X	X	X
<i>Paspalum notatum</i>	bahiagrass			X	X				PP			X			
<i>Passiflora edulis</i>	purple granadilla			U	X										
<i>Pastinaca sativa</i>	wild parship					U			U		X				
<i>Paulownia tomentosa</i>	princesstree	X	X	X	X	X	X	X	X		X		X	X	X
<i>Pennisetum glaucum</i>	pearl millet		X	X	X	X	X	X	U	X	X	X			X
<i>Perilla frutescens</i>	beefsteakplant	X	X	X		X	X		X	X	X		X		X
<i>Phalaris canariensis</i>	annual canarygrass														U
<i>Philadelphus coronarius</i>	sweet mock orange				X										
<i>Phleum pratense</i>	timothy	X	X	X		X	X		U	U	X			U	X
<i>Photinia serratifolia</i>	Taiwanese photinia											X			

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Photinia villosa</i>	Oriental photinia							X							
<i>Phyllostachys aurea</i>	golden bamboo				X			X		X					
<i>Phyllostachys meyeri</i>	Meyer's bamboo							X							
<i>Picea abies</i>	Norway spruce					X	X	H							
<i>Plantago lanceolata</i>	narrowleaf plantain	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Plantago media</i>	hoary plantain										U				
<i>Poa annua</i>	annual bluegrass	X	X	X	X	X	X	X	X		X	X			X
<i>Poa compressa</i>	Canada bluegrass	X		U		X	X		U		X	X			X
<i>Poa lanuginosum</i>				X											
<i>Poa pratensis</i>	Kentucky bluegrass	X		X	X	X	X		U	U	X		X	X	X
<i>Poa trivialis</i>	rough bluegrass					X									
<i>Polygonum aviculare</i>	prostrate knotweed			X	X	X	X		U	X					X
<i>Polygonum convolvulus</i>	black bindweed	X				X	X				X				X
<i>Polygonum cuspidatum</i>	Japanese knotweed		X			X	X				U				X
<i>Polygonum hydropiper</i>	marshpepper knotweed			U			U		U					U	U
<i>Polygonum persicaria</i>	spotted ladythumb			U		X	X		X		X		X		X
<i>Poncirus trifoliata</i>	hardy orange			X	X			X				X			
<i>Populus alba</i>	white poplar		X	X	X	U	U		PP		X				U
<i>Populus nigra</i>	Lombardy poplar				X										
<i>Populus X canescens</i>	gray poplar			U			U	X			U				
<i>Portulaca grandiflora</i>	rose moss								U						
<i>Portulaca oleracea</i>	little hogweed		X			U	X		U		X				X
<i>Potentilla erecta</i>	erect cinquefoil						X								
<i>Potentilla recta</i>	sulphur cinquefoil	X	X	X	X	X	X		U		X				X
<i>Prunus avium</i>	sweet cherry	X		X				X			X				
<i>Prunus cerasus</i>	sour cherry		X	X				X							
<i>Prunus mahaleb</i>	Mahaleb cherry					U									X
<i>Prunus persica</i>	peach	U		X	X	X	X	X	U	X	X	X	U		U

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Pueraria montana</i>	kudzu			X	X	X	U	X	X	X	X	X	X		X
<i>Pyrus calleryana</i>	Callery pear/Bradford pear			X	X	X		X			U				X
<i>Pyrus communis</i>	common pear			X	X	X	X	X	U	X	U	X		X	X
<i>Quercus acutissima</i>	sawtooth oak							X							X
<i>Ranunculus acris</i>	tall buttercup					X					U		X		
<i>Ranunculus arvensis</i>	corn buttercup		X		X										
<i>Ranunculus bulbosus</i>	St. Anthony's turnip		X	X	X	X		X	U		X			X	U
<i>Ranunculus muricatus</i>	spinyfruit buttercup								U						
<i>Ranunculus parviflorus</i>	smallflower buttercup			U	X		X		U					U	U
<i>Ranunculus repens</i>	creeping buttercup		X			U					U				
<i>Ranunculus sardous</i>	hairy buttercup			X		U	X		X	X	X				X
<i>Raphanus raphanistrum</i>	wild radish			X			U		PP						U
<i>Rhodotypos scandens</i>	jetbead			X			X								
<i>Ricinus communis</i>	castorbean						U								
<i>Rorippa sylvestris</i>	creeping yellowcress					U					X				
<i>Rosa bracteata</i>	Macartney rose		X												
<i>Rosa canina</i>	dog rose		X								U				
<i>Rosa eglanteria</i>	sweetbriar rose														X
<i>Rosa micrantha</i>	smallflower rose								U						
<i>Rosa multiflora</i>	multiflora rose	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Rosa wichuraiana</i>	memorial rose				X	X			X						X
<i>Rubus armeniacus</i>	Himalayan blackberry														X
<i>Rubus bifrons</i>	Himalayan berry				X				PP	X	X	X		X	X
<i>Rubus phoenicolasius</i>	wine raspberry	X				U	U	X							
<i>Rumex acetosa</i>	garden sorrel												X		
<i>Rumex acetosella</i>	common sheep sorrel	X	X	X	X	X	X	X	U	X	X			X	U
<i>Rumex conglomeratus</i>	clustered dock			U			X								X
<i>Rumex crispus</i>	curley dock	PP	X	X	X	X	X		X	X	X	X		X	X

[illegible]

