CONSERVATION ISSUES

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Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA

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ABSTRACT: The Adirondack Chapter of The Nature Conservancy conducted a volunteer monitoring program for nonindigenous invasive plant species in the Adirondack Park of New York State, USA. Volunteers determined the presence and approximate distribution of 13 nonindigenous invasive plant species along all major roadways in the western section of the park. White sweet-clover (*Melilotus alba* Medikus), Japanese knotweed (*Fallopia japonica* [Houtt.] Ronse Decraene = *Polygonum cuspidatum* Sieb. & Zucc. per Gleason and Cronquist 1991), and fly and Tartarian honeysuckle (*Lonicera morrowii* A. Gray., *L. tatarica* L.) were the most commonly observed species; garlic mustard (*Alliaria petiolata* [Bieb.] Cavara & Grande) and black swallow-wort (*Cynanchum nigrum* [L.] Pers. = *Vincetoxicum nigrum* [L.] Moench per Gleason and Cronquist 1991) were rarely observed or absent along park roadways. Other species, including Russian and autumn olive (*Elaeagnus angustifolia* L., *E. umbellata* Thunb.), purple loosestrife (*Lythrum salicaria* L.), common reed (*Phragmites australis* [Cav.] Steud.), common and glossy buckthorn (*Rhamnus cathartica* L., *R. frangula* L.), and black locust (*Robinia pseudo-acacia L.*), were observed at intermediate frequencies along roadsides. Nature Conservancy staff have used results of the survey to prioritize management actions and to initiate discussion among nonprofit and government organizations about a coordinated approach to nonindigenous invasive plant species monitoring and management within the Adirondacks. In addition, a core group of highly skilled volunteers was established, many of whom are expanding their work to include additional invasive species monitoring and control efforts. We identified a number of procedures that should be used when volunteers conduct monitoring programs, including defining appropriate goals for volunteers and agencies, designing data collection and management systems, and providing volunteer support.

Index terms: Adirondack Park, nonindigenous invasive species, The Nature Conservancy, roadside survey, volunteer monitoring

INTRODUCTION

Having limited financial and staff resources, natural area managers are often constrained in their ability to conduct applied research essential to making informed management decisions. As conservation organizations such as The Nature Conservancy (TNC) change their strategy from preserving small natural areas to managing large, mixed-use landscapes in cooperation with other public and private landowners (The Nature Conservancy 1996), lack of data on conservation threats may become particularly acute.

Many nonprofit and government agencies have begun using trained volunteers to collect natural resources data from broad geographic areas. For example, New York and other states conduct breeding bird and herptile surveys using volunteers, and the national Global Learning to Benefit the Environment (GLOBE) program involves kindergarten through twelfth-grade students in collecting land cover, water quality, and atmospheric data across the United States and internationally (Andrle and Carroll 1988, Bonney and Dhondt 1997, Means 1998). In several studies, data collected by trained volunteers and students were of similar quality to those collected by trained professionals, and thus were considered to be an accurate and reliable source of information for scientists (Rock and Lauten 1996, Becker et al. 1998) and resource managers (Bloniarz and Ryan 1996).

The control of nonindigenous invasive plant species is another management challenge in which volunteers can play an important role (Hiebert et al. 1997, Farnsworth 1998, Krasny et al. 2000). Because small, initial infestations of invasive plant species are difficult to detect, collecting information on these species can be very time-consuming, particularly in large preserves. Yet it is critical to monitor natural areas for early infestation; small patches can spread rapidly, suddenly becoming difficult and expensive to manage (Forcel-

la and Harvey 1988, Kummerow 1992, Stein and Flack 1996). Park and preserve managers recognize the problems nonindigenous invasive species pose to native flora and fauna (Stein and Flack 1996), including threats to biodiversity through competition, suppression, and displacement of native species (Bratton 1982), and through the alteration of ecosystem functions such as nutrient cycling and hydrology (Vitousek 1990, Randall 1996).

In this paper, we describe an effort undertaken by the Adirondack Chapter of TNC to involve volunteers in developing baseline data on presence and distribution of nonindigenous invasive plant species in the Adirondack Park of New York State (NYS). In particular, we (1) outline results of the monitoring survey conducted by volunteers, (2) show how results were applied to management of natural areas, and (3) make recommendations for natural areas managers considering developing such programs based on our own experience and review of similar volunteer initiatives.

