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Division of Natural Resources
Division of Planning

Department of Park Operations
Division of Outdoor Education
Division of Parks

Invasive Plant Management Program (IPMP) for Cleveland Metroparks Version 1.3

Cleveland Metroparks Technical Report 2009/NR-01

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The highest function of ecology is understanding consequences.

Pardot Kynes, Planetary Ecologist, Arrakis

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On the front cover (clockwise from top left): Japanese knotweed, lesser celandine, phragmites, narrow-leaved cattail at Lake Abram, Big Creek Reservation.

1.0 OVERVIEW[1]

Over the past 200 years, the introduction of non-native, invasive plants has altered virtually every landscape in North America, resulting in dramatic changes in natural habitats across the continent. Every year the total burden of invasive species, both plant and animal, to the American people exceeds $100 billion. Even more alarming is the fact that non-native species are second only to habitat destruction in threatening the existence of native species.

> *"Introduced plants, animals, and pathogens often pose an initially hidden but eventually monumental problem. Their harmful effects are often subtle and surreptitious, but the eventual impacts on the economy or natural environment are no less real, and often disastrous and even irreversible, as when native species disappear.' - - Daniel Simberloff (1996)*
>
> *From: Consequences: The Nature & Implications of Environmental Change.*

Non-native, invasive species are widely recognized as a major threat to the ecological integrity of natural plant and animal communities around the world. Non-native, invasive species (invasive plants) are species that 1) historically have not be found within the area of interest and 2) have since developed self-sustaining and expanding populations within a natural plant community (Vitousek et al. 1995). Without natural predators or other environmental controls, many invasive plants are able to spread quickly and displace native plants or other species of interest (such as agricultural or ornamental plants). Once established, many invasive species displace native plant communities, disrupt nutrient and fire cycles, cause changes in natural plant succession, and reduce the ecological integrity of native habitats in numerous other ways.

Since the beginning of European settlement, a vast array of plant and animal species have been purposefully introduced into the United States for medical, ornamental, agricultural, and game purposes. A large number of invasive species have been unintentionally introduced through human activities. At least 4,600 non-native species have become established in the United States (Office of Technology Assessment 1993). Every year the damage caused by, and attempted control of, invasive species in the United States amounts to more than $100 billion (Pimentel et al. 1999). The extensive and rapid spread of invasive species pose a significant threat to native plant and animal communities. Most experts agree that invasive species are second only to habitat destruction in threatening the existence of native species (The Nature Conservancy 2002). Invasive species have contributed to the decline of 42% of native species listed under the Endangered Species Act (The Nature Conservancy 2002). Invasive species have played a major role in the decline of nearly half of 1,880 species in the United States that are considered "imperiled" (Wilcove et al. 1998).

Concerns about invasive species have reached the highest levels of government around the world. In 1999, President Clinton issued Executive Order 13112, which recognized the need to halt the spread of invasive species and minimize the associated economical, ecological, and human health impacts. President Bush's budget for the 2003 fiscal year proposed an increase of $18 million in funding to the Department of the Interior for invasive species research and management. In addition, the federal government has established the National Invasive Species Council, a Cabinet-level

[1] Much of this section was taken from a Grant Proposal, *Bringing Back the Natives* (Petit 2003).

committee that directs the federal efforts to prevent, control, and minimize invasive species and their impacts. (National Invasive Species Council 2008), and the management-oriented Federal Interagency Committee for the Management of Noxious and Exotic Weeds, which facilitates the development of biologically and economically sound techniques to manage invasive plants on federal and private lands. The United States Congress, too, has recognized the urgent need to stem the spread of invasive species through enhancement of the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990, the National Invasive Species Act of 1996, and other legislation. Finally, many states, local agencies, and conservation and scientific organizations have taken steps in the past decade to increase awareness of invasive species.

Once invasive species become established, control can be difficult. Invasive species often are successful because of lack of natural controls over population growth which leaves human action as the main control to population expansion. Once populations are well-established, control efforts can be expensive and require a sustained effort of several years. Control is further complicated by a lack of information on the species biology or the most effective control options and the potential risk to native species and humans. Nevertheless, success has been achieved in controlling numerous problematic species in many locations around the United States. Key to those successes has been: 1) a well-researched, science-based approach to local invasive species control, 2) an aggressive, concerted effort by affected landowners, 3) rigorous monitoring to measure the success of initial control efforts, and to make adjustments if necessary, 4) long-term rehabilitation and monitoring of affected sites, including immediate control of any newly colonized plants.

Ohio has not been spared the impacts of invasive species. Approximately one-quarter (500 species) of all plants growing in the wild in Ohio are non-native (Cooperrider et al. 2001). While only several dozen of these are considered serious threats, the Ohio Department of Natural Resources considers control of these species to be critically important to the future preservation of native Ohio landscapes. Cleveland Metroparks is the largest single landholder in Cuyahoga County, Ohio, maintaining stewardship of over 21,000 acres of largely forested lands used for conservation, education, and recreation. Invasive plants are increasingly threatening Cleveland Metroparks. This document outlines the immediate actions that are necessary to gain control over populations of invasive species that threaten Cleveland Metropark's natural habitats, particularly within the ecologically diverse ecosystems of the reservations. While dozens of nonnative species are present within the park district, several provide the most immediate threats to the long-term viability of the natural ecosystems managed by Cleveland Metroparks.

The Invasive Plant Management Plan (IPMP) will focus on the plants with the most invasive characteristics that have a significant presence in the park system. In addition, a program to detect new invasive species populations within the reservations will complement the work of this plan. The IPMP will implement science-based management actions to: 1) control or reduce to low levels those invasive species of greatest concern; 2) identify and further develop the most effective methods for controlling invasive species; and 3) implement restoration of native plant communities in areas where invasive plants are controlled.

Within Cleveland Metroparks, 12 species or species groups have been identified as the most serious threats to the long term integrity of the parks' natural resources (Table 1). Not all of these plants are significant problems at every reservation. Each reservation has its own mix of problem species and the reservations have differing levels of infestation (Table 2). Of the 16 reservations in Cleveland Metroparks, 5 have been identified as having moderately high to very high levels of infestation of one or more invasive plant species: Bedford, Big Creek (Lake Abram-Lake Isaac area), Brecksville, Ohio & Erie Canal and Rocky River. Large multi-year control efforts will be focused on these reservations and the particular invasive plant(s) of concern. These large, multi-year efforts will be in addition to on-going control efforts aimed at all of the species in Table 1 that are present at a particular reservation, with the goal of eradicating or controlling these low level infestations. In addition to focusing on the species in Table 1, future invasive species (e.g. giant hogweed) or other species of concern that are becoming invasive (e.g. teasel, Canada thistle) can be addressed on a case by case basis.