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Silene vulgaris</i>	maidenstears					U									
<i>Sinapis arvensis</i>	charlock					X									U
<i>Sisymbrium altissimum</i>	tall tumbledmustard														U
<i>Sisymbrium officinale</i>	hedgemustard		X	X		U	X		U		X		X		X
<i>Solanum dulcamara</i>	climbing nightshade												X		
<i>Solanum lycopersicum</i>	garden tomato						X								
<i>Solanum physalifolium</i>	hoe nightshade						U								
<i>Sonchus asper</i>	spiny sowthistle		X	X	X	X	X		PP	X	X				X
<i>Sonchus oleraceus</i>	common sowthistle				X				U						
<i>Sorghum bicolor</i>	sorghum						U				U				
<i>Sorghum halepense</i>	Johnsongrass	X		X	X	X	X	X	U	X	X	X		X	X
<i>Spiraea cantoniensis</i>	Reeves' meadowsweet				X										
<i>Spiraea japonica</i>	Japanese meadowsweet		X	X		X									
<i>Spiraea prunifolia</i>	bridalwreath spirea			X		X	X	X						X	X
<i>Spiraea sanssouciana</i>				X											
<i>Spiraea thunbergii</i>	Thunberg's meadowsweet			X			X								
<i>Spiraea X vanhouttei</i>			X		X		X								
<i>Stellaria graminea</i>	grass-like starwort		X			U			U						U
<i>Stellaria media</i>	common chickweed	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Syringa vulgaris</i>	common lilac						U								X
<i>Taraxacum laevigatum</i>	rock dandelion										X				
<i>Taraxacum officinale</i>	common dandelion	X	X	X	X	X	X	X	X	X	X		X	X	X
<i>Thlaspi alliaceum</i>	roadside pennycress										U				
<i>Thlaspi arvense</i>	field pennycress		X			U					X				X
<i>Thuja plicata</i>	western redcedar							X							
<i>Torilis arvensis</i>	spreading hedgeparsley			X		X	U		U						X
<i>Torilis japonica</i>	erect hedgeparsley						X				U				
<i>Tradescantia zebrina</i>	inchplant										U				

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Tragopogon dubius</i>	yellow salsify					U	U				X				X
<i>Tragopogon lamottei</i> (= <i>T. pratensis</i>)	Jack-go-to-bed-at-noon						X								X
<i>Trifolium arvense</i>	rabbitfoot clover	U			X				U	X	X	X			
<i>Trifolium aureum</i>	golden clover										X				
<i>Trifolium campestre</i>	field clover	X		X	X	X	X		U	X	X	X	X	X	X
<i>Trifolium dubium</i>	suckling clover	X		U		U	X		X	X				U	
<i>Trifolium hybridum</i>	alsike clover					X	X		U		X				U
<i>Trifolium incarnatum</i>	crimson clover			X	X?		X		U	X					X
<i>Trifolium nigrescens</i>	small white clover														U
<i>Trifolium pratense</i>	red clover	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Trifolium repens</i>	white clover	X	X	X	X	X	X	X	X	X	X		X	X	X
<i>Trifolium resupinatum</i>	reversed clover														U
<i>Trifolium vesiculosum</i>	arrowleaf clover												U		
<i>Triticum aestivum</i>	common wheat			X			X		X						X
<i>Tussilago farfara</i>	coltsfoot					X									
<i>Ulmus glabra</i>	Wych elm											X			
<i>Ulmus pumila</i>	Siberian elm						X	X							
<i>Valerianella dentata</i>	narrowfruit cornsalad														U
<i>Valerianella locusta</i>	Lewiston cornsalad	X			X	X	X		X				X	X	U
<i>Verbascum blattaria</i>	moth mullein			U	X	X	X		U		X	X		X	X
<i>Verbascum phlomoides</i>	orange mullein										U				
<i>Verbascum thapsus</i>	common mullein		X	X	X	X	X			X	X		X	X	X
<i>Verbena brasiliensis</i>	Brazilian vervain			X	X				U	X		X	X		
<i>Verbena rigida</i>	tuberous vervain											X			
<i>Veronica agrestis</i>	green field speedwell	X		X		U									X
<i>Veronica arvensis</i>	corn speedwell	X		X	X	X	X		U	X	X	X		X	X
<i>Veronica hederifolia</i>	ivyleaf speedwell		X	X	X	U		X	X				X		X

[illegible]

Although the numbers varied by park, approximately 395 non-native and invasive species were eliminated from this list. Some were eliminated because they are ubiquitous or common and well established in all parks. Others were eliminated because they pose less of a threat due to self-decline, low management need, or low native biodiversity impact. Finally, some were planted for landscaping purposes and do not pose a threat to park resources. Examples include narrowleaf plantain (*Plantago lanceolata*), Norway spruce (*Picea abies*), and common dandelion (*Taraxacum officinale*). Narrowleaf plantain was present in every park, Norway spruce was most likely planted and isn't an immediate concern for CUGA and FODO, and common dandelion was present in every park with the exception of Ninety Six National Historic Site (NISI). Background data was not available for NISI, but due to the general widespread distribution of common dandelion, 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:

Plants

1. [USDA PLANTS database](#)
2. [The Biota of North America Program \(BONAP\) web-based U.S. County-Level Atlas of the Vascular Flora of North America](#)
3. [Early Detection and Distribution Mapping System \(EDDMapS\)](#)
4. [Invasive Plant Atlas of the MidSouth \(IPAMS\)](#)
5. [NatureServe Explorer](#)
6. [U.S. Department of Agriculture Plant Hardiness Zones](#)
7. Communications with park personnel and contractors familiar with the parks.
8. Jordan, T.R., and M. Madden, 2010. Digital Vegetation Maps for the NPS Cumberland-Piedmont I&M Network: Final Report November 1, 2010. Natural Resource Technical Report NPS/CUPN/NRTR—2010/406. National Park Service, Fort Collins, Colorado.
9. [Eastern Forest Environmental Threat Assessment Center](#)
10. [Cogongrass](#)
11. The University of Georgia, Center for Invasive Species and Ecosystem Health: Chuck Barger, Technology Director and Karan Rawlins, Invasive Species Coordinator.
12. Randy Westbrook, Invasive Species Prevention Specialist, former USGS employee.
13. Rickie White, Plant Ecologist, NatureServe.
14. Milo Pyne, Southeast Regional Ecologist, NatureServe.
15. [Alabama Invasive Plant Council](#)
16. [Alabama Forestry Commission](#)
17. [Auburn University School of Forestry and Wildlife Sciences](#)
18. [Georgia Exotic Pest Plant Council](#)
19. [Georgia Invasive Species Task Force](#)
20. [Invasive Plants of Georgia's Forests](#)
21. [University of Kentucky Invasive Species Working Group](#)
22. [Kentucky Exotic Pest Plant Council \(KY-EPPC\)](#)
23. [Kentucky Department for Natural Resources Division of Forestry](#)

