Assessing the invasive plant issue

By Pamela Benjamin and Ron Hiebert

As a major focus of the Natural Resource Challenge, management of alien species has begun to receive an increasing amount of support throughout the National Park Service (NPS). In particular, the establishment of Exotic Plant Management Teams (EPMTs) is a major contribution to increasing our ability to control invasive weeds. However, an array of assessment tools is needed in order to ensure that these teams, as well as monitoring network and park staffs, target the control of invasive plants of highest priority, in areas of greatest value, and with the highest potential for restoration.

Several approaches have begun to provide consistency in the inventory and mapping of weeds (Beard et al. 2001, Benjamin 2001), to establish guidelines for long-term monitoring (Hiebert 2002), and to assist in the assessment of the restoration potential of weed-infested sites (Benjamin 2004). Yet, despite these substantial advances, limitations remain that significantly jeopardize our attempt to win the battle against invasive plants.

This article focuses on the role of weed assessments in developing effective weed management strategies at multiple levels throughout the National Park Service. It also summarizes the benefits of emerging guidelines for the inventory, mapping, and monitoring of invasive weed species, and for assessing the restoration potential of weed-infested areas. Furthermore, it provides specific recommendations on future steps needed to ensure that the National Park Service continues to serve its role in preserving the natural and cultural heritage of this nation.

Importance of establishing a baseline

Most parks lack complete weed inventories, which makes assessing impacts and establishing management priorities difficult. By far, the overriding benefit of evaluating weed infestations in parks is the resulting ability of resource managers to analyze and prioritize invasive plant management needs, and to appropriately direct work efforts and resources. As such, understanding baseline conditions can enhance the time and cost-effectiveness of invasive plant management actions. Additionally, documenting areas not yet infested is as important as documenting the locations of where weeds occur. This information affords resource managers the greatest opportunity to be proactive and to employ the most cost-effective and efficient of all weed management strategies—prevention.

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Assessing invasive plant issues is not a simple undertaking and requires the integration and understanding of complex physical, biological, and ecological factors. Resource managers need to address several basic, but often difficult-to-answer, questions before effective weed management strategies can be identified and implemented. These questions can be categorized and include:

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- **Inventory, mapping, and monitoring**
  What is the distribution and relative abundance of weeds within and adjacent to a park? What physical and biological factors are contributing to the distribution? How is the distribution of weeds changing over time?

- **Identifying priority species and priority treatment areas**
  Which species are most invasive or represent the greatest threat to park resources? What is the biology of the targeted weed species? Which areas are currently not infested by alien plants? Which areas have the highest ecological significance or integrity?

- **Identifying the restoration potential of an area**
  What type of disturbance or activity has allowed invasive species to become established? What is the potential for a site to be restored to its natural condition and maintained thereafter? What is the restoration feasibility of a weed-infested site? What types of management actions are needed? What level of expertise is required to ensure recovery of the targeted natural system or landscape?

Guidelines for inventory, mapping, and monitoring

In 2002 the NPS Inventory and Monitoring (I & M) Program hosted a workshop in Fort Collins, Colorado, to develop guidelines and tools that would support I & M networks, parks, and cooperating land managers in developing protocols for inventory and monitoring of invasive plants. The objective of the workshop was to compile, apply, and modify existing inventory, mapping, and monitoring guidelines and protocols, and not to "reinvent the wheel." The document resulting from the workshop is available from the NPS Inventory and Monitoring Web site (Hiebert 2002).

Effective invasive plant management requires identified goals, measurable objectives, and protocols for inventory, mapping, and monitoring (fig. 1). Following this structure, workshop participants proposed and adopted for use four general inventory, mapping, and monitoring goals for mitigating invasive plants throughout the National Park System:

1. Determine the distribution and abundance of known nonnative plant species within and surrounding parks. Assess which plants are present and which have a high potential to become invasive.

2. Prevent and detect new alien plant invasions, and eradicate new invasives.
3. Evaluate the effects of management actions on targeted plant species and the ecosystems they have invaded, and determine whether management actions have accomplished strategic goals.

4. Determine the status and trends of plant invasions over time and space, and develop predictive models to better guide future monitoring and management efforts.

