Early Detection of Invasive Species: A US National Park Service Approach

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Abstract

In 2008, the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN) of the US National Park Service (NPS) began early detection of invasive species surveillance monitoring throughout 20 parks in the Northeast Region. This monitoring effort is a component of the nationwide NPS Inventory and Monitoring Program. Early detection monitoring of incipient invasive plants, animals, and diseases was ranked among the top priorities in the ERMN and the NETN due to the known ecological impacts of invasive species on ecosystems, including loss of threatened and endangered species, altered community structure and composition of terrestrial and aquatic communities, and reduction in overall species diversity. While long-term changes associated with invasive species are being assessed through other monitoring protocols, it is also critical to detect new populations of invasive species early in their invasion of incipient and sensitive habitats. Only when invasions are caught early will the chance of eradication remain high. Early detection monitoring in the ERMN and NETN includes three main components: (1) creation of individual park early detection species lists; (2) opportunistic surveillance monitoring of invasive plant and forest pest species that focus on educating monitoring field crews, cooperators, volunteers, and resource managers on invasive species identification; and (3) development and maintenance of a coherent framework for reporting and disseminating information on potential infestations. These components allow park resource managers to assess each invasive species' early detection on an individual basis and target limited management resources and coordination toward the highest priority risks. During invasive species early detection surveillance monitoring in 2008 and 2009, a total of 20 new invasive plant and pest occurrences were documented at five parks in which data were collected. Of the 15 new plant occurrences, 10 consisted of single specimens and/or small populations that were successfully hand-pulled or chemically treated.

Resumen

En 2008, las redes de los ríos y las montañas del Este (ERMN) y templados del Nordeste (NETN) del Servicio de Parques Nacionales (NPS) comenzó la detección temprana de especies invasoras con la monitorización y vigilancia a lo largo de veinte parques de la región Nordeste. Este esfuerzo de monitoreo es un componente a través de la nación del Programa de Inventario y monitorea del NP.

[1] Presenter.

La detección temprana de incipientes plantas invasoras, animales y enfermedades se encuentra entre las principales prioridades en la ERMN y NETN debido a los conocidos impactos ecológicos de las especies invasoras en los ecosistemas, incluyendo la pérdida de especies amenazadas y en peligro de extinción, alterando la estructura de las comunidades y la composición de los sistemas terrestres y comunidades acuáticas, y la reducción de la diversidad de especies en general. Si bien los cambios a largo plazo asociados con las especies invasoras se están evaluando a través de otros protocolos de monitoreo, también es fundamental coger nuevas poblaciones de especies invasoras al comienzo de su invasión de nuevos y sensibles hábitats. Sólo cuando se detecta a tiempo las invasiones la posibilidad de la erradicación siguen siendo altas. La detección temprana en el ERMN y NETN incluye tres componentes principales: (1) creación de listas de parques individuales de detección temprana de especies; (2) vigilancia oportunista de plantas invasoras y especies forestales plaga que se centran en educar a los equipos de seguimiento en el campo, colaboradores, voluntarios y administradores de recursos sobre la identificación de especies invasoras; y (3) el desarrollo y mantenimiento de un marco coherente de información y difusión de información sobre infestaciones potenciales. Estos componentes permiten a los administradores de recursos del parque evaluar detección precoz de cada especie invasora de de forma individual y orientar los limitados recursos de manejo y coordinación hacia los riesgos más alta prioridad. Durante seguimiento, vigilancia y detección temprana de las especies invasoras en 2008 y 2009, un total de veinte nuevas casos de plantas y plagas invasoras fueron documentados en cinco parques en los que se obtuvieron datos. De los quince nuevos acontecimientos de plantas, diez consistieron en muestras individuales y/o poblaciones pequeñas y fueron exitosamente controladas a mano o tratados químicamente.

Background

During 2008, the Eastern Rivers and Mountains Network (ERMN) and Northeast Temperate Network (NETN) of the US National Park Service (NPS) began early detection of invasive species surveillance monitoring throughout 20 parks in the Northeast Region. This monitoring effort is a component of the ERMN and NETN Vital Signs monitoring program (Marshall and Piekielek 2007; Mitchell et al. 2006), which is part of the nationwide NPS Inventory and Monitoring Program (IMP) (Fancy et al. 2009). The following parks are included in the Early Detection of Invasive Species: Surveillance, Monitoring, and Rapid Response Protocol.

Eastern Rivers and Mountains Network

All ERMN parks (Figure 1): Allegheny Portage Railroad National Historic Site, Bluestone National Scenic River, Delaware Water Gap National Recreation Area, Fort Necessity National Battlefield, Friendship Hill National Historic Site, Gauley River National Recreation Area, Johnstown Flood National Memorial, New River Gorge National River, and Upper Delaware Scenic and Recreational River.