24. [North Carolina Exotic Pest Plant Council](#)
25. [North Carolina Native Plant Society](#)
26. [North Carolina Department of Agriculture & Consumer Services](#)
27. [North Carolina Department of Environment & Natural Resources, Aquatic Weed Control Program](#)
28. [South Carolina Exotic Pest Plant Council](#)
29. [South Carolina Department of Natural Resources, Aquatic Nuisance Task Force](#)
30. [South Carolina Forestry Commission](#)
31. [Tennessee Exotic Pest Plant council](#)
32. [Tennessee Cooperative Weed Management Area \(TNCWMA\)](#)
33. [Oak Ridge National Environmental Research Park](#)
34. [Southern Appalachian Native Plant and Invasive Species Initiative](#)
35. [Virginia Invasive Species Council \(VAISC\)](#)
36. [Virginia Department of Conservation and Recreation \(VADCR\)](#)
37. Pratt, P. D.; Pemberton, R. W. 2004. Skunk vine. In: Coombs, Eric M.; Clark, Janet K.; Piper, Gary L.; Cofrancesco, Alfred F., Jr., eds. Biological control of invasive plants in the United States. Corvallis, OR: Oregon State University Press: 449.

Pests

1. [Expert assessment by contributors to the North American Forest Commission Exotic Forest Pest Information System \(NAFC-ExFor\)](#)
2. [National Agricultural Pest Information System \(NAPIS\)](#)
3. [USGS Non-indigenous Aquatic Species \(NAS\)](#)
4. [USDA Forest Service Forest Health Protection Mapping and Reporting](#)
5. [USDA Forest Service Alien Forest Pest Explorer](#)
6. [U.S. Department of Agriculture National Invasive Species Information Center Eastern Forest Environmental Threat Assessment Center](#)
7. [Alabama Forestry Commission](#)
8. [Georgia Forestry Commission: Forest Health in Georgia](#)
9. [University of Kentucky College of Agriculture: Cooperative Agricultural Pest Survey](#)
10. [Mississippi Forestry Commission: Forest Health](#)
11. [North Carolina Forest Service: Forest Health](#)
12. [South Carolina Forestry Commission: Forest Health](#)
13. [Tennessee Department of Agriculture: Forest Health](#)
14. [Virginia Department of Conservation and Recreation: Invasive Species in Virginia Resources:](#)
15. [An Identification Tool for Bark Beetles of the Southeastern United States](#)
16. [Center for Invasive Species and Ecosystem Health: Invasive and exotic species of North America](#)
17. [USDA National Agricultural Library: National Invasive Species Information Center](#)
18. [North American Plant Protection Organization's Phytosanitary Alert System'](#)
19. [National Park Service: Explore Biology: Invasive Species Management](#)
20. [Sampling Methods for Forests and Shade Tree Insects of North America](#)

Approximately 40 invasive species currently absent from CUPN parks were added to the candidate list. For example, cogongrass (*Imperata cylindrica*) is a Federal noxious weed. It was reported as a severe threat by the Tennessee Exotic Pest Plant Council, a severe threat and noxious weed in South Carolina, one of Alabama's "Worst 10" invasive species, a Category 1 Alert species in Georgia, and an early detection species North Carolina. Cogongrass has been detected in Catoosa County Georgia (county where CHCH is located) and Jackson County, Alabama (where RUCA is located), and counties adjacent to Cherokee County, Alabama (county where LIRI is located).

Once the invasive species candidate list was constructed each species was then researched and prioritized. During this process, each park natural resource manager, regional experts from the University of Georgia and from the United States Geological Society (USGS) 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 (rare, threatened, or endangered species, 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. What is the known cold hardiness of the species?
12. 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?
13. 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.
14. 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 25 early detection species, 29 low priority species, and 13 questionable species were designated for CUPN 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 2012 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 May 2012 final invasive early detection plant species for the Cumberland Piedmont Network (CUPN) 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 pest and plant species and May 2012 final invasive early detection species for the Cumberland Piedmont Network (CUPN) 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.

* Nomenclature follows the PLANTS Database developed by the Natural Resource Conservation Service in cooperation with the Biota of North American Program (United States Department of Agriculture, Natural Resources Conservation Service, <http://plants.usda.gov>, 6 August 2012); To avoid confusion, some synonyms are listed as well as multiple common names; # Denotes taxa that have associated National Park Service identification cards; † Denotes taxa that have associated USDA Forest Service identification cards; ED=September 2012 final early detection pest and plant species; P=already present within park; PP= probably present in 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 2012 final prioritization process); ?=considering adding to 2013 early detection list; U= unconfirmed if present in park; Parks include: Abraham Lincoln Birthplace National Historic Site (ABLI), Carl Sandburg Home National Historic Site (CARL), Chickamauga and Chattanooga National Military Park (CHCH), Cowpens National Battlefield (COWP), Cumberland Gap National Historical Park (CUGA), Fort Donelson National Battlefield (FODO), Guilford Courthouse National Military Park (GUCO), Kings Mountain National Military Park (KIMO), Little River Canyon National Preserve (LIRI), Mammoth Cave National Park (MACA), Ninety Six National Historical Site (NISI), Russell Cave National Monument (RUCA), Shiloh National Military Park (SHIL), and Stones River National Battlefield (STRI).