Table 1. Top 12 invasive plant species and species groups in Cleveland Metroparks in 2008.

Common name	Scientific name(s)	Habitat
Cattails (Narrow-leaved cattail, hybrid cattail)	*Typha angustifolia, T.* x *glauca*	wetlands
Eurasian buckthorns (European buckthorn, glossy buckthorn)	*Rhamnus cathartica, Rhamnus frangula (*synonym *Frangula alnus)*	mesic woods, wetlands
Garlic mustard	*Alliaria petiolata*	upland forests
Honeysuckles (Japanese honeysuckle, bush honeysuckles)	*Lonicera japonica, L. maackii, L. morrowii, L. tatarica*	upland forests
Japanese barberries (Japanese barberry, common barberry)	*Berberis thunbergii, B. vulgaris*	upland forests
Japanese knotweed	*Polygonum cuspidatum* (*Fallopia japonica*)	mesic floodplains
Lesser celandine	*Ranunculus ficaria*	upland and wetland forests and fields
Multiflora rose	*Rosa multiflora*	upland and wetland forests and fields
Norway maple	*Acer platanoides*	upland forests
Phragmites	*Phragmites australis* subsp. *australis*	wetlands
Purple loosestrife	*Lythrum salicaria*	wetlands
Reed Canary Grass	*Phalaris arundinacea*	wetlands

The primary goals of the IPMP vary depending on the type and size of infestation or potential infestation. There are three main goals:

1. For large infestations in particular parks, the goal is to reduce the areal extent of a particular large infestation by 90% by 2014 (reduction and/or rescue). This goal will generally be measured by mapping reductions in the areal extent of a large infestation and reporting changes in acres covered by the plant. Parkwide, the goal is to reduce overall coverage of invasive plants to less than $1/10^{th}$ of 1% (0.1%) (~220 acres).

2. For small infestations, the goal is to protect the uninfested acreage of the particular park from the spread of the invasive plant or plants (contain) and if it is practicable, eradicate the plant(s). This goal will generally be measured by mapping areas where the spread of a plant was prevented and reported as acres of park protected from further spread of the plant.

3. The final goal is to protect a park from new infestations of invasive plants present elsewhere in the park system (e.g., lesser celandine in Hinckley Reservation) or from new infestations of invasive plants that have not become established in the park system (e.g., giant hogweed or black swallow-wort).

2.0 APPROACH FOR INVASIVE PLANT MANAGEMENT PROGRAM (IPMP)

2.1 Basic Approach

The IPMP adopts an early detection-early control (ED-EC) approach, so that invasive plants can be managed in a "day-to-day" maintenance mode with existing Cleveland Metroparks financial and staff resources. To implement this approach at Cleveland Metroparks, a combination of volunteer, full-time and seasonal staff will find and remove infestations of invasive plants before they can expand. However, at many reservations with existing large scale infestations, separate multi-year programs will need to be implemented before these low threshold levels will be attained.

Recon Teams comprised primarily of volunteers will be recruited for each reservation and assigned to a geographic area. They will be equipped with low cost GPS units and high resolution maps. Several times a year, the recon teams will be asked to physically survey their assigned area and report back with locations and assessments of invasive plant populations. These problem areas will then be assigned to Strike Teams comprised primarily of full time and seasonal park staff. The Strike Team will focus on the removal of smaller infestations although larger areas may also be addressed. Large infestations will be approached with separate focused campaigns until they are controlled or sufficiently contained. Control of larger infestations, e.g. lesser celandine in Rocky River, will require a coordinated effort of Recon and Strike Team efforts and/or an outside contractor.

2.2 Implementing the Approach

This program is structured to take a species- and a site-based approached, with removal goals tailored to the species or reservation. For example, some particularly

problematic species, (e.g. lesser celandine) will be targeted wherever and whenever they occur, even if the infestation is relatively small, because of its substantial risk of spreading (species-based approach). In contrast, a site-based approach may be taken for a particularly high quality resource (e.g. targeting all invasive species at Hinckley Reservation) or at a reservation overrun with many different invasive plants (e.g. Ohio & Erie Canal). Once a species or site has been identified for control, differing levels of effort and periods of time can be invested in achieving the goal for that site or species. Site goals can include containment, rehabilitation, maintenance or prevention. Time frames can be short or long with 5-10 years often needed to achieve a high level of control.

Twelve species or species groups (such as invasive shrubs or wetland invaders) will be the primary targets for control from 2009 to 2014 (Table 1). However, other invasive plants can be added to the program on a case-by-case basis if they are becoming problematic. The 12 species or species groups were selected based on their widespread distribution within one or more Cleveland Metroparks Reservations and the negative impact on the native plant and animal communities and represent the most imminent threat to the ecological integrity of the park district. Each species has its own history, habitat, and impact on native species and will require its own approach for control, including time of year for management actions, type of mechanical or chemical control, and need for repeated versus single actions. Appendix A includes ecological biographies for each species, as well as the proposed initial approach to management and control of these invasive populations.

The IPMP will be implemented throughout the Cleveland Metroparks, but as Table 2 indicates, five reservations within Cleveland Metroparks have the high infestations of one or more invasive plants (Bedford, Big Creek, Brecksville, Ohio & Erie Canal and Rocky River) and will have large-scale campaigns, in addition to other invasive plant control efforts.

Table 2. Invasive plant problems by reservation. Reservations with high levels of infestation are highlighted.

reservation	size of reservation (acres)	degree of infestation	initial estimates of invasive plant acreage	Description
Bedford	2206	moderately-high	100-200 acres	• Primary: Garlic mustard, barberry • Secondary: localized infestations of reed canary grass, Eurasian buckthorns, honeysuckles, multiflora rose, Japanese knotweed, cattails, phragmites, purple loosestrife
Big Creek	781	high	100-200 acres	• Primary: Garlic mustard, honeysuckles, Japanese knotweed in upland areas; cattails, phragmites, reed canary grass in wetland areas • Secondary: localized infestations of lesser celandine, Eurasian buckthorns, purple loosestrife, multiflora rose
Bradley Woods	795	low	<10 acres	Localized infestations of garlic mustard, lesser celandine, barberry, Eurasian buckthorns, honeysuckles, multiflora rose, phragmites
Brecksville	3494	moderately-high	100-200 acres	• Primary: Garlic mustard in upland areas; cattails, phragmites, purple loosestrife in wetland areas • Secondary: localized infestations of barberry, reed canary grass, Eurasian buckthorns, honeysuckles, multiflora rose, Japanese knotweed
Brookside	145	moderately-low	<25 acres	Localized infestations of most of the Table 1 species and species groups
Euclid Creek	345	moderate	<25 acres	Localized infestations of most of the Table 1 species and species groups
Garfield Park	213	moderate	<25 acres	Localized infestations of most of the Table 1 species and species groups
Hinckley	2682	low	<25 acres	Localized infestations of most of the Table 1 species and species groups
Huntington	103	moderately-low	<5 acres	Localized infestations of most of the Table 1 species and species groups
Mill Stream Run	3189	moderate	50-100 acres	• Primary: Garlic mustard in upland areas; cattails, phragmites, purple loosestrife, reed canary grass, Eurasian buckthorns in wetland areas • Secondary: localized infestations of lesser celandine, barberry, honeysuckles, multiflora rose, Japanese knotweed
North Chagrin	2140	moderately-low	<25 acres	Localized infestations of most of the Table 1 species and species groups