Northeast Temperate Network

All NETN parks (Figure 2): Acadia National Park, Appalachian National Scenic Trail, Boston Harbor Islands National Recreation Area, Marsh-Billings-Rockefeller National Historical Park, Minute Man National Historical Park, Morristown National Historical Park, Roosevelt-Vanderbilt National Historic Sites, Saint-Gaudens National Historic Site, Saugus Iron Works National Historic Site, Saratoga National Historical Park, and Weir Farm National Historic Site.

Introduction

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). Early detection followed by rapid response can detect and eradicate incipient populations of invasive species before they have a chance to become widely established, eliminating the need for costly and resource-intensive control programs (Ashton and Mitchell 1989; OTA 1993; Atkinson 1997; Myers et al. 2000; Timmins and Braithwaite 2001; Harris et al. 2001; Rejmánek and Pitcairn 2002). Only when invasions are caught early will the chance of eradication remain

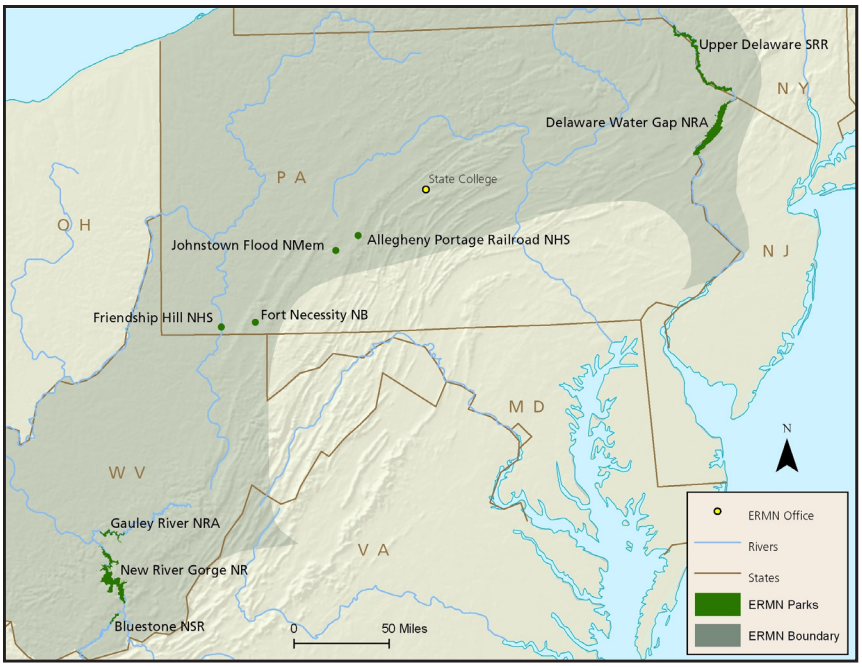

Figure 1. Location of parks in the Eastern Rivers and Mountains Network (ERMN).

high (Rozenfelds et al. 1999; NISC 2008). In addition to saving money, Early Detection and Rapid Response (EDRR) efforts minimize ecological damage by preventing habitat fragmentation and ecosystem degradation associated with large or widespread infestations of invasive species populations and related management activities (Smith et al. 1999; Timmins and Braithwaite 2001).

One of the most vital steps in confronting new invasive species problems is to know they exist (FICMNEW 2003). EDRR 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 EDRR System for Invasive Plants (FICMNEW 2003). Next to prevention, EDRR is a critical second defense against the establishment of invasive populations" (NISC 2008).

To understand the benefits of early detection, it is easier to calculate the costs of an invasion where early detection was not performed. Damages associated with alien invasive species effects and their control amount to approximately $120 billion per year (Pimentel et al. 2005). For example, the total cost of destruction by introduced rats on farms in the United States 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 US (Pimentel et al. 2005). The chestnut blight fungus (*Cryphonectria parasitica* (Murrill) ME Barr) and the virtual elimination of the American chestnut (*Castanea dentata* (Marsh) Borkh.) 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 longer-term costs and consequences (MacDonald et al. 1989; Braithwaite 2000). EDRR success stories include