Scientific Name*	Common Name*	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
PESTS															
<i>Adelges tsugae</i> #	hemlock woolly adelgid		P	ED		P	ED				ED		ED		ED
<i>Agrilus planipennis</i> #	Emerald ash borer	ED	ED	ED	ED	ED	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	ED	ED	ED	ED	ED	ED
<i>Lymantria dispar</i> #	European gypsy moth	ED	ED	P/ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Pityophthorus juglandis</i> #	walnut twig beetle/Thousand Cankers Disease	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Sirex noctilio</i> #	Sirex woodwasp	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Tomicus piniperda</i> #	Common pine shoot beetle	ED			ED									ED	
AQUATIC PLANTS															
<i>Alternanthera philoxeroides</i> #	alligatorweed		ED	U/ED		L	U	ED		P			U/ED	U/ED	ED
<i>Alternanthera sessilis</i>	sessile joyweed														
<i>Didymosphenia geminata</i>	didymo														
<i>Egeria densa</i>	Brazilian elodea			U									U		
<i>Eichhornia crassipes</i>	common water hyacinth														
<i>Hydrilla verticillata</i> #	waterhyme/hydrilla		ED	U		ED		ED		ED		ED			
<i>Myriophyllum aquaticum</i>	brazilian watermilfoil		P	U										P	
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil		P	?			U			?			U/?		

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Najas minor</i>	brittle waternymph			U			U	PP		U		?	U		
<i>Nasturtium officinale</i>	watercress	L	L	U	L	P	U	L	L	U	U	L	U	L	U
<i>Nymphoides cristata</i>	crested floatingheart	L	L	L	L	L	L	L	L	L	L	L	L	L	L
<i>Potamogeton crispus</i>	curly pondweed			U			U			U			U		
<i>Salvinia molesta</i>	kariba-weed, aquarium water-moss	L	L	L	L	L	L	L	L	L	L	L	L	L	L
PLANTS															
<i>Acer platanoides</i> [†]	Norway maple	ED	?		L	ED	P	?	L		ED	L			
<i>Achyranthes japonica</i> [#]	Japanese chaff flower	ED				ED	ED				ED				ED
<i>Aegilops cylindrica</i>	jointed goatgrass	L	L	L	L	L	L	L	L	L	L	L	L	L	U
<i>Ailanthus altissima</i> [†]	tree of heaven	PP	P	P	P	P	U	P	P	P	P	PP	P	P	P
<i>Akebia quinata</i>	chocolate vine		L		L			P	L		L	L			
<i>Albizia julibrissin</i>	silk tree	PP	PP	P	P	P	P	P	P	P	P	P	P	P	P
<i>Alliaria petiolata</i> [†]	garlic mustard	PP/ED	ED	P	ED	P	ED	ED	ED	ED	P	ED	ED	ED	P
<i>Ampelopsis brevipedunculata</i>	Amur peppervine		P												
<i>Anthoxanthum odoratum</i>	sweet vernalgrass		P	P	P	P		P	PP	P	P	P		P	
<i>Arctium minus</i>	lesser burdock		P	P		U	U				P				P
<i>Arthraxon hispidus</i>	small carpgrass		P	P		U	P	P	P	P	P			P	
<i>Arundo donax</i>	giant reed				P						P				U
<i>Berberis thunbergii</i> [†]	Japanese barberry	P	P	P	ED	P	P	P	ED	?	P	ED	?	ED	ED
<i>Bromus tectorum</i>	cheatgrass					U	P		U	P	P		U	U	P
<i>Broussonetia papyrifera</i>	paper mulberry				P		U	P	U				U	P	
<i>Carduus nutans</i>	nodding plumeless thistle	P				P	P				P				P
<i>Cayratia japonica</i>	bushkiller	L	?	L	L	L	L	?	L	L	L	L	L	L	L
<i>Celastrus orbiculatus</i> [†]	Oriental bittersweet	P	P	P	ED	P	ED	P	ED	ED	P/ED	ED	ED	ED	ED
<i>Centaurea stoebe ssp. micranthos</i>	spotted knapweed	P				P					P				U
<i>Cirsium arvense</i> [†]	Canada thistle		ED		P	U/ED		ED	ED		ED	ED			
<i>Cirsium vulgare</i>	bull thistle	P	P	U	P	P	U			P	P	P			P

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Clematis terniflora</i>	sweet autumn virginsbower			P		P	P	P			P		P		P
<i>Commelina benghalensis</i>	tropical spiderwort	L	L	L	L	L	L	L	L	L	L	L	L	L	L
<i>Commelina communis</i>	Asiatic dayflower	P	P	P	P	P	P	P	P	P		P		P	
<i>Conium maculatum</i>	poison hemlock		P			U					P				P
<i>Crotalaria spectabilis</i>	showy rattlebox									P					
<i>Cuscuta japonica</i>	Japanese dodder	L	L	L	L	L	L	L	L	L	L	L	L	L	L
<i>Dioscorea oppositifolia/polystachia</i>	Chinese yam	PP/?	P	P	PP/?	P	P	P	P	P	P	?	P	P	P
<i>Dipsacus fullonum</i>	Fuller's teasel	P				P	U				P				P
<i>Elaeagnus angustifolia</i>	Russian olive				P			P							
<i>Elaeagnus pungens</i>	thorny olive			P				P				P			
<i>Elaeagnus umbellata</i> [†]	autumn olive	P	P	P	P	P	P	P	PP	ED	P	P	ED	ED	ED
<i>Eleusine indica</i>	Indian goosegrass		P	P	P	P	P		U		P		P	P	P
<i>Eragrostis curvula</i>	weeping lovegrass					U	U							U	P
<i>Euonymus alatus</i> [†]	burningbush	P	P	P	P	P	P	P	L	L	P	L	L	L	P
<i>Euonymus fortunei</i> [#]	winter creeper	P	P	P	P	U/ED	P	P	ED		PP	L			P
<i>Euphorbia cyparissias</i>	cypress spurge	L	L	L	L	L	L	L	L	L	U	L	L	L	L
<i>Fatoua villosa</i>	hairy crabweed														
<i>Firmiana simplex</i>	Chinese parasoltree														
<i>Galega officinalis</i>	professor-weed, goatsrue														
<i>Hedera helix</i>	English ivy	P	P	P	P	P	P	P	P	P	P	L	L	P	P
<i>Heimerocallis fulva</i>	orange daylily	P		P	P	P	P	P	U		P		P	P	P
<i>Heracleum mantegazzianum</i>	giant hogweed	L	L	L	L	L	L	L	L	L	L	L	L	L	L
<i>Humulus japonicus</i>	Japanese hop	L	L	L	L	L	L	L	U	L	L	L	L	L	L
<i>Hypericum perforatum</i>	common St Johnswort						U	P			P			P	P
<i>Imperata cylindrica</i> [†]	cogongrass	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED	ED
<i>Inula britannica</i>	British yellowhead														
<i>Ipomoea hederacea</i>	ivyleaf morning-glory			P	P	P	P		U	P	P			P	P