Ohio & Erie Canal	312	very high	100-200 acres	Primary: honeysuckles and garlic mustard in upland areas; Japanese knotweed on floodplains; cattails, phragmites, purple loosestrife in wetland areas • Secondary: localized infestations of Eurasian buckthorns, multiflora rose, barberry, Norway maple
Rocky River	2572	high	>300 acres	• Primary: lesser celandine, garlic mustard, Norway maple, Japanese knotweed • Secondary: localized infestations of Eurasian buckthorns, multiflora rose, barberry, phragmites, purple loosestrife, cattails
South Chagrin	1521	moderately-low	<25 acres	Localized infestations of most of the Table 1 species and species groups
Washington Park	59	moderately-low	<5 acres	Localized infestations of cattails, phragmites, reed canary grass in wetland areas
West Creek	278	low	<10 acres	Localized infestations of most of the Table 1 species and species groups
Zoo	168	low	<10 acres	Localized infestations of most of the Table 1 species and species groups
			945 - 1380 acres	Initial round figure estimate of invasive coverage or ~5-7% of park

Table 3. Organizational responsibilities for Invasive Plant Management Program for Cleveland Metroparks

division	responsibilities
Contractor(s)	Large-scale herbicide application (generally areas >1ac or that would require >1 day of staff time to apply herbicide to); woody species removal requiring staff trained with chain saws, large amounts of chipping
Park Operations (Natural Landscape Specialist, Forestry, Arborists)	Program to remove Norway maple from interior forest areas of Rocky River and isolated trees from other reservations. Care will need to be taken to do this in an unobtrusive manner, e.g. girdling of trees in interior forests.
Golf Services	Mapping and control of invasive plants within golf courses, adjust mowing program in spring to limit lesser celandine spread in Rocky River, change equipment cleaning practices to limit spread of seed and roots, quarantine of equipment from Rocky River golf courses to limit spread of lesser celandine
Human Resources - Volunteer Coord.	Provide coordination of volunteers for Invasive Plant Recon Teams (IPRCs)
Legal	Research legal issues associated with controlling invasive plants on land adjacent to metroparks
Marketing	Outreach and contact to neighbors about program and spraying of plants outside park; coordination of internal communications to park staff about program goals and activities
Natural Resources	Overall project management, staff and oversee invasive plant strike teams (IPSTs) training and coordination of recon and strike team, oversight of contractors, mapping and planning, research
Outdoor Education	Interpretation of program, Outdoor Education assistance with volunteer recon teams
Park Operations	Mapping and control of invasive plants within golf courses, adjust mowing program in spring to limit lesser celandine spread in Rocky River, change equipment cleaning practices to limit spread of seed and roots, quarantine of equipment from Rocky River golf courses to limit spread of lesser celandine
Planning	planning, GIS support, mapping, aerial interpretation
Volunteers	Staff invasive plant recon teams (IPRCs), perform on-the-ground identification and assessment of new infestations, perform post-treatment assessments to document results

2.3 Organizational Responsibilities within Cleveland Metroparks

The scale of the effort to control invasive plants in Cleveland Metroparks to an amount that can be managed with resources available in 2009 will require the commitment and involvement across nearly every part of the Cleveland Metroparks organization. Table 3 outlines primary organizational tasks. These are discussed in more detail below.

2.3.1 Natural Resources and Planning

The Divisions of Natural Resources and Planning will be responsible for day to day oversight and technical and scientific direction of the invasive plant management program. Oversight and coordination of invasive plant recon and strike teams will be performed by Natural Resource Area Managers. Oversight and coordination of mapping of invasive plants will be performed by the Division of Planning.

2.3.2 Park Operations

The Division of Park Operations will be responsible for the day-to-day management of invasive plant removal when performed by full time and seasonal Park Operations staff, and for the coordination of invasive plant management activities with the Natural Resource and Planning Divisions Strike Teams. Additionally, Park Operations and Natural Resources staff will implement "best management practices" to minimize the spread of invasive plants from equipment, materials storage sites, and other day-to-day operations (Kearns and Chapin 2008).

2.3.3 Outdoor Education and Visual Communications

The Division of Outdoor Education will be responsible for the interpretation of the Invasive Plant Management Program. Interpreting the need for invasive plant management, the use of chemical herbicides, the scale of the problem within Cleveland Metroparks, the need for volunteers to implement the program, among other things, is a critical part of an integrated invasive plant program. Nature Center managers are also in a key position to effect understanding in the greater public, leverage existing volunteer networks, aid in invasive plant control by full-time staff, and identify and monitor existing and new invasive plant infestations.

2.3.4 Volunteer Services

The Cleveland Metroparks volunteer coordinator in the Human Resources Department will play key role with coordinating the large number of volunteers needed to perform invasive plant reconnaissance and mapping activities.

2.3.5 Golf Services

Invasive plants are present within golf courses owned and managed by Cleveland Metroparks. In particular, lesser celandine control in Rocky River Reservation will require the active involvement of Little and Big Met and Mastick Woods Golf Courses. Given the constant attention required to maintain the golf course areas, active management to remove invasive plants and minimize secondary natural resource damage

is required indefinitely. The use of appropriate "best management practices" to minimize the unintentional spread of invasive plants will also be explored and adopted (Kearns & Chapin 2008).

2.3.5 Zoo

The horticultural (Don Krock) and facility operation staff of the Zoo have been removing invasive plants for over 5 years within and around the Cleveland Metroparks Zoo. Substantial gains have been made in eradicating invasive plants from the Zoo. It is recommended that Zoo staff be responsible for continued invasive plant management at the Zoo and within Brookside Reservation and surrounding areas in lower Mill Creek watershed.

3.0 ANNUAL PROGRAM IMPLEMENTATION

Success of the program will require collaboration, cooperation and consistency within and between departments and divisions of Cleveland Metroparks. In addition, the overall program goals will need to be implemented 1) by prioritizing sites and species and with explicit measures of success; 2) regular training of team members; 3) and support from area, park and nature center managers.