METHODS

The volunteer survey of nonindigenous invasive plants was designed to meet long-term conservation goals, both by collecting data that could be used in management decisions and by providing volunteers with a meaningful experience so that they would participate in future conservation efforts. Specific objectives of the survey were to (1) identify new, small infestations of nonindigenous invasive plant species that may pose a threat within the Adirondack Park; (2) develop baseline information to more effectively direct conservation efforts; and (3) develop a network of knowledgeable volunteers that would continue to support conservation efforts within the region.

The Adirondack State Park consists of 3 million ha of publicly and privately owned lands in northern NYS, and represents one of the largest areas of relatively intact forest in the northeastern United States. TNC cooperates with other public and private landowners in the park to manage the region on a landscape scale. The volunteer invasive plant survey was conducted along 3,120 km of county and state roads in a 1,548,000-ha area of the Adirondack Park (Figure 1). This area was targeted for conservation protection by TNC because of its high biological integrity (as determined by low road density and large blocks of intact forest). Because the Adirondacks had no known, major infestations of terrestrial, nonindigenous invasive plants at the time of this survey (Hunt 1998), we felt that the opportunity existed to take a proactive approach to invasive plant management and, hopefully, to maintain an ecologically intact landscape.

We initially considered all species that were a known threat to adjoining natural areas in Vermont, central NYS, and the Hudson Valley of NYS. Ecologists familiar with the Adirondacks then selected 13 species to inventory: garlic mustard (*Alliaria petiolata* [Bieb.] Cavara & Grande), Russian and autumn olive (*Elaeagnus angustifolia* L., *E. umbellata* Thunb.), fly and Tartarian honeysuckle (*Lonicera morrowii* A. Gray, *L. tatarica* L.), purple loosestrife (*Lythrum salicaria* L.), white sweet-clover (*Melilotus alba* Medikus), common reed (*Phragmites australis* [Cav.] Steud.), Japanese knotweed (*Fallopia japonica* [Houtt.] Ronse Decraene = *Polygonum cuspidatum* Sieb. & Zucc. per Gleason and Cronquist 1991), common and glossy buckthorn (*Rhamnus cathartica* L., *R. frangula* L.), black locust (*Robinia pseudoacacia* L.), and black swallow-wort (*Cyn-*