[illegible]

Scientific Name [*]	Common Name [*]	ABLI	CARL	CHCH	COWP	CUGA	FODO	GUCO	KIMO	LIRI	MACA	NISI	RUCA	SHIL	STRI
<i>Striga asiatica</i>	Asiatic witchweed	L	L	L	L	L	L	L	L	L	L	L	L	L	L
<i>Tamarix gallica</i>	French tamarisk														
<i>Triadica sebifera</i> [#]	Chinese tallow		?	ED	?			?	?	ED		ED			
<i>Tribulus terrestris</i>	puncturevine														
<i>Tussilago farfara</i>	coltsfoot					P									
<i>Vernicia fordii</i>	tungoil tree														
<i>Vinca major</i>	bigleaf periwinkle		P	P	P	P	U	P	U	P					P
<i>Viburnum dilatatum</i>	linden arrowwood	L	L	L	L	L	L	P	L	L	L	L	L	L	L
<i>Wisteria spp (floribunda, sinensis)</i> [#]	wisteria	ED	P	P	P	P	ED	P	P	ED	P	P	ED	P	ED
<i>Youngia japonica</i>	Oriental false hawksbeard								P						

Literature Cited

- 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://nbii-nin.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.

Appendix B: Contact lists for the Cumberland Piedmont Network (CUPN)

Appendix B, Table 1. National Park Service (NPS) contact information.

Park	Contact
Abraham Lincoln National Historic Site (ABLI)	Jennie Jones 2995 Lincoln Farm Road Hodgenville, KY 42748 Phone: (270) 358-3137 Email: Jennifer_L_Jones@nps.gov
Carl Sandburg Home National Historic Site (CARL)	Irene Van Hoff 81 Carl Sandburg Lane Flat Rock, NC 28731-8635 Phone: (828) 693-4178 Email: Irene_Van_Hoff@nps.gov
Chickamauga & Chattanooga National Military Park (CHCH)	Jim Szykowski P.O. Box 2128 Fort Oglethorpe, GA 30742 Phone: (423) 752-5213 Jim_Szykowski@nps.gov
Cowpens National Battlefield (COWP)	Kathy McKay P.O. Box 308 Chesnee, South Carolina 29323 Phone: (864) 461-2828 Email: Kathy_McKay@nps.gov
Cumberland Gap National Historical Park (CUGA)	Jenny Beeler P.O. Box 1848 Middlesboro, KY 40965 Phone: (606) 246-1110 Email: Jenny_Beeler@nps.gov
Cumberland Piedmont Network (CUPN)	Teresa Leibfreid (Plants) PO Box 8 Mammoth Cave, KY 42259 Phone: (270) 758-2135 Email: Teresa_Leibfreid@nps.gov
	Kurt Helf (Pests) PO Box 8 Mammoth Cave, KY 42259 Phone: (270) 758-2163 Email: Kurt_Helf@nps.gov
Fort Donelson National Battlefield (FODO)	Bill Barley P.O. Box 434 174 National Cemetery Drive Dover, TN 37058-0434 Phone: (931) 232-5706 x 109 Email: Bill_Barley@nps.gov

Appendix B, Table 1 (continued). National Park Service (NPS) contact information.

Park	Contact
Guilford Courthouse National Military Park (GUCO)	Steve Ware 2332 New Garden Road Greensboro, NC 27410-2355 Phone: (336) 288-1776
Kings Mountain National Military Park (KIMO)	Chris Revels 2625 Park Road Blacksburg, South Carolina 29702 Phone: (864) 936-7921 Email: Chris_Revels@nps.gov
Little River Canyon National Preserve (LIRI)	Mary Shew 4322 Little River Trail NE, Suite 100 Fort Payne, AL 35967 Phone: (256) 845-9605 Email: Mary_Shew@nps.gov
Mammoth Cave National Park (MACA)	Brice Leech P.O. Box 7 Mammoth Cave, KY 42259 Phone: (270) 758-2142 Email: Brice_Leech@nps.gov
Ninety Six National Historic Site (NISI)	Tim Cruze 1103 Highway 248 Ninety Six, SC 29666 Phone: (864) 543-4068 Email: Tim_Cruze@nps.gov
Russell Cave National Monument (RUCA)	Mary Shew 3729 County Road 98 Bridgeport, AL 35740 Phone: (256) 495-2672 Email: Mary_Shew@nps.gov
Shiloh National Military Park (SHIL)	Marcus Johnson 1055 Pittsburg Landing Road Shiloh, TN 38376 Phone: (731) 689-5275 Email: Marcus_Johnson@nps.gov
Stones River National Battlefield (STRI)	Troy Morris 3501 Old Nashville Highway Murfreesboro, TN 37129 Phone: (615) 893-9501 Email: Troy_Morris@nps.gov

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 CUPN, at least one the following individuals and/or agencies must be contacted to report the new discovery (Table 2 and Table 3).

Appendix B, Table 2. Federal contact information for reporting new noxious weed occurrences.