Preliminary mapping and identification of invasive plants was undertaken by the Natural Resource Area Managers in 2008. This mapping was not complete for every individual stand of the species in Table 1. Improved mapping will occur over a period of several years through the cooperation of the Recon Teams, Area Managers, strike teams, and other park staff. It is hoped that these efforts will suffice for the purposes of the IPMP without an extensive, quantitative invasive plant inventory effort. Control of an invasive plant in a particular location will be visually confirmed and documented by photographs.

The 2009 program will be structured as a collaborative effort between Park Operations and Natural Resource Divisions (Figures 1, 2 and 3). Subsequent years of the program may use the same structure or modify it based on the experience of 2009 and available staff. The Chief of Natural Resources and an Invasive Plant Coordinator will provide overall strategic and tactical direction through a weekly briefing with Area Managers, the Aquatic Biologist, the Natural Landscape Specialist and seasonal invasive plant staff. Based on annual priorities of species and sites to address in 2009, daily and seasonal weather conditions, etc., weekly assignments will be made to seasonal invasive plant staff. Staff may work as an independent crew under the direction of the Invasive Plant Coordinator or be assigned for short or extended periods of time to specific Area Managers, the Aquatic Biologist or the Natural Landscape Specialist.

Chief of Park Operations. Coordinate and collaborate on implementation of program with Chief of Natural Resources NR). Supervise Natural Landscape Specialist.

Chief of Natural Resources. Provide overall program supervision and direction. Develop annual and multi-year work programs for program staff. Supervise Area Managers and ensure coordination between all program staff. Coordinate with Natural Landscape

Specialist on implementation of Woody Invasive Species portion of the program. Supervise Invasive Plant Coordinator. Lead weekly briefings.

Invasive Plant Coordinator. Act as lead worker in coordinating field activities. Coordinate the development of priorities and assignments to implement annual work program. Perform invasive plant control. Oversee contractors. Coordinate and collaborate with Natural Landscape Specialist, Area Managers and Aquatic Biologist on staffing, supply and equipment needs and implementing priorities and assignments on a weekly, monthly and seasonal basis. Work closely with Chief of NR in developing and modifying strategy and tactics for program.

Natural Landscape Specialist. Act as park-wide lead on Woody Invasive Species control program. Formulate priorities and assignments for annual work program. Coordinate with Invasive Plant Coordinator, Arborists and Forestry Division. Oversee contractors, perform and direct woody invasive species control. Supervise assigned seasonal workers. Coordinate with Area Managers on projects within their areas.

Area Managers. Formulate priorities and assignments for annual work program. Coordinate with Natural Landscape Specialist, Invasive Plant Coordinator, Arborists and Forestry Division. Oversee contractors, perform and direct invasive species control. Supervise assigned seasonal workers. Coordinate with Natural Landscape Specialist on woody species control projects. Work closely with Chief of NR in developing and modifying strategy and tactics for program.

Aquatic Biologist. Formulate priorities and assignments for annual work program focusing on wetlands and aquatic invasive plants especially phragmites, invasive cattails and reed canary grass. Coordinate with Invasive Plant Coordinator and Area Managers. Oversee contractors, perform and direct invasive species control. Supervise assigned seasonal workers. Work closely with Chief of NR in developing and modifying strategy and tactics for program.

Priorities and schedules for a particular species or site will be developed based on six factors: 1) phenology of each species relative to most effective timing of removal treatments; 2) distribution and abundance of each population at a given location; 3) weather; 4) quality of the community to be protected or restored; 5) level of effort required to contain or remove the infestation; and 6) funding.

A management treatment will be prescribed for each population based upon the best available scientific information (see Appendix A). The Strike Teams and contractors will proceed through each reservation in a careful, systematic way. Follow-up visits will be made during the same season or in subsequent years to ensure that the specific site goals are being met. Using the principles of integrated vegetation management, which uses a combination of methods and timing to control invasive species (Nowak and Ballard 2005), some sites will have multiple yearly treatments. The success of removal methods will be monitored during the year in which it was implemented and in subsequent years. Larger scale infestations may require separate work plans addressing the particular circumstances associated with that infestation and reservation.

Locations identified for treatment will have a goal and management specified for the treatment. Goals and management can and often will change from year-to-year as control efforts are initiated and become effective, as follows:

Site Goals (desired future condition of a specified area)

PREVENT - Early detection - rapid response. Eradicate population upon discovery. Prevent any seed set or reproduction if found. Highest quality sites which are surveyed annually for invasion ("watch areas").

MAINTAIN – Invasive plants are below acceptable threshold. Minimal annual effort (e.g. one treatment only).

RESCUE – High-value site has good native diversity or resilience and/or good restoration potential if invasives removed or controlled (e.g. mature forest with garlic mustard invasion, high quality wetland with purple loosestrife).

REDUCE - Several years of sustained effort needed. Overall annual reduction of 25-50% per year. Prevent seed set or other reproduction, remove mature plants, and/or shrink patch as goals. Site may be of lower ecological value than "rescue" sites, but are still important for invasive plant removal. (Restoration of site could shift goal from "reduce" to "rescue" over time.)

CONTAIN - Prevent population from spreading further especially along available pathways (e.g. off-site population where access not allowed to control at source).

AESTHETICS - Control where appearance is important. Ecological concerns may be secondary at this site.

Management Intensity (annual effort at a specified site)

WATCH – Annual or seasonal surveys needed to ensure that area is not invaded by important invasive plants.

SWEEP - "Hiking with herbicide." Cover lots of ground where density of invasives relatively low (e.g. forest with scattered patches of barberry).

MOP-UP - Seasonal (or follow up 1-2 months after treatment) to continue mapping, treat missed plants, resprouts, rootsprouts, seedlings.

STANDARD - Labor-intensive but still selective effort characteristic of early stages of control program.

HEAVY - Intensive and relatively nonselective level effort to control large scale infestations or especially pernicious new or existing infestations (e.g. controlling a new stand of giant hogweed).

4.0 MONITORING AND ASSESSMENT

Monitoring and assessment will be primarily visual and qualitative. No quantitative vegetation monitoring is proposed, except on a case by case basis and/or in conjunction with another program. For example, quantitative vegetation monitoring is proposed as part of the Lake-to-Lake Ecosystem Management Plan and will be available to track success of invasive species management in this area.

Four types of data are proposed to be collected: a tracking data sheet to be filled out when mapping or treating a stand, latitude/longitude from a geographic positioning system device, a hand-drawn polygon on a map showing the approximate extent of the population, and a digital photograph(s).