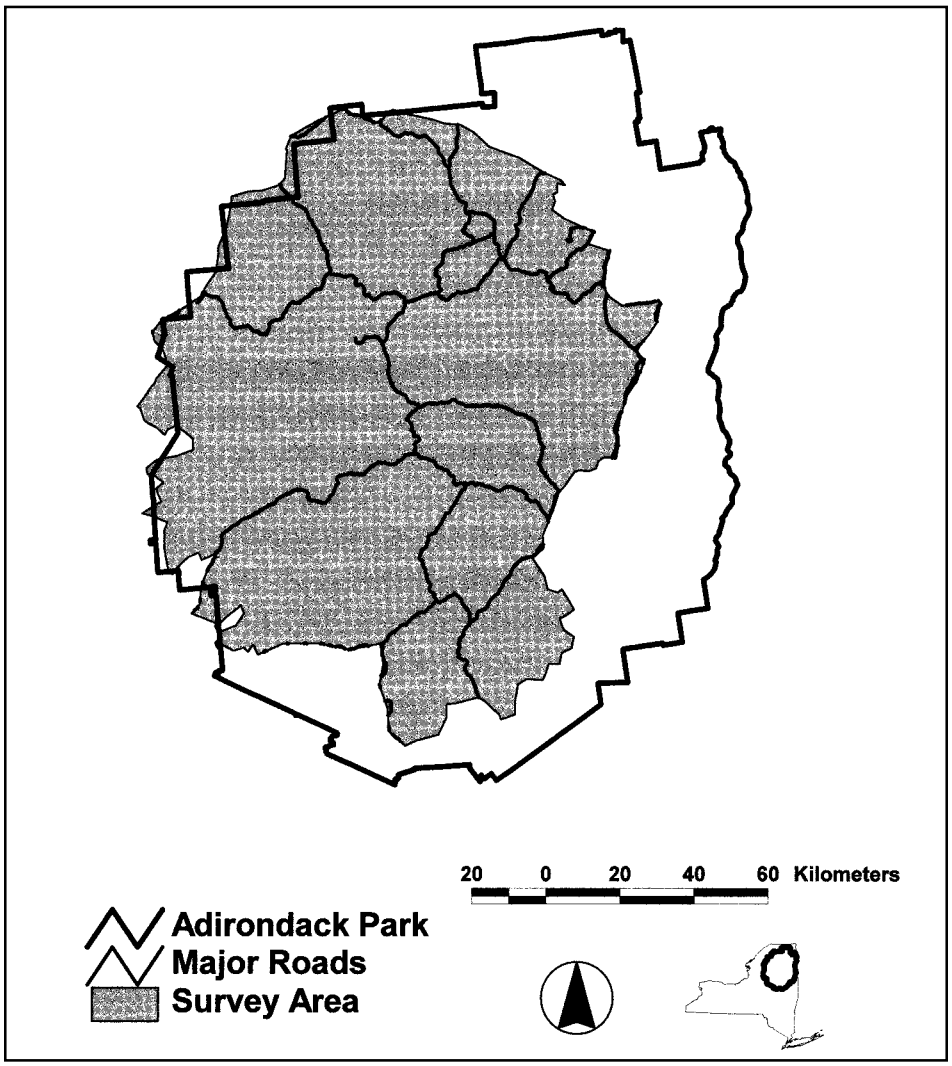

Figure 1. Nonindigenous invasive plant species survey area in the Adirondack Park of northern New York State, USA.

anchum nigrum [L.] Pers. = *Vincetoxicum nigrum* [L.] Moench per Gleason and Cronquist 1991). (Nomenclature follows Gleason and Cronquist 1991 unless noted.) No attempt was made to distinguish species of the two congeneric shrubs (*Lonicera* and *Rhamnus* species). Aquatic invasive plant species were not included in this preliminary inventory because the NYS Department of Environmental Conservation and several Adirondack lake associations were already monitoring some aquatic species.

To ensure the highest quality data possible, we identified 19 volunteers skilled in plant identification and familiar with the study area, and provided them with an intensive, one-day training workshop prior to the start of the survey. Training focused on identification and potential impacts of target nonindigenous invasive plant species, as well as sampling and mapping techniques. We divided the survey area into counties, and small groups of volunteers worked locally as a team to survey all public roads within their county. Because each volunteer set his/her own schedule, the frequency of sampling varied for each road section (although each section was surveyed at least once during the summer). For all targeted nonindigenous invasive plant species encountered, volunteers recorded the location, abundance, and proximity to wetlands or heritage sites that might be impacted by the targeted species, or to streams that might transport propagules of these species.

We decided to use a volunteer survey of public road corridors conducted from cars for several reasons. First, although we investigated other means of surveying nonindigenous invasive species (e.g., aerial photographs and ground surveys), these methods were not suitable for detecting small occurrences of invasive species in a large area dominated by intact forest. Second, since roads extended the length of the park, a roadside survey provided an opportunity to collect data over a large geographic area. Third, roadsides are good locations for spotting initial invasions because such sites often favor colonization by natural seed dispersal (often from nearby landscape plantings), by propagules that have hitched a ride on automobiles, or by contaminated fill (Clifford 1959, White and Stiles 1991, Tyser and Worley 1992). Finally, we decided to use volunteers for the roadside survey because TNC lacked staff to conduct broad-scale monitoring, but already had a pool of knowledgeable and committed volunteers from which to draw for this project.

At the same time, we recognized that a roadside survey conducted by volunteers from cars had limitations, including (1) no data were collected for invasive plant species within the forest interior and other non-roadside habitats, (2) the potential existed to overlook small and less conspicuous species, and (3) volunteers may have varied in identification and observation skills. Thus, a volunteer roadside survey is not a rigorous scientific tool, but if conducted properly, may provide good baseline information on nonindigenous invasive species occurrences for natural area managers.

RESULTS

Volunteers recorded 412 observations of targeted invasive plant species along public roads. Data collected by volunteers were entered into a database and imported into an ArcView Geographic Information System (GIS) for evaluating, prioritizing, and managing nonindigenous invasive plant species within the Adirondacks.

Several species, including garlic mustard and black swallow-wort, were observed rarely or not at all in the park (Figure 2). Two other species, white sweet-clover and Japanese knotweed, were each recorded at over 100 sites located throughout the survey area. Fly and Tartarian honeysuckle were also distributed across the park, usually associated with old farms or houses. Similarly, black locust was observed primarily near residential areas where the species had likely been planted, but at fewer sites than the honeysuckles. Other species were observed infrequently, and were restricted primarily to specific habitats (e.g., purple loosestrife was found in wetlands and ditches, common reed was found mostly in wetlands in the northwestern corner of the study area, Russian and autumn olive were most abundant at the eastern edge of the park, and common and glossy buckthorn were most common at the northwestern edge of the park).