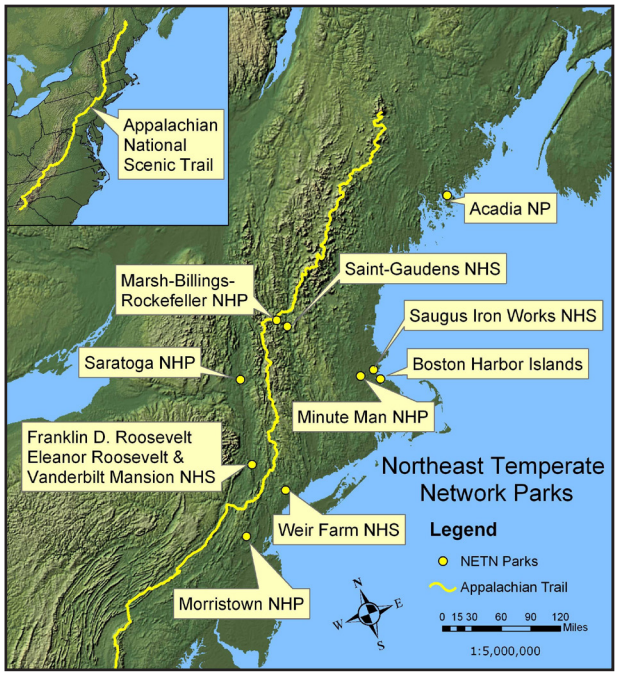

Figure 2. Location of parks in the Northeast Temperate Network (NETN).

restharrow (*Ononis alopecuroides* L.) in San Luis Obispo County, California (Tu 2002a); Egeria (*Egeria densa* Planch.) in the Connecticut River (Tu 2002b); and water hyacinth (*Eichhornia crassipes* (Mart.) Solms) and parrot-feather watermilfoil (*Myriophyllum aquaticum* (Vell.) Verdc.) in the Shawnee National Forest, Mississippi (Corey 2008).

Measurable Objectives

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

The focus of early detection monitoring in the ERMN and NETN began with surveillance monitoring 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. The protocol also provides a coherent framework for reporting and disseminating information on potential infestations.

The primary monitoring objective is to detect incipient populations (that is, small or localized populations) and new introductions of target invasive species on each park's early detection list through opportunistic observations before the species become established.

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

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

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

Methods

Although a brief overview of the invasive species early detection (ISED) method is provided here, a detailed explanation of the background, rationale, and methods, in addition to Standard Operating Procedures, are provided in the Early Detection of Invasive Species: Surveillance Monitoring and Rapid Response Protocol (Keefer et al. 2010). Details regarding 2008–2009 early detection information and associated rapid responses are provided in the 2008–2009 annual summary report (Keefer 2010). Both reports are available online at: http://science.nature.nps.gov/im/units/ermn.

Selecting early detection species

The process for selecting a short list of invasive species for inclusion in the ISED program for each park in the ERMN consisted of four main steps: (1) review existing park datasets and literature and compile a list of all invasive plant and pest species known or thought to occur in the parks; (2) eliminate all common and well-established species as candidates for "early detection;" (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 ISED list; and (4) conduct more extensive research on each candidate species and consult with park natural resource managers to narrow down and finalize each park ISED list (Keefer et al. 2010). At the conclusion of this process, each park's final ISED list generally consisted of between 10 and 20 species.

Opportunistic sampling

"Every person working or recreating in a national park has the potential to serve as an early detector" (Williams et al. 2007). Knowledgeable crew members provide an additional "set of eyes and ears" to detect invasive species occurrences

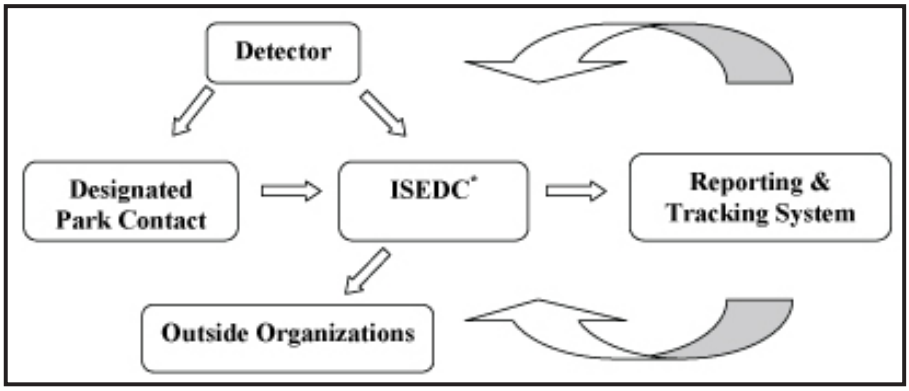

Figure 3. Early Detection of Invasive Species: Surveillance Monitoring and Rapid Response Protocol alert system. *Invasive Species Early Detection Coordinator (ISEDC).

while they are collecting data at monitoring sites, walking to and from monitoring sites, and driving along park roads. Invasive plants and pests present on each park's ISED list are sought during routine vegetation (Perles et al. 2010; Tierney et al. 2009), benthic macroinvertenrate (Tzilkowski et al. 2010) and water quality, and streamside bird (Mattsson and Marshall 2010) monitoring. Park natural resource managers, NPS Exotic Plant Management Teams (EPMTs), volunteers, and other NPS employees with scientific backgrounds also serve as early detectors during daily park activities.