5.0 PROJECTED BUDGET FOR PROGRAM

The budget for the program was estimated for 2009 to 2014 (Table 4). Budget numbers are expected to be within the correct order of magnitude but may be under estimates or the program may take longer than 6 years to accomplish its goals. The program budget will be reevaluated after the 2009 field season. The budget is based on the estimates of invasive acreage in Table 1 and the number of contractor days or seasonal field crews estimated to control a portion of the infestation in each year. Budget numbers decline over the course of the program in the expectation that the relative intensity of effort for the priority sites will decrease, because the acreage under "maintenance management" will increase. (See Appendix B for explanations of site goals and management intensity.)

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TABLE 4. REVISED INVASIVE PLANT MANAGEMENT PROGRAM BUDGET (28 September 2009)

contractor	description	2009	2010	2011	2012	2013	2014	SUBTOTAL	TOTAL
Woody species Control	58 contractor sites inventoried @~$6,000 per site on average	$ 42,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 342,000	
Lesser Celandine	Approximately 100 acres of contractor LC control at ~$640 ac	$ 12,042	$ 25,600	$ 25,600	$ 25,600	$ 25,600	$ 9,600	$ 124,042	$ 466,042
	CONTRACTOR SUBTOTAL PER YEAR	$ 54,042	$ 85,600	$ 85,600	$ 85,600	$ 85,600	$ 69,600	$ 466,042	
Seasonal Staff	Invasive Plant Coordinator	$ 25,000	$ 27,000	$ 27,000	$ 27,000	$ 27,000	$ 27,000	$ 160,000	
	Invasive Plant Strike Team ($9.50 per hour)	$ 23,000	$ 49,400	$ 49,400	$ 49,400	$ 24,700	$ 24,700	$ 220,600	$ 380,600
	SEASONAL STAFF SUBTOTAL PER YEAR	$ 48,000	$ 76,400	$ 76,400	$ 76,400	$ 51,700	$ 51,700	$ 380,600	
Capital Equipment	Argo Amphibious ATV	$ 17,200	$ -	$ 17,200	$ -	$ -	$ -	$ 34,400	
	Large volume powered tank sprayer	$ -	$ 5,000	$ -	$ 5,000	$ -	$ -	$ 10,000	
	Refurbished Chipper	$ -	$ 25,000	$ -		$ -	$ -	$ 25,000	
Equipment	Backpack sprayers, Brush Cutters, GPS units, cameras	$ 2,596	$ 2,400	$ 1,200	$ 600	$ 600	$ 600	$ 7,996	
Supplies	Ephemera (soap, gloves, sorbent, pens, paper, repellent, first aid etc.)	$ 483	$ 966	$ 966	$ 966	$ 483	$ 483	$ 4,347	
	Minor equipment (pruners, loppers, buckets, containers, clipboards, nozzles, hoses, etc.)	$ 1,600	$ 1,600	$ 1,600	$ 800	$ 400	$ 200	$ 6,202	
	Work gear (safety equipment, gloves, shirts, boots, waders, etc.)	$ 1,294	$ 3,883	$ 3,883	$ 2,589	$ 1,294	$ 1,294	$ 14,239	
Herbicide	$36.00/gal (includes adjuvents, stickers, dies, etc.)	$ 2,952	$ 7,200	$ 7,200	$ 7,200	$ 3,600	$ 3,600	$ 31,752	$ 133,936
	EQUIPMENT AND SUPPLY SUBTOTAL PER YEAR	$ 26,126	$ 46,050	$ 32,050	$ 17,155	$ 6,378	$ 6,178	$ 133,936	
Public Relations	Interpretation, Publicity, Posters	$ 5,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 10,000	$ 10,000
Reconnaissance Teams	Per team cost ~$600 (field vests, compasses, first, aid, GPS, camera, backpack, clip boards, bug spray, etc.)	$ 2,400	$ 2,400	$ 2,400	$ 2,400	$ 2,400	$ 2,400	$ 14,400	$ 14,400
	ANNUAL PROGRAM COST	$135,568	$211,450	$197,450	$182,555	$147,078	$130,878	GRAND TOTAL	$1,004,978
Post-Treatment Restoration	Active plant community restoration through seed or live plant material following invasive plant control, if native plants do not recolonize site	$10K to 100K	$10K to 100K	$10K to 100K	$10K to 100K	$10K to 100K	$10K to 100K	$60 to 600K	

TABLE 4. REVISED INVASIVE PLANT MANAGEMENT PROGRAM BUDGET (28 September 2009)

NUMBERS OF SITES, STAFFS, TEAMS, GALLONS USED TO ESTIMATE COSTS PER YEAR

	WOODY CONTRACTOR SITES PER YEAR	7	10	10	10	10	10	57	
	LC CONTRACTOR ACRES PER YEAR	25	40	40	40	40	15	200	
	STRIKE TEAM STAFF (APRIL-OCT) 850 hrs	2	4	4	4	2	2	18	
	STRIKE TEAM STAFF (JUNE-AUG) 450 hrs	2	4	4	4	2	2	18	
	GALLONS OF HERBICIDE PER SEASON	82	200	200	200	100	100	882	
	RECONNAISSANCE TEAMS ADDED PER YEAR	4	4	4	4	4	4	24	

Appendix A

Life history traits,
impacts on native ecosystems, and
control methods

A1. GARLIC MUSTARD

Life History

Garlic mustard *(Alliaria petiolata)* is native to Europe and was first recorded in the United States in 1868 in Long Island, New York. Garlic mustard is a biennial herb in the mustard family (Brassicaceae) that has heart-shaped, coarsely serrated leaves which emit a garlic scent when crushed. First-year seedlings exist as rosettes during the winter, then bolt and flower in the following spring. The second-year flowering plant reaches 2-5 feet in height and produces clusters of cross-shaped, small white flowers. A single plant can disperse thousands of seeds. At four sites in Ohio, the seedbank (number of viable seeds lying dormant in the soil) averaged 936 seeds/m in the top 10cm of soil (Byers and Quinn 1998). Seeds can remain viable in the soil for five or more years. Garlic mustard ranges from eastern Canada to Virginia and west to Nebraska (Nuzzo 1993). In North America, it invades wet to somewhat dry deciduous forest, partially shaded oak savanna, forest edges, hedgerows, and shaded roadsides.