DISCUSSION

Use of the Roadside Survey

We recognize the potential for error in a roadside survey conducted by volunteers, but given the resources available to the Adirondack Chapter of TNC and other Adirondack management agencies, it is unlikely that we can validate data collected by volunteers. On the other hand, given that volunteers were largely trained or amateur botanists and were familiar with the survey area, and that we surveyed a discreet group of relatively easily identified species, it is likely that their identifications and locations were accurate. Thus, we know at a minimum which species were present along roadsides. In addition, we know that certain species were widespread, although we cannot be certain that those found less commonly were not overlooked. In the case of garlic mustard in particular, volunteers may have overlooked first-year, nonflowering individuals of this biennial species. (During the year following the early detection survey described here, volunteers returned to the area where garlic mustard was initially sighted to locate additional infestations.)

Data collected by volunteers were combined with published information about the individual species' impacts on native communities and species (e.g., Fowells 1965; Conolly 1977; Converse 1984a, b; Beerling 1991; McNabb and Batterson 1991; Marks et al. 1993; Nuzzo 1994; Sheeley and Raynal 1996; Sieger and Merchant 1997; Sather and Eckardt 1998), the conservation value of the habitats/areas the invasive species might infest, and the ability to control them with available resources and technology. This information was used to develop management priorities for the Adirondacks using TNC's Site Weed Management Plan framework (Randall and Meyers-Rice 1998, Table 1). Although this framework has not been extensively peer-reviewed, it is used widely by TNC natural area managers. Species such as black swallow-wort, garlic mus-