Agency and Contact	State	Weed Type	Noxious Weed Lists
Animal and Plant Health Inspection Service (APHIS) : National Noxious Weed Program Jeff Head, State Plant Health Director 1836 Glynwood Drive 1st Floor ADP RM Prattville AL 36066 Jeffrey.L.Head@aphis.usda.gov Phone: (334)-358-4920 Bill Kauffman, State Plant Health Director 1506 Klondike Road, Suite 306 Conyers, GA 30094 william.c.kauffman@aphis.usda.gov Phone: (770)-860-4020 Deborah Stewart, State Plant Health Director 930 Main Campus Dr. Ste 200 Raleigh, NC 27606 deborah.j.stewart@aphis.usda.gov Phone: (919)-855-7600 Yvonne Demarino, State Plant Health Director 1410 Kensington Square Ct., Suite 101 Murfreesboro, TN 37130-6902 Yvonne.M.Demarino@aphis.usda.gov Phone: (615)-907-3357 Bernetta Barco State Plant Health Director 5657 South Laburnum Avenue Richmond, VA 23231-4536 bernetta.g.barco@aphis.usda.gov Phone: (804)-771-2042	AL GA NC, SC TN, KY VA	Federal Noxious¹	Federal Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=Federal
Alabama Department of Agriculture & Industries: Division of Plant Industry Dennis Barclift, Plant Pest Administrator Email: dennis.barclift@agi.alabama.gov Phone: (334)-240-7225	AL	State Noxious ²	Alabama State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=01
Georgia Department of Agriculture: Plant Industry Division Trey Clark, Plant Health Inspections and Pest Surveys Email: James.Clark@agr.georgia.gov Phone: (770)-228-7215	GA	Federal Noxious ³	Federal Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=Federal

Agency and Contact	State	Weed Type	Noxious Weed Lists
Kentucky Department of Agriculture: Noxious Weed Control Program Kevin Ferguson Email: kevin.ferguson@ky.gov Phone: (502)-573-0282	KY	State Noxious	Kentucky State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=21
North Carolina Department of Agriculture & Consumer Services: Division of Plant Industry Rick Iverson, Weed Specialist Email: Rick.Iverson@ncagr.gov Phone: (919)-707-3749 Can also call toll free number to report a new invasive species: Phone: 1-800-206-9333 or report by email: newpest@ncagr.gov	NC	State Noxious	North Carolina State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=37
Clemson Department of Plant Industry Steve Compton Email: scompto@clemson.edu General report-a-sighting phone number: (864)-646-2130	SC	State Noxious	South Carolina Exotic Pest Plant Council; http://www.se-eppc.org/southcarolina/invasivePlants.cfm South Carolina State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=45
Tennessee Cooperative Weed Management Area (TNCWMA) Report a sighting here : Tennessee CWMA Report a Sighting; http://eppserver.ag.utk.edu/Extension/TNCWMA/reporting.html	TN	State Noxious	Tennessee State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=47
Virginia Department of Agricultural and Consumer Services : Plant Industry Services Debra Martin, Cooperative Agricultural Pest Survey Coordinator Email: debra.martin@vdacs.virginia.gov Phone: (804)-786-3515	VA	State Noxious	Virginia State-listed Noxious Weeds; http://plants.usda.gov/java/noxious?rptType=State&statefips=51

¹ In the United States, the legislation that defines a noxious weed is the Federal Noxious Weed Act, 1974. It defines a noxious weed as, “any living stage (including seeds and reproductive parts) of a parasitic or other plant of a kind which is of foreign origin, is new to or not widely prevalent in the U.S., and can directly or indirectly injure crops, other useful plants, livestock, poultry or other interests of agriculture, including irrigation, navigation, fish and wildlife resources, or the public health” (United States Congress 1974).

² The Federal Noxious Weed Act, 1974, does not invalidate any state or local laws regulating noxious weeds. States are encouraged to have parallel legislation and to add species that may only be noxious within their areas. Most states have parallel legislation as a part of their agricultural regulation, and many defer to the federal list and regulatory language.

³ “Plants listed on the Federal Noxious Weed List are prohibited from sale or distribution in Georgia. This includes varieties of *Imperata cylindrica* (e.g. ‘Japanese Bloodgrass’, ‘Red Baron’)” (Georgia Department of Agriculture 2008).

Appendix B, Table 3. State cooperating entomologist/taxonomist contact information for reporting new pest occurrences.

Agency/Institution and Contact	State	Notes
Forest Health Protection, USDA Forest Service Forrest Oliveria, Field Office Representative Email: foliveria@fs.fed.us Phone: (318) 473-7294 Bill Carothers, Field Office Representative Email: wcarothers@fs.fed.us Phone: (828) 257-4321	AL GA, KY, NC, SC, TN and VA	Field office in Pineville, LA also serves LA, MS, TX, OK, and AR Field office in Asheville, NC and Regional Office in Atlanta, GA serves all of the states listed.
Auburn State University, Insect Taxonomist Charles Ray Email: raychah@auburn.edu, raychah@aces.edu Phone: (334) 844-3836	AL	
Georgia Forestry Commission, Forest Health Coordinator James Johnson Email: jjohnson@gfc.state.ga.us Phone: (706) 542-9608	GA	
University of Kentucky, State Plant Regulatory Official John Obrycki Email: john.obrycki@uky.edu Phone: (859) 257-5838	KY	
North Carolina Department of Agriculture & Consumer Services, Staff Entomologist K. Lane Kreitlow Email: Lane.Kreitlow@ncagr.gov Phone: (919) 733-6932 x237	NC	
South Carolina Forestry Commission, Forest Health Program Coordinator Laurie Reid Email: lreid@forestry.state.sc.us Phone: (803) 896-8830	SC	
Division of Regulatory Service, State Entomologist Steve Powell Email: steve.powell@tn.gov Phone: (615) 837-5139	TN	

Agency/Institution and Contact	State	Notes
Virginia Tech Insect Identification Lab, Manager Eric Day Email: idl原因@vt.edu Phone: (540) 231-4899	VA	

Literature Cited

Georgia Department of Agriculture. 2008. Summary of Plant Protection Regulations. 6 pp.
<http://www.nationalplantboard.org/docs/summaries/georgia.pdf> (accessed on-line Sept. 21, 2012).

United States Congress. 1974. Federal Noxious Weed Act. 2801-2814.