Ecological Impacts

Garlic mustard can have severe negative impacts on native forest plants and animals by out-competing those species for light, nutrients, and water. Garlic mustard is also allelopathic to other plant species (Meekins & McCarthy 1999), and has recently been implicated in the suppression of mycorrhizal relationships of canopy tree seedlings (Roberts and Anderson 2001). Spring wildflowers (e.g. spring beauty, wild ginger, bloodroot, Dutchman's breeches, hepatica, toothworts, and trilliums), in particular, are at greatest risk. This competition leads to the decline in native populations and inevitably will eradicate the native species altogether. This negative impact on the quality of the forest habitat is not only detrimental to plants, but also detrimental to forest fauna. Reduction in native plant populations lessens availability of foliage, pollen, nectar, seeds and fruits upon which a variety of insects and mammals depend.

Control Methods

Garlic mustard can be controlled using mechanical (pulling or cutting) or chemical methods. Mechanical methods are often not effective unless the entire population can be pulled and is probably only useful for relatively small infestations where pulling can occur year after year (K. Adair, personal communication). Mechanical pulling of plants must occur before seed set and is designed to prevent introduction of new seeds into the seedbank. In spring and early summer before flowering is initiated, all adult garlic mustard must be carefully pulled from the ground. If completed well before flowering, plants can be left onsite to decompose. The result is elimination of all seed production for that year. For herbicide application, overwintering rosettes are treated with the herbicide glyphosate. This herbicide is effective at relatively low concentrations and has a low potential for bioaccumulation. The half-life of its biological activity in soil and water is short (2 months) (Rueppel et al. 1977). Application of glyphosate can begin in autumn after native plants have gone dormant. Spraying can continue throughout winter, except when snow is on the ground (K. Adair, personal communication), and into spring until native ephemerals are emerging. Glyphosate (commercial name: Roundup), when applied at 1- 3% concentrations to dormant rosettes in late fall or early spring (3%

in colder weather) reduced adult cover of garlic mustard by >95% (Nuzzo 1991, 1996). Glyphosate, which does not accumulate in the soil, is a non-selective herbicide, such that any non-targeted plant that gets exposed will die. Treating Garlic mustard in the fall, when most other plants are dormant, minimizes this risk. In addition to glyphosate, The Nature Conservancy in Northeast Ohio has had successful results using Scythe (palergonic acid) which is a contact (not systemic) herbicide and can successful top-kill flower garlic mustard plants (K. Adair, personal communication).

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mechanical (pulling)		X	X									
Chemical (Glyphosate)						X	X	X	X	X	X	X

A2. JAPANESE KNOTWEED

Life History

Japanese Knotweed *(Polygonum cuspidatum)* is native to Eastern Asia and was introduced to the United States in the late 1800's. The introduction of this species included use as ornamental hedges and for use in erosion control (Pridham and Bing 1975). It is still found in horticultural trade, often under the synonym *Fallopia japonica*. Knotweed is a herbaceous perennial in the buckwheat family (Polygonaceae) with 6-inch-long leaves that are broadly ovate with an abrupt tip. It grows 4-8 feet high and produces a panicle of small, greenish-white flowers. Because seeds rarely establish new colonies, the primary spread of this species is through mechanical movement of rhizomes (Muenscher 1955, Figueroa 1989). Knotweed can also colonize new locations if it is transported as a contaminant in fill dirt. Today, Japanese knotweed is found in 36 of the lower 48 states, from Maine to Louisiana and scattered across the midwestern and western states. This species can tolerate a variety of adverse environmental conditions, but most often is found along stream and riverbanks, roadsides, and other wet sites.

Ecological Impacts

Since Japanese Knotweed can spread via rhizomes, it is capable of forming very dense thickets that crowd out all other vegetation (Ahrens 1975). This aggressive species degrades the native landscape by altering habitat structure and native plant species composition. Once established, knotweed can spread extremely quickly and displace native plants and animals that depend upon native vegetation.

Control Methods

This species can be difficult to control because its extensive system of rhizomes and because the plant can re-sprout from small fragments of those rhizomes. Because of this, mechanical management techniques such as mowing and cutting are not appropriate by themselves and control requires use of an herbicide. However, if stands are mowed in early prior to fully flowering, they can be more easily treated in late summer after they resprout. This also is effective in reducing seed production for that year. The most

effective management technique for Japanese knotweed is a foliar application of glyphosate at 2% (by volume) concentrations. The most effective time of the year for application is late in the growing season when the plant is transferring nutrients from foliage to rhizomes. Two applications, one month apart, will be delivered.

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mechanical mowing followed by chemical application			X	X								
Chemical (Glyphosate)				X	X	X						

A3. PURPLE LOOSESTRIFE

Life History

Purple loosestrife *(Lythrum salicaria)* is native to Eurasia, but is now found in Britain, across central and southern Europe to central Russia, Japan, Manchuria China, southeast Asia; and northern India. The first introduction into North America occurred along the eastern seaboard of the United States, although the date remains unknown. It was so well established however, that by the 1830's, Torrey and Gray (1840) considered it to be "probably native" in their first edition of *A Flora of North America.* Purple Loosestrife is an erect, perennial herb in the loosestrife family (Lythraceae) that has opposite or whorled stalkless, lance-shaped leaves. It can grow to 6 feet and produces a spike of magenta colored lowers, Mature plants can have as many as 50 stems arising from a single rootstock and can produce up to 2.7 million seeds per plant yearly (Thompson, Stuckey and Thompson 1987). This reproductive capability has allowed purple loosestrife to spread to 1 million additional acres of wetlands each year. Purple loosestrife now occurs in every state except Florida, primarily in wetlands and moist soils areas.

Ecological Impacts

The spread of purple loosestrife can have detrimental economic implications when plants clog irrigation or drainage ditches on farmlands or when it displaces native vegetation causing degradation and loss of forage value of lowland pastures. Purple loosestrife can readily adapt to wetlands and spreads primarily by floating seeds or propagules, which means that even a small infestation into a wetland can become overwhelming in a very short period of time. Loosestrife seeds are usually present in such high densities that growth of native seedlings is suppressed (Rawinski 1982). This species has the ability to adjust to a variety of environmental conditions that give it a competitive advantage over native plant species. The overwhelming dominance of purple loosestrife changes the composition and structure of wetlands and reduces the quality for waterfowl, aquatic mammals, and other aquatic life.

Control Methods

Due to the vigorous and persistent nature of purple loosestrife, an aggressive management regimen of herbicide applications is required. In 1982, a new formulation of glyphosate (commercial name Rodeo) was approved for use over water. Rodeo uses the same active ingredient (glyphosate) but uses a non-ionic surfactant (Ortho X-77), which is preferable for over-water applications. Toxicity tests indicate that it is virtually non-toxic to all aquatic animals tested. Glyphosate biodegrades quickly and completely in the environment into natural products including carbon dioxide, nitrogen, phosphate and water. Finally, since glyphosate does not volatilize, it will not vaporize from a treated site and move to a non-target area (Brandt 1983; Comes, Burns and Kelly 1976, Monsanto 1985). Foliar application prior to fruiting is very effective (K. Adair, personal communication). In recent years, a biological control (leaf-feeding beetles, *Galerucella* spp), which reduce the growth and reproduction of purple loosestrife, are available but usually cost-effective on large stands that can support a healthy beetle population (Loos and Ragsdale 2009). Any control effort should be followed up the same growing season and for several years afterwards since some plants will be missed and new seedlings may sprout from the extensive seed bank (Henderson 1987, Minnesota DNR 1987).