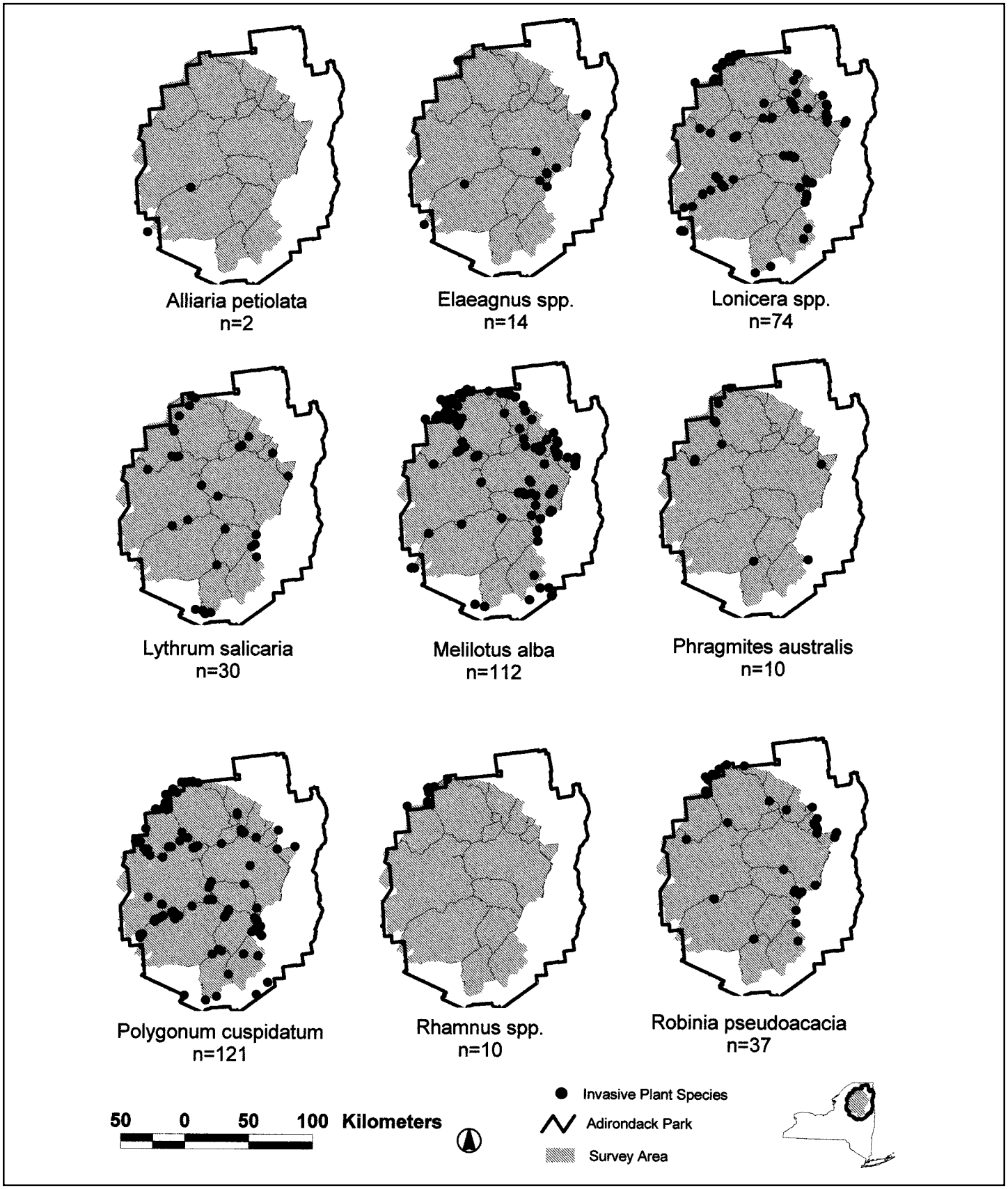

Figure 2. Distribution of targeted nonindigenous invasive plant species along roadways, and number of sightings (n) of each species or genus in the Adirondack Park of northern New York State, USA. Number of dots representing sightings is generally fewer than number of sightings because of map scale. There is no map for black swallow-wort because no individuals were sighted in the survey area.

tard, and purple loosestrife, which are not yet prevalent in the Adirondacks but have high potential impact on natural communities and are known to be difficult to control, were ranked as high priority for management. Other species, such as white sweet-clover, black locust, and common buckthorn, were sometimes more widespread, but were judged to have lower potential impact on natural communities in the Adirondacks; thus, these species were ranked as lower management concerns. In line with adaptive management principles, TNC plans to reassess species priorities as additional information is gathered in the future.

In addition to the actual survey data they collected, the volunteers' informal observations and knowledge of botany were used by TNC to help set management and monitoring priorities. For example, observations that purple loosestrife had spread over the past 5 years were important in making this species a management priority. Input from volunteers also was used to add three new nonindigenous invasive plant species—Japanese barberry (*Berberis thunbergii* DC.), oriental bittersweet (*Celastrus orbiculatus* Thunb.), and spotted knapweed (*Centaurea maculosa* Lam.)—to the monitoring program the following summer. All three are known to cause management problems in natural areas (McNab and Meeker 1987, Mauer et al. 1987, Ehrenfeld 1997).

TNC has begun using the survey data for additional purposes. First, the data have provided a starting point for discussions with government and nonprofit groups (including the NYS Department of Environ-

Table 1. Prioritized list of invasive plant species for the Adirondacks using criteria suggested by Randall and Meyers-Rice (1998). Nomenclature follows Gleason and Cronquist (1991).

Common Name	Scientific Name	Current Extent[a]	Potential Impact[b]	Value of Habitat[c]	Ability to Control[d]	Priority Rank[e]
Black swallow-wort	*Cynanchum nigrum*	1	2	2	1	6
Garlic mustard	*Alliaria petiolata*	2	2	2	1	7
Purple loosestrife	*Lythrum salicaria*	2	1	2	2	7
Common reed	*Phragmites australis*	2	3	2	1	8
Glossy buckthorn	*Rhamnus frangula*	2	2	2	2	8
Russian and autumn olive	*Elaeagnus* spp.	2	3	3	2	10
Japanese knotweed	*Polygonum cuspidatum*	3	2	2	3	10
Fly and tartarian honeysuckle	*Lonicera* spp.	3	3	3	3	12
White sweet-clover	*Melilotus alba*	3	4	3	2	12
Black locust	*Robinia pseudoacacia*	2	4	3	3	12
Common buckthorn	*Rhamnus cathartica*	2	4	3	3	12

[a] Current Extent:
1 = species not yet on the site but which are present nearby,
2 = species present as new populations or outliers of larger infestations,
3 = species present in large infestations that continue to spread.

[b] Potential Impact:
1 = species that alter ecosystem processes such as hydrology or nutrient cycling,
2 = species that outcompete natives and dominate undisturbed native communities,
3 = species that prevent or depress regeneration of native species or eliminate resources,
4 = species that exclude natives following natural disturbances such as floods or windstorms.