Appendix C: CUPN Invasive Species Early Detection Field Guide Copyright Restrictions by Photographer

Last updated on October 22, 2012

Bugwood.org

“Images included in the Bugwood Network Image Archives (ForestryImages.org, IPMImages.org, Invasive.org, and InsectImages.org) are made available under a [Creative Commons](https://creativecommons.org/licenses/by/4.0/) license. Individual photographers retain all rights to images included in the archive. Creative Commons definitions: 1) You must attribute the work in the manner specified (but not in any way that suggests endorsement); 2) You may not use this work for commercial purposes unless permission is granted by the photographer or copyright owner.” “Anytime an image from the Bugwood Network image archive is used, IT MUST BE CITED.” See [Forestry Images Image Usage](https://www.bugwood.org/forestryimages/image-usage/) instructions for more information.

Pests

Asian longhorned beetle

UGA 2159062: adult Asian long-horned beetle
UGA 1393011: oviposition niche
UGA 1393002: exit hole - 3/8"
UGA 3225081: boring dust
UGA 5016094: leaf damage
UGA 5203071: adult whitespotted sawyer
UGA 0014056: female (middle), male (bottom) compared to cottonwood borer (top)

Common pine shoot beetle

UGA 2105040 : adult, lateral view
UGA 1292071 : graphic, posterior teeth
UGA 1300028 : exit holes of newly emerging adult pine shoot beetle
UGA 1300029 : entrance turrets of adult pine shoot beetle on pine terminal
UGA 1300032 : pine tree with many dying, flagging terminals
UGA 1300034 : crown damage

Emerald ash borer

UGA1241011: adult on penny
UGA 5016058: adult abdominal view
UGA 1372003: "D" shaped exit hole and a woodpecker hole
UGA 5016053: bark fissure, revealing galleries
UGA 1301042: crown dieback
UGA 5147090: galleries
UGA 5016041: bronze birch borer
UGA 2133022: six-spotted tiger beetle
UGA 5022085: ground beetle

European gypsy moth

UGA 0488025: adult moths, male and female
UGA 5020018: adult moth
UGA 5445757: larva, caterpillar
UGA 1454012: adult moth and egg sac
UGA 1370017: male and female pupae
UGA 1233209: eastern tent caterpillar larva, caterpillar
UGA 1398247: forest tent caterpillar, late-instar caterpillar
UGA 1394023: fall webworm larva, caterpillar
UGA 0907030: eastern tent caterpillar, silken tent in a tree crotch

Hemlock woolly adelgid

UGA 3225077: adults
UGA 5018073: crawler
UGA 5125062: needle damage
UGA 2167012: tree decline and mortality
UGA 1122010: close-up of elongate hemlock scale
UGA 1122011: elongate hemlock scale

Sirex woodwasp

UGA 5314009: adult female
UGA 5314012: adult male
UGA 1349007: crown dieback
UGA 2166052: resin beads
UGA 1231229: exit holes
UGA 5006017: adult paper wasp
UGA 5007028: adult cicada killer

Thousand Cankers Disease

UGA 5406088: Branch cankers that have developed around twig beetle galleries. *Geosmithia* can be seen fruiting in the center gallery. Associated with the walnut twig beetle.
UGA 5406094: Canker development around walnut twig beetle gallery in English walnut.
UGA 5406047: Black walnut showing early stage external symptoms of thousand cankers. A few branches in the crown are showing flagging and there is crown thinning. Associated with walnut twig beetle.
UGA 5406045: Black walnut in end stage of thousand cankers. Photograph June 25, 2009; tree was removed one week later. Associated with walnut twig beetle.
UGA 5406073: Exit wounds made by adults.

Plants

Alligatorweed

UGA 2117075: infestation
UGA 1539028: foliage
UGA 5225063: flowers, stems
UGA 4723003: flower
UGA 5242054: prostrate knotweed, stems and flowers

Bush honeysuckles

UGA 5453350: Bell's honeysuckle, flowers
UGA 1237035: Amur honeysuckle, leaves and fruit
UGA 2308047: Morrow's honeysuckle, flowers
UGA 5448038: Tatarian honeysuckle, flowers
UGA 1330043: listed as Tatarian honeysuckle (misidentified), fruits
UGA 5447977: Amur honeysuckle, bark

Chinaberrytree

UGA 2307036: trees
UGA 0016028: leaf
UGA 2307033: bark
UGA 1380478: flowers
UGA 5424036: fruits

Chinese tallow

UGA 2151095: infestation
UGA 2307038: foliage and flowers
UGA 0016234: fall foliage
UGA 5407195: foliage, showing paired glands
UGA 2151097: bark
UGA 0016034: Ripening fruit and waxy coated seeds
UGA 0008318: eastern cottonwood, foliage
UGA 5242091: eastern cottonwood, flower
UGA 5424047: eastern cottonwood, fruits

Hydrilla

UGA 5345047: infestation
UGA 5399498: foliage
UGA 5399531: leaves
UGA 5396707: common elodea, leaves
UGA 5447183: Brazilian waterweed, flowers and foliage

Japanese chaff flower

UGA 5443694: infestation
UGA 5427471: flower, leaf

UGA 5427353: flowers, leaves
UGA 5427352: fruit(s)
UGA 5396512: redroot pigweed, foliage

Japanese climbing fern

UGA 5005022: plants, climbing tree
UGA 5238093: foliage
UGA 2122082: fertile fronds
UGA 1346033: spore-producing fronds
UGA 1461105: old world climbing fern, fertile frond

Phragmites/common reed

UGA 5241085: plants
UGA 0016216: plants, dormant aspect
UGA 5241088: flowers
UGA 1237029: giant reed, plants
UGA 5391907: giant reed, leaf sheaths
UGA 2132033: giant reed, flower

Purple loosestrife

UGA 1459323: infestation
UGA 1459315: single stem
UGA 1552184: foliage
UGA 0022075: inflorescence
UGA 0024065: close-up of inflorescence

Tropical soda apple

UGA 4054012: plants
UGA 5403102: foliage
UGA 2254059: flowers
UGA 1624037: fruits
UGA 5294047: fruits
UGA 1120247: Carolina horsenettle, leaves and flowers

Wavyleaf basketgrass

UGA 5389748: close-up of foliage
UGA 5389747: infestation
UGA 5389751: spikelets

Winter creeper

UGA 5422001: plants
UGA 5330077: plants, climbing up tree
UGA 2307141: foliage
UGA 5440007: vinca, underside and topside of leaves
UGA 5248094: vinca, flower

Wisteria (Japanese & Chinese)

UGA 5351097: plants

UGA 2307174: foliage

UGA 2188058: flowers

UGA 2307175: fruits

UGA 5393172: American wisteria, flowers

UGA 1553043: trumpet honeysuckle/trumpet creeper, leaves and flowers

Individual Photographer Copyrights:

All photos listed below may only be used for noncommercial and educational purposes within the realm of the Early Detection of Invasive Species Surveillance and Monitoring Plan. Any other uses must be negotiated with the individual photographers.