Workshop participants also agreed that specific data elements as identified by the North American Weed Management Association (NAWMA) (Beard et al. 2001)

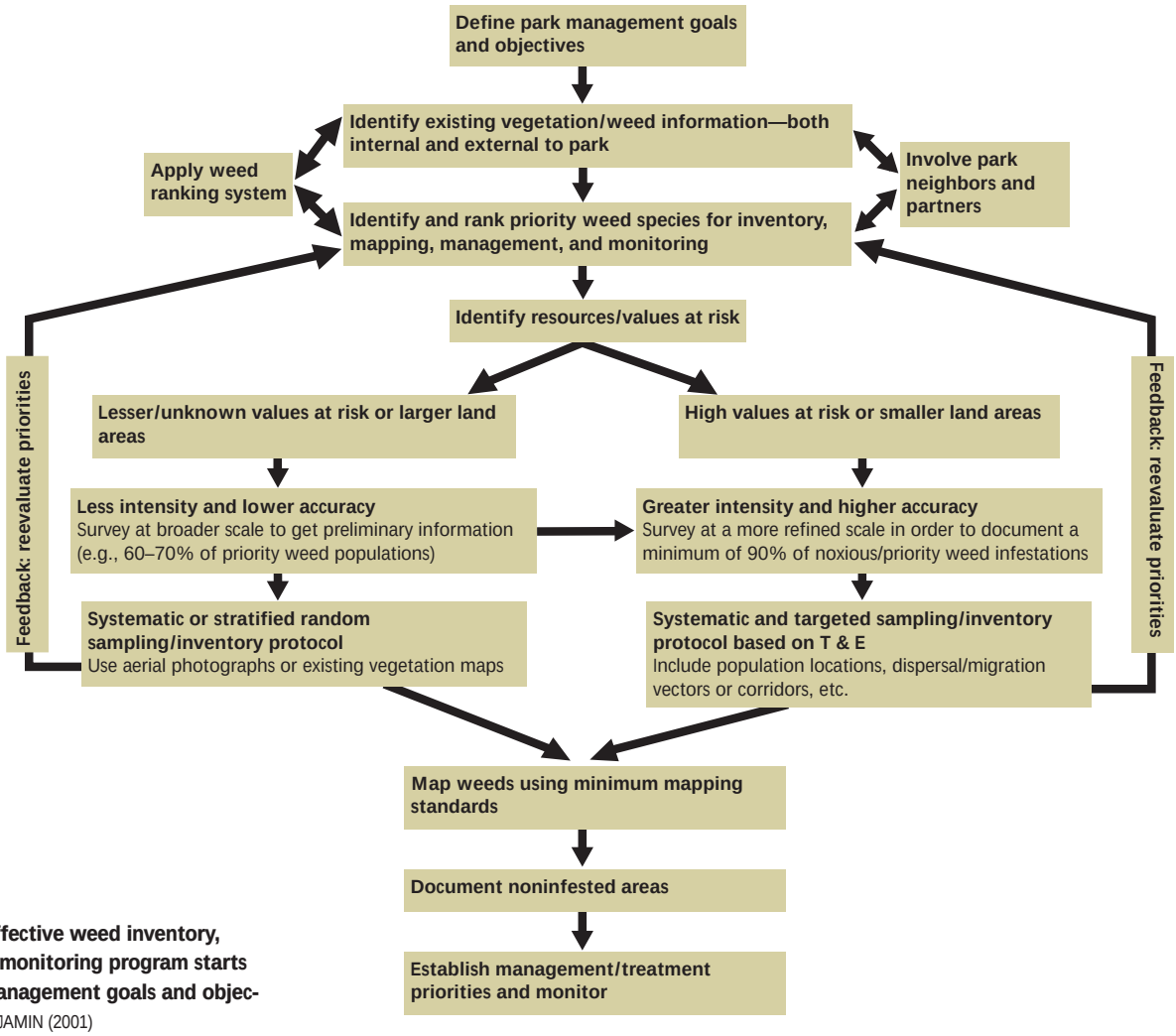

Figure 1. An effective weed inventory, mapping, and monitoring program starts by defining management goals and objectives. FROM BENJAMIN (2001)

and by the draft Intermountain Region "Weed Inventory, Mapping, and Database Development Guidelines" (Benjamin 2001) should be adopted as the NPS standards for invasive plant inventory and mapping. Currently, all state and federal land managing agencies in the western United States have adopted the NAWMA standards. Wide use of these basic data standards in the collection of weed distribution information provides the greatest ability to share meaningful information between agencies while assessing weed distributions and impacts at multiple scales (park, network, and region). A listing of the NPS-adopted standards and data elements (required and optional) and their definitions appear in Appendix A of the workshop report (Hiebert 2002).

Identifying priority species and priority areas for treatment

Mapping, controlling, and monitoring all nonnative plants in all units of the National Park Systems is physically and fiscally impossible. Although a majority of nonnative plants are relatively innocuous and do not tend to invade intact habitats or cause significant negative impacts in or near parks, the presence of invasive nonnative weeds requires focused management efforts. Therefore, managers must be able to prioritize species and the locations for management for species identified as being invasive (or capable of causing adverse impacts). To assist in these efforts, the Alien Plants Ranking System (APRS)—a cooperative effort among the National Park Service, Northern Arizona University, Ripon College, University of Minnesota, and the U.S. Geological Survey—helps managers prioritize decisions concerning invasive nonnative plants. This automated system ranks species based upon their current presumed site impacts, their innate ability to be pests, and the feasibility of control (ARPS Implementation Team 2001).