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Biological controls												
Very large populations		X	X	X								
Chemical (Glyphosate)				X	X							

A4. PHRAGMITES

Life History

Phragmites or common reed *(Phragmites australis)* is found on every continent except Antarctica and may have the widest distribution of any flowering plant (Tucker 1990). This widespread distribution has made it difficult to determine the origin of phragmites. Recent genetic research has identified a native ecotype of phragmites (Blossey 2002, Saltonstall et al. 2004), which has subsequently been found at a handful of northeastern Ohio sites (J. Bissell pers. comm.) Phragmites is a perennial rhizomatous grass (Poaceae) that has slender, lanceolate leaves 8-12 inches long. It can grow up to 18 feet and produces a large panicle of dense floral spikelets. While phragmites can reproduce by seed, the primary method of reproduction occurs vegetatively through the spread of stout rhizomes. The vegetative spread by subterranean rhizomes results in dense clonal stands (200-300 stems/m^2; Hara et al.1993). Currently this species has a very extensive range across the United States and is found in every state except Alaska and Hawaii. Phragmites is usually considered a wetland species (principally marshes and swamps), but often is found in disturbed, upland areas. It is especially common along

railroad tracks, roadside ditches, and piles of dredge spoil, wherever even slight depressions hold water (Ricciuti 1983).

Ecological Impacts

The extent and spread of this species poses a massive concern for the integrity of native habitats. Much like Japanese knotweed, phragmites forms dense mats of rhizomes that out-compete native vegetation. The resulting community structure is reflected by a dense monospecific stand of phragmites. In the Mississippi River Delta of southern Louisiana phragmites has displaced species that provided valuable forage for wildlife, particularly migratory waterfowl (Hauber 1991). Displacement of native species, both plant and animal, is a regular occurrence in areas where phragmites is found. Disturbances or stressors, such as pollution, alteration of the natural hydrologic regime, dredging, and increased sedimentation, favor invasion and continued spread of phragmites (Roman et al. 1984).

Control Methods

The management protocol selected for this species requires treatment with the a wetland-approved glyphosate herbicide such as Rodeo. All treatments requiring an herbicide application will be performed only when weather conditions are appropriate. Therefore, no application will occur in windy conditions, as the spray will drift or if rain is forecast within 12 hours because the herbicide will wash away before it has a chance to act (Daly 1984). A similar approach to control described for purple loosestrife will be used for phragmites. The highly-selective but labor-intensive methods of “clip and drip” or hand-wicking may maximize the uptake of the herbicide while minimizing the potential harmful effects to surrounding vegetation. This technique is appropriate only at sparse stand densities with extensive native plant populations, when performed in late summer or early autumn. A 50-70% mortality rate can be obtained using the cut and drip method with a 25% concentration of Rodeo (Tu 2000). In areas where phragmites forms extensive homogenous stands of 5-20 acres, a foliar application will be performed. Foliar application is the preferred method here since the stand is so large and the understory is severely degraded. A concentration of 1.5% Rodeo applied from backpack sprayers with 5 foot wand extensions can achieve over 97% mortality after the first year of spraying (Tu 2000). In dense stands, subdominant plants are protected by the thick canopy and thus may not receive adequate herbicide. For these reasons, repeat visits over two years may be necessary (Lehman 1984)

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Chemical (Habitat)			X	X	X	X						
Chemical (Glyphosate, Accord, Glypro)				X	X	X						

A5. LESSER CELANDINE

Life History

Lesser celandine *(Ranunculus ficaria)* is native to Europe and western Asia and was introduced as an ornamental plant into the United States. Lesser celandine is a spring ephemeral perennial herb in the buttercup family (Ranunculaceae) with shiny, dark green heart-shaped leaves arranged in a loose rosette. It reaches only 4-12 inches in height and produces single glossy, butter-yellow flowers with 8 petals that appear in March and April. In June, lesser celandine begins to die back. Reproduction and dispersal occurs through spread of seed and vegetatively through small underground tubers. Lesser celandine is currently found in twenty northeastern states and in Oregon and Washington. Regionally, it is found in 12 of Ohio's 88 counties, including Cuyahoga and Lake. It is considered a moderate to serious invasive threat (Gardner 2000). Lesser celandine can be found in a variety of habitats, but most commonly colonizes areas of moist forested floodplains, damp hedgerows, ditches and riverbanks.

Ecological Impacts

Lesser celandine has a very short window of above-ground existence. However, when it appears it dramatically affects the native spring ephemeral flowering plants. Spring ephemeral plants complete the reproductive part of their life cycle during the late winter and spring. This type of life cycle allows these plants to take advantage of the abundant sunlight that occurs in spring. However, lesser celandine emerges earlier than most native spring wildflowers, sometimes by as much as several months and thus establishes dense clumps of rosettes that out-compete the emerging native plants for light. Unlike most native spring ephemerals, lesser celandine has the ability to produce dense foliage that often completely covers the forest floor. These dense clumps or patches of plants form monospecific carpets that out-compete native species for light, water, and nutrients.

Control Methods

Mechanical controls for lesser celandine are minimally effective due to the extensive tuber system. No biological control is currently available, so chemical treatment is the most appropriate option to control this species. Herbicidal control must be timed carefully because lesser celandine is above ground only for a very short time. The best time to control this species is as soon as it becomes identifiable in late winter or early spring. Treating this species as early as possible in its life cycle reduces the chance of the herbicide affecting any non-targeted or native plants. Foliar applications of a glyphosate herbicide (with surfactants to penetrate the waxy leaf surfaces) should begin in March or April, providing the ambient temperature is above 40° F. Repeat treatments over several years are likely necessary for adequate control.

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Chemical Habitat - imazapyr	X	X										
Chemical Various brands - glyphosate)	X	X										X

A6. BUCKTHORN

Life History

European buckthorns *(Rhamnus cathartica, R. frangula)* are native to Eurasia and were introduced into the United States sometime before 1800 as an ornamental hedgerow (Wyman 1971). Buckthorn (family Rhamnaceae) is a tall shrub or small tree that can reach 25 feet in height. Reproduction in this species occurs through massive seed production and the subsequent dispersal by birds and small mammals. The combination of prolific seed production and a wide habitat tolerance allows buckthorn to disperse over great distances. Principal habitats for common buckthorn (*R. cathartica*) are forest edges, woodlots, and old fields. Glossy buckthorn (*R. frangula*) invades old fields, forest edges, woodlots, and open or shrubby wetlands. Buckthorn ranges into 27 states in the United States.