Barnes, Thomas G.

© Thomas G. Barnes, University of Kentucky: American climbing fern, fronds

- Written permission received from the author in 2012.
- Photograph reproduced from USDA PLANTS Database

<http://plants.usda.gov/java/profile?symbol=LYPA3>. (accessed on-line April 13, 2012).

Any use of copyrighted images requires notification of the copyright holder, though they may be freely used for any non-commercial purpose. Commercial use must be disclosed to and conditions of use negotiated with the copyright holder. Use by non-profit organizations in connection with fund-raising or product sales is considered commercial use. If you want to use this picture in any way, please contact Thomas G. Barnes.

Please credit the artist, original publication if applicable, and the USDA-NRCS PLANTS Database. The following format is suggested and will be appreciated:

Thomas G. Barnes @ USDA-NRCS PLANTS Database / Barnes, T.G., and S.W. Francis. 2004. *Wildflowers and ferns of Kentucky*. University Press of Kentucky.

Baskauf, Steven J.

© 2004 Steve Baskauf: sweet breath of spring, flowers

© 2003 Steve Baskauf: sweet breath of spring, fruit

- Written permission received from the author in 2008.

Photographs reproduced from [CAS Vanderbilt Bioimages](#). Any other uses must be negotiated with the copyright owner by writing to steve.baskauf@vanderbilt.edu. Photo credit must be given.

LaBonte, Jim

Oregon Department of Agriculture: top and side view of the walnut twig beetle

Photos reproduced from [Thousand Cankers and Black Walnut Disease](#). Photo credit must be given.

Landry, Louis-M.

© 2005 Louis-M. Landry: blue vervain

- Written permission received from the author in 2009.

Photographs reproduced from [Calphotos](#). Any other uses must be negotiated with the copyright owner by writing to Louis_Landry@videotron.ca. Photo credit must be given.

Matson, Steve

© 2009 Steve Matson, phragmites stem

- Written permission received from the author in 2012.

Photograph reproduced from [Calphotos](#). The thumbnail photo (128x192 pixels) on this page may be freely used for personal or academic purposes without prior permission under the Fair Use provisions of US copyright law as long as the photo is clearly credited with © 2009 Steve Matson. For other uses, or if you have questions, contact Steve Matson, ssmat@sbcglobal.net. Photo credit must be given.

Mehrhoff, Leslie J.

© Les Mehrhoff, 2008-2010 (flowers)

© Les Mehrhoff, 2008-2010 (fruits)

Photographs reproduced from [Discover Life](#). Photo credit must be given.

“You may use our images in hard-copy publications, reports, and CD's that are not sold and are not used for commercial purposes if

1. you credit each image individually with the following text:
Copyright owner's name / www.discoverlife.org
2. the above credit has a relative font size no smaller than one size below the majority of text on your page
3. the resolution of the image does not exceed 640 x 640 pixels
4. your publication is suitable for children and does not advocate hatred or crimes against others
5. you do not use more than 20 such images in your product”

Saulys, Eleanor S.

© 1999 Eleanor S. Saulys: swamp loosestrife

- Written permission received from the author in 2009.

Photograph reproduced from [Connecticut Botanical Society](#). Any other uses must be negotiated with the copyright owner by writing to sam.saulys@comcast.net. Photo credit must be given.

Solheim, Stephen L.

© Stephen L. Solheim

Robert W. Freckmann Herbarium, University of Wisconsin-Stevens Point

Photograph reproduced from the Wisconsin Plants web site, [Robert W. Freckmann Herbarium](#).

These data and maps are copyrighted to the Robert W. Freckmann Herbarium, University of Wisconsin-Stevens Point. The Herbarium shall remain the sole and exclusive owner of all rights, title, and interest in and to all specifically copyrighted information created and posted for inclusion in this system. Use and reproduction of these data and/or maps is authorized for educational or other noncommercial purposes without prior permission from the copyright holder but acknowledgment must be cited as Robert W. Freckmann Herbarium, University of Wisconsin-Stevens Point. Wisconsin Plants web site (<http://wisplants.uwsp.edu>). Use or reproduction of the data and/or maps for commercial purposes is prohibited without prior written permission of the copyright holders. Please e-mail the Herbarium's web master (mblack@wisc.edu) for permission requests. See Photographer Information for permission to use images.

Stoughton, Thomas

© 2008 Thomas Stoughton: fireweed

- Written permission received from the author in 2009.

Photograph reproduced from [Calphotos](#). Any other uses must be negotiated with the copyright owner by writing to tstoughton@fs.fed.us. Photo credit must be given.

Walker, Ken

2006 K. Walker: Pigeon horntail (*Tremex columbia*)

Photograph reproduced from the Pest and Diseases Image Library, [PaDIL](#). Material from the PaDIL website can be saved or printed for research, plant health education, plant health promotion and for personal use. Authors (or the original copyright holder) retain the rights to use the illustrations in their future publications and works. PaDIL does not own copyright on any of the images on the PaDIL website. Material includes information, text and images in this website and its sub-websites. The material is not available to be sold or re-sold without prior written permission from all of the participating institutions. Photo credit must be given.

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 910/124412, April 2014

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™