The Alien Plant Ranking System has proven to be an extremely beneficial tool in prioritizing invasive species at park and local levels. However, a preliminary screening before species are ranked at a specific site is often necessary. Morse and others (2004) developed criteria that prioritize invasive plants on national or regional scales and rank species based on their negative impacts to native biodiversity. Currently available on the Web, this new ranking tool places invasive species in one of four categories: high, moderate, low, or insignificant based on their potential for adverse impact on a landscape scale (see Morse et al. 2004 for address). This system is beginning to receive wide acceptance and has been adopted by several states to rank invasive weed species, including Virginia, California, Arizona, and Nevada. We propose that this system could be used to categorize priority species at the I & M network level and for identifying the highest priority invasive species regionally. Priority species ranked in the high and moderate categories at the regional or network level could then be further prioritized at the park level using the Alien Plant Ranking System.

A conceptual framework for assessing invasive plants at the I & M network level begins by categorizing nonnative plants known to exist within the geographical area of a network (fig. 2). Species that are thus categorized as causing high, or possibly moderate, impacts to regional biodiversity would be targeted as priorities for surveys and mapping in parks. Parks and areas of parks where a priority invasive species does not occur would also be documented during this process. Park and network managers would then target areas identified as not infested for prevention and early detection efforts. Based upon survey data and additional ranking through the Alien Plant Ranking System, managers would tally a list of priority species for each park within the network. A system similar to the New Zealand site-led system (Timmons and Owens 2001) could then be applied to rank the relative ecological value of invaded and non-invaded sites within

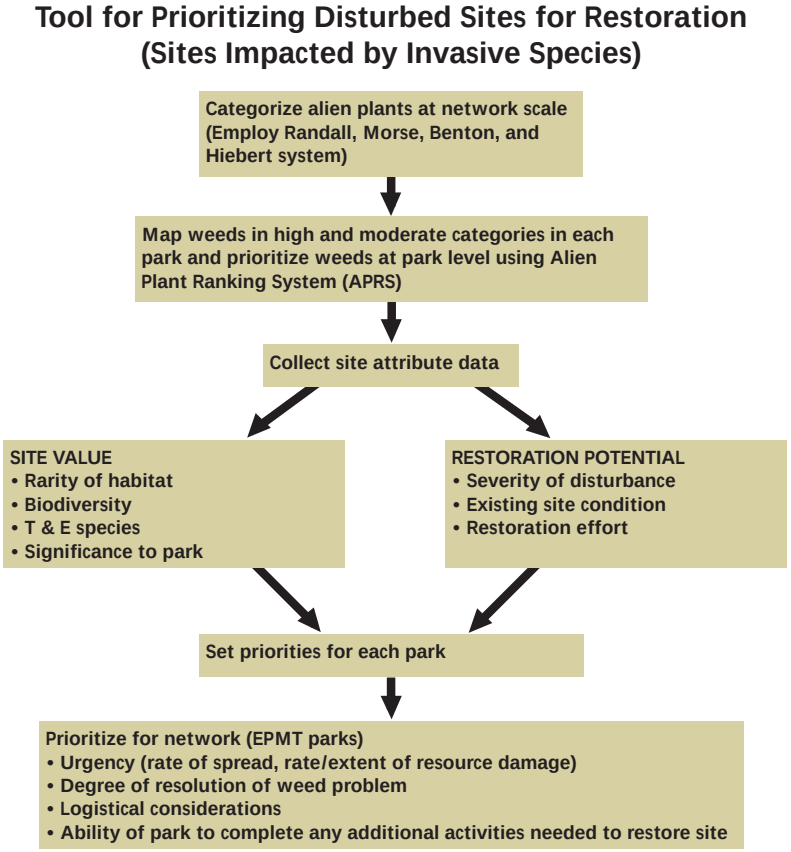

Figure 2. Prioritizing weed management sites begins by categorizing alien plants known to exist within the geographical area of an I & M network.

parks. Concurrently, invaded sites would be evaluated based upon the feasibility and level of effort required to restore the site. Using general inventory, mapping, and monitoring goals, managers would determine priority species and sites for management action for each park within the network. This information would then serve as the basis for prioritizing management actions and monitoring by EPMTs or by individual park staffs.

Assessing the restoration potential of weed-infested sites

A specific goal of all invasive plant management actions is not just to eliminate alien plants but also to protect or restore the function, structure, and composition of the ecosystems that the National Park Service is entrusted to manage. Because the presence of weed species is as much a symptom of degraded habitat as it is a cause, land managers must begin to holistically evaluate weed-infested lands by addressing the question: What is happening in the system that allowed the weeds to invade and become established?