[c] Value of Habitat:
1 = infestations that occur in areas that contain rare or highly valued species/communities;
2 = infestations with potential to infest forest interior, wetlands, lakes, and rivers;
3 = infestations that occur in less highly valued portions of the site such as towns or restricted to roadsides, but have the potential to invade habitats such as calcareous sites.

[d] Ability to Control:
1 = species likely to be controlled or eliminated with available technology and resources,
2 = species difficult to control with available technology and resources,
3 = species unlikely to be controlled with available technology and resources.

[e] Priority Rank: combined rank from 4 (higher priority) to 13 (lower priority).

mental Conservation, Adirondack Aquatic Institute, Adirondack Park Agency, and the NYS Department of Transportation) focusing on developing cooperative management plans for nonindigenous invasive plants along roadsides and other areas of the Adirondack Park. Furthermore, the baseline data will be used in future years to evaluate changes in the spread of nonindigenous invasive plant species and to determine the effectiveness of control programs. Finally, the data have contributed to a statewide survey of nonindigenous invasive plant distribution conducted by the Invasive Plant Council of NYS, Inc.

In addition to identifying nonindigenous invasive plant species that may pose a threat within the Adirondacks, and to providing baseline information to more effectively direct conservation efforts, the intent of the survey was to develop a network of knowledgeable volunteers who would continue to support conservation efforts in the Adirondacks. Of the 19 volunteers trained in 1998, 17 participated in the 1998 survey and 14 participated in 1999. People who left the program did so because of health, personal problems, or moving from the area rather than dissatisfaction with their volunteer experience. During 1999, volunteers monitored forest interior sites along trails and waterways for the presence of nonindigenous invasive plants, made observations along transects to determine if invasive plant species were spreading from roadsides into natural areas, and conducted more intensive surveys of individual TNC preserves. They also assisted in initial control efforts of garlic mustard at a major site identified in the roadside survey and at several smaller patches identified later. In the future, TNC plans to expand volunteer activities to encompass a long-term early detection and monitoring program, which will include aquatic and additional terrestrial species, as well as opportunities for volunteers to work on control efforts.

Recommendations

In addition to evaluating our work with the volunteers in the Adirondack survey, we reviewed a number of similar programs, including ones that focused on (1) early detection and control of purple loosestrife in Acadia National Park (Hiebert et al. 1997), (2) inventory and removal of nonindigenous invasive plants conducted by the Vermont Chapter of TNC (S. Crawford, Water Chestnut Volunteer Coordinator, TNC, Vermont, pers. com.), (3) assessing control efforts conducted by the Connecticut Chapter of TNC (Farnsworth 1998), and (4) collaborating with educational and land-management organizations to design and implement small-scale invasive plant monitoring and control efforts conducted by Cornell University (Krasny et al. 2000). We gathered information on each of these programs through written documents, interviews with program managers, and site visits (Brown 1999). Based on our findings from these programs and from the Adirondack project, we have developed the following recommendations for individuals or agencies considering initiating an invasive species management program utilizing volunteers.

—Program Goals: Clearly identify the goals for nonindigenous invasive species management and for volunteer involvement. Based on conservation goals for individual sites, it is possible to determine what level of invasion requires conservation action, and to recognize the ecological and economic consequences of failing to act. The volunteer initiative is likely to focus on one aspect of the larger conservation goal. This smaller project must have clear and achievable goals to ensure that the investment of volunteer time and effort leads to conservation results (B. Schultz, Invasives Volunteer, TNC, Vermont, pers. com.).

Where possible, focus on early detection and control of invasive species. This not only provides the greatest conservation benefit (Forcella and Harvey 1988, Soulé 1990, Kummerow 1992, Tyser and Worley 1992, Ruesink et al. 1995), but is also an efficient use of limited time, financial, and human resources. Moreover, it is a good use of volunteer skills and allows volunteers to see results of their work. Although in some cases it may be difficult to motivate individuals and agencies to take action before nonindigenous invasive species reach a crisis level, awareness of the threat posed by invasives is increasing among educators, conservation volunteers, and preserve managers (M. Krasny and S.K. Lee, unpubl. data).