Invasive Species Early Detection Field Guide

To assist with the identification of early detection species, ISED guides were provided to monitoring crews and interested parties. Hand-held, weather proof pocket guides (Invasive Plants Field and Reference Guide: An Ecological Perspective of Plant Invaders of Forests and Woodlands: http://www.treesearch.fs.fed.us/pubs/20715) were provided cost-free by the US Forest Service, in addition to a supplemental identification field guide developed by the ERMN, which were in combination used to distribute target species identification information. Production of the Early Detection of Invasive Species Surveillance Monitoring Field Guide and nine species cards was completed in summer 2009 and six new species cards were added in spring 2010. Each completed species card, as well as the entire field guide, are posted on the ERMN website and are available for download at: http://science.nature.nps.gov/im/units/ermn/monitoring/earlydetection.cfm.

Alert system

Data acquired from ISED is time sensitive and all new detections are immediately reported through the appropriate chain of command. Each observer or monitoring crew leader is responsible for alerting the designated park contact and Invasive Species Early Detection Coordinator (ISEDC) to all new species detections. In cases where noxious weeds or high-priority pests are detected, the coordinator will follow up with each designated park contact and may assist with alerting relevant outside agencies. The reporting and tracking system also serves as an alert system and enables anyone to sign-up to receive alerts when a new species is detected in user-chosen counties and/or states. Figure 3 depicts the Early Detection of Invasive Species: Surveillance Monitoring and Rapid Response Protocol alert system.

Reporting and tracking

The Early Detection and Distribution Mapping System (EDDMapS), in conjunction with the ERMN 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 pertinent information. To view the current ERMN website and EDDMapS, visit: http://science.nature.nps.gov/im/units/ermn/monitoring/EarlyDetection.cfm and http://www.eddmaps.org, respectively.

Rapid response

Rapid responses to invasions are effective and can prevent the spread and permanent establishment of invasive species. Coordinating and/or executing a rapid response is primarily the responsibility of the 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 EPMTs,

agencies such as the Bureau of Plant Industry and the Animal and Plant Health Inspection Service (APHIS) within the USDA, local weed management organizations, Network and park personnel, as well as park interns. Each response is based on the individual needs of the park and the resources available (Keefer et al. 2010).

Is the ISED Protocol Working?

During invasive species early detection surveillance monitoring in 2008 and 2009, 20 new invasive plant and pest occurrences were documented at five parks in the ERMN by the vegetation monitoring crew, Delaware Water Gap National Recreation Area Biologist, New River Gorge National River Biological Technician, and APHIS (Keefer 2010). New species occurrences included Japanese barberry (*Berberis thunbergii* DC.), narrowleaf bittercress (*Cardamine impatiens* L.), privet species (*Ligustrum* L.), gypsy moth (*Lymantria dispar* L.), Amur corktree (*Phellodendron amurense* Rupr.), Japanese knotweed (*Polygonum cuspidatum* Siebold and Zucc.), linden arrowwood (*Viburnum dilatatum* Thunb.), emerald ash borer (*Agrilus planipennis* Fairemaire), and viburnum leaf beetle (*Pyrrhalta viburni* Paykull) (Keefer 2010). Of the 15 new plant occurrences, 10 consisted of single specimens and/or small populations that were hand-pulled or chemically treated (Keefer 2010).

Conclusion and Future Directions

While discovering every new incipient invasive species is not probable, EDRR increases the chance of eradicating new species before they have a chance to become established and decreases the time and resources devoted to a generally uphill battle. In addition, recognizing and identifying organizational strengths and limited resources is crucial to developing a successful invasive species EDRR system. The four key components for this type of system are: (1) early detection species lists; (2) educational materials or a way to teach and present species identifying characteristics; (3) an alert system; and (4) a plan for rapid response. With these four components in place, it is possible for any organization, regardless of size and resources, to create a simple invasive species EDRR system to help cope with myriad future invaders.

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. Volunteers, park maintenance crews, and local organizations could also be trained to aid in the early detection effort. The more knowledgeable "eyes and ears" in our national parks, the better chance we have of discovering and eradicating future invaders.

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