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As part of an overall effort by the NPS Geologic Resources Division and NPS Biological Resource Management Division to develop a disturbed lands "restoration assessment tool," staffs have initiated work that will build upon inventory, mapping, and identified management priorities by assisting land managers in assessing the restoration potential of weed-infested sites. The restoration assessment tool (Benjamin 2004) builds upon an easy-to-use format (similar to that used by the Bureau of Land Management for assessing "potential natural communities and rangeland health" [Pellant et al. 2000]), and provides both direct and indirect assessments of several parameters related to the ecological integrity of a site. The NPS Washington Office has received funding to field-test this tool, with preliminary testing beginning in 2004. The data collected from these preliminary field investigations will be subsequently used to identify any modifications needed to ensure the greatest application of the restoration assessment tool throughout the National Park System. We expect a formal version of the restoration assessment tool to be available for implementation by the end of 2006.

Future steps

Examples of progress and success in NPS efforts to address invasive plant threats include exemplary programs at Acadia, Glacier, Rocky Mountain, and Yellowstone National Parks, and parks in southern Florida, Hawaii, and the National Capitol Region. The creation of 16 Exotic Plant Management Teams and the increase in park base funding provided by the Natural Resource Challenge also indicate progress. In addition, assessing invasive plant issues and designing weed monitoring programs are high priorities for many I & M networks. Yet, the fiscal and human resources needed for larger-scale inventory and mapping of weed infestations, for the development and implementation of long-term weed management strategies and associated monitoring, and for assessing the restoration potential of weed-infested sites remain low. Without augmented resources and a more coordinated effort, we predict the impacts of invasive plants will continue to increase. To counter this continued spread of invasive plants, some necessary, immediate actions are required.

- Develop stronger policy to support effective prevention and proactive management actions throughout the National Park Service.

- Establish designated invasive plant management positions for parks and monitoring networks. This issue is much too large and serious to address as a collateral duty.

- Establish regional invasive species coordinator positions to (1) enhance invasive species management and partnership abilities (e.g., inventory and mapping; species assessments, control, restoration, and research; and needed regional partnerships), (2) coordinate performance management goals related to invasive species, (3) maintain regional database(s) related to invasive species management (e.g., infested areas, pesticide use), (4) facilitate the development and implementation of regional and network invasive species action plans, (5) coordinate performance management goals related to invasive species, and (6) serve as NPS regional liaisons for regional and national initiatives or working groups related to invasive species management.

- Enhance research capabilities and funding for invasive species research.

Conclusion

Invasive plants represent one of the greatest threats to the natural and cultural resources in the National Park System, yet until recently, our abilities to address this threat have been limited. The creation of EMPTs has proven invaluable in our abilities to undertake invasive plant control activities. However, the development of

baseline information and viable tools for assessing and prioritizing weed management and restoration activities is critical to ensure the best use of limited personnel and financial resources. As such, new tools and conceptual frameworks are being developed to improve weed management and habitat restoration capabilities. These contributions represent a significant step forward in addressing the invasive plant issue, yet without further augmentation of resources (personnel and funds), invasive weeds will remain a prominent threat to the resources of our national parks.

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Under natural conditions—without earthworms—fallen leaves decompose slowly, creating a spongy layer of organic duff, which is the natural growing environment for native woodland ferns and wildflowers. The duff layer also provides habitat for ground-dwelling animals and helps prevent erosion (Holdsworth et al. 2004). Invading earthworms eat the leaves that create duff, thereby eliminating the layer and decimating forest floors. Mature trees survive, but saplings, ferns, and flowers perish.

Although beneficial in many urban and agricultural settings, earthworms create a soil of a certain consistency, which can have adverse effects in northern forest ecosystems by actually compacting soil. Compaction decreases water infiltration, and less infiltration combined with less duff results in increased surface runoff and erosion (Holdsworth et al. 2004).

In addition to changing the structure of soil, exotic earthworms alter the chemistry of soil. Invasion alters the location and nature of nutrient cycling in soil profiles and changes total carbon and phosphorus pools, carbon-nitrogen ratios, and the loss and distribution of different phosphorus fractions. The organism factor in soil formation also is affected by earthworm invasion: the distribution and function of roots and microbes is significantly disturbed (Bohlen et al. 2004).

The take-home lesson: Exotic earthworm invasion is a significant factor that will influence the structure and function of temperate forest ecosystems over the next few decades. Researchers have little doubt that earthworms are invading new habitats in northern forest ecosystems and that such invasion constitutes a potentially important change in these systems over wide geographic areas (see pages 61–62). If earthworm invasion is an important factor influencing patterns of nutrient cycling and loss in northern forests in the coming decades, then regional evaluations of forests will need to consider the presence or absence of earthworms along with other important drivers of those processes, such as pollution, climate, or underlying soil characteristics (Bohlen et al. 2004). —K. KellerLynn

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