Volunteers can also play a role in applied research. Good control methods are available for only a few invasive species and, thus, data collected by preserve managers and volunteers on the efficacy of various control measures may be useful to others. Research scientists developing control technologies also may be interested in cooperating with land preserves to test new methods. For example, researchers at Cornell University have cooperated with youth and other volunteer groups to monitor the efficacy of beetles used in control of purple loosestrife. Another example comes from the WeedMaster Program developed by the Connecticut Chapter of TNC, in which volunteers conducted intensive scientific monitoring and implemented control measures for three invasive plant species (Farnsworth 1998).

—Program Organization: Be aware of the time involved in working with volunteer monitors. Volunteers have a role to play in nonindigenous invasive species management in natural areas, but they need training, support, and recognition. Thus, we recommend hiring a volunteer coordinator. The coordinator for the Adirondack survey spent about 1 day per week over the course of 14 months preparing materials, training and supporting volunteers, compiling and entering data, and preparing reports. In addition, the director of stewardship for the Adirondack TNC spent 1–4 hours per week during the first 8 months of the project assisting the coordinator. The project coordinator felt that in the absence of volunteers, a full-time employee would have been required to complete the survey.

Keep scientific data collection as simple as possible. Provide data forms and instructions. Forms used in the Adirondack project took 5-10 minutes for volunteers to complete for each plant noted.

Design and implement a system for data management. Managers from the Acadia National Park and TNC programs stressed

the need to track locations of invasions, identify affected landowners, and record control efforts. Regular reports, including maps, should be kept to provide institutional memory. Global positioning systems (GPS) may be used to locate sites and GIS may be useful in organizing data.

Build networks with other organizations. Through a Cornell University program, we forged partnerships among TNC, the Finger Lakes Land Trust, and Cornell Cooperative Extension. Although Cornell Cooperative Extension had not been previously involved in terrestrial invasive plant species management in natural areas, county extension staff and volunteers expressed a great deal of interest and conducted numerous management and educational activities focused on this issue. Preliminary results from this program indicate that Cooperative Extension county staff and 4-H and Master Gardener volunteers are eager to conduct nonindigenous invasive plant species programs in their counties in cooperation with conservation organizations, schools, and the horticultural industry (Krasny et al. 2000).

Enlist stakeholder support in control efforts. For many species, the most effective control may entail herbicide use, which may raise concerns among private landowners, preserve managers, and the public. Concerns should be addressed to determine if a particular control method should be used in a given situation.

—*Volunteer Management: Identify volunteer interests (e.g., monitoring, control, data management, scientific research) and match individuals with appropriate tasks.* For example, youth may like raising and releasing insects used in biological control, but may be less interested in hand-pulling or monitoring nonindigenous invasive plant populations. Some volunteers may be more interested in learning new information; others are motivated by their commitment to environmental conservation. Some may wish to be involved in project planning; others may prefer hands-on work in the field.

Provide opportunities for volunteers to work locally. Volunteers in the Adirondack project were able to provide anecdotal knowledge in addition to requested data because they were familiar with the county assigned to them. Similarly, when TNC volunteers in Vermont were allowed to inventory and control nonindigenous invasive species in an area they were familiar with, they felt a strengthened commitment to their sites. Working over large geographic regions or under adverse conditions requires careful planning to maintain the motivation and involvement of volunteers.

Develop a sense of commitment and camaraderie among volunteers. Trainings, frequent follow-up contacts, and recognition can help create a sense of camaraderie and connection to the larger program or agency mission. Establishing a team approach, rather than working with volunteers individually, helps to build program commitment.

Provide recognition to volunteers and the program. Volunteer recognition can include involvement in program planning and goal setting, press releases, thank-you gifts, and award ceremonies.

CONCLUSIONS

It is widely accepted that control of initial, small infestations of nonindigenous invasive plants is essential for the conservation of native species and habitats (Forcella and Harvey 1988, Kummerow 1992, Stein and Flack 1996). However, management agencies responsible for large natural areas often do not have resources to develop monitoring programs to detect small infestations. Engaging knowledgeable volunteers in regional monitoring programs can provide important baseline data on distribution of nonindigenous, invasive plant species. Although conducting volunteer programs requires resources (e.g., hiring a project coordinator, supporting volunteers, setting up a GIS for data analysis), results of such initiatives can make substantive contributions to management efforts. As a result of the Adirondack volunteer monitoring project, TNC is developing a coordinated approach to the management of nonindigenous invasive plants in the Adirondack Park, which will help maintain and protect the integrity of the region's biodiversity.

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