Ecological Impacts

The first few individual plants that colonize a natural area are usually established from seeds transported by birds. This species has a long growing season and very rapid growth rate. Once established, buckthorn rapidly forms dense, even-aged thickets that effectively crowd out most other woody and herbaceous species. Buckthorn also leafs out prior to most woody deciduous plants, around late April to mid-May (Malicky et al. 1970), and stays green into late October or early November, giving it a competitive edge over native trees and shrubs.

Control Methods

A combination of mechanical and chemical control is the most effective means for eradicating buckthorn. Open stands in fields can be brush hogged and then sprayed with glyphosate after they resprout. Dense stands can be tackled by high-volume foliar application. Alternatively, buckthorn can be cut and stump treated: buckthorn is cut down at the base, and the cambium tissue along the stump's rim is immediately painted with glyphosate. An herbicidal stump treatment is a targeted method that can occur at any point in the growing season (it works especially well in later summer and fall) which minimizes contact with the surrounding vegetation. Stump application of 20% glyphosate in August yielded 100% control of buckthorn (Kline 1983). However, some individual buckthorn plants may need to be treated again because it is known to re-sprout even after treatment. Alternative treatment regimens may include application of triclopyr herbicide (trade names Garlon 3A, Garlon 4, or Pathfinder II) using cut stump treatments or basal bark treatments using oil-based herbicides in penetrating oil.

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mechanical (brush hogging or hydro-axe	X	X	X	X	X	X	X	X	X	X	X	X
Chemical Foliar with glyphosate			X	X	X	X	X	X				
Chemical Cut stump or basal bark with triclopyr			X	X	X	X	X	X	X	X	X	

A7. HONEYSUCKLES

Life History

Several *Lonicera* species, known as the Asian bush honeysuckles, are not native to the United States. These species, including *Lonicera maack*ii, *L. tatarica* and *L. morrowii*, are native to Eurasia and were introduced into the United States in the late 1800s as ornamentals. Bush honeysuckles (family Caprifoliaceae) are generally deciduous shrubs that are 6-20 feet tall. These exotic species tend to be shade-intolerant and most often occur along forest edges, abandoned fields, and other open, upland habitats. Colonization of new habitats occurs most often through bird-aided seed dispersal.

Ecological Impacts

Bush honeysuckles have a detrimental effect on native habitats in a fashion similar to that of buckthorn. Honeysuckles invade and overtake a site by forming dense shrub layers that crowd and shade out native plant species. Their vigorous growth has the capability of replacing the native species by depleting soil moisture and nutrients. In a survey of Ohio forests, tree seedling density, tree seedling species richness, and herb cover were all inversely related to *L. maackii* cover, and tree regeneration was inhibited (Hutchinson 1997). Forest canopy growth and timber productivity is significantly restricted where Amur honeysuckle dominates the understorey (Hartman & McCarthy 2007.)

Control Methods

Well established stands of bush honeysuckles are best managed much in the same way buckthorn is controlled. A stump treatment of 20% glyphosate appears to be an effective control method. Combined mechanical and chemical control is also effective for eradicating honeysuckles. Open stands in fields can be brush hogged and then sprayed with glyphosate after they resprout. Dense stands can be tackled with high-volume foliar spray application (glyphosate), or basal bark treatment with triclopyr in basal oil, with the dead stems left to decompose in place. Alternatively, honeysuckles can be cut and stump treated: honeysuckle is cut down at the base, and the outer rim of the stump is immediately painted with glyphosate. An herbicidal stump treatment is a targeted method that can occur at any point in the growing season and minimizes contact with the surrounding vegetation. A 1998 survey of The Nature Conservancy land managers found that most used glyphosate, and used it as a cut stump treatment, to control *L. maackii* and *L. tatarica* (Randall and Rice 2003). Alternative treatment regimens may include application of triclopyr herbicide (trade names Garlon 3A, Garlon 4, or Pathfinder II) using cut stump treatments or basal bark treatments using oil-based herbicides in penetrating oil.

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mechanical (brush hogging or hydro-axe)	X	X	X	X	X	X	X	X	X	X	X	X
Chemical			X	X	X	X	X	X				

foliar with glyphosate									
Chemical									
Cuts stump or basal bark with triclopyr	X	X	X	X	X	X	X	X	X

Japanese Barberry

Life History: Japanese Barberry *(Berberis thunbergii)* is native to Asia and was introduced to the United States around 1875 as an ornamental shrub. It is a compact, spiny shrub in the barberry family (Berberidaceae) that commonly grows up to about 3 feet high in northeastern Ohio. Japanese barberry reproduces by seed and through clonal root spread. This species readily colonizes new areas when birds and rabbits disperse the seeds. In North America, Japanese barberry can be found from Nova Scotia south to North Carolina and west to Montana. It has a wide range of environmental tolerance and can be found along roadsides, fences, old fields, and open woods. It naturalizes and persists from cultivation, and may be found as a dominant species in secondary forests near urban and exurban areas (Barton et al. 2004).

Ecological impacts: Japanese barberry has the ability to survive under a broad range of environmental conditions such as low light and soil moisture (Silander 1999). It has high rates of reproductive success from seeds and vegetative spread and low mortality rates once mature (Ehrenfeld 1999).With such high adaptability, this species suppresses the growth of native herbs by competing for resources. It has been shown to alter forest soil microbial communites and nutrient cycles, which favors its establishment and persistence in forest understories (Ehrenfeld 2001).

Control Methods: Japanese barberry can be removed by digging it up although this causes considerable soil disturbance and possible invasive pathway for other invasive plants. A hoe or mattock can be used to uproot the bush but it is imperative that all connected roots are removed. This physical removal can occur at anytime during the year. Foliar application (using a surfactant is critical) is very effective and avoids soil disturbance.

Treatment	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mechanical												
Digging	X	X	X	X	X	X	X	X	X	X	X	X
Chemical												
Foliar with glyphosate		X	X	X	X	X						

Appendix B

Invasive Plant Management Program:
Definitions of Site Goals and Management Intensity

Site Goals (desired future condition of a specified area)

PREVENT - Early detection - rapid response. Eradicate population upon discovery. Prevent any seed set or reproduction if found. Highest quality sites which are surveyed annually for invasion ("watch areas").

MAINTAIN - Weeds are below acceptable threshold. Minimal annual effort (e.g. one treatment only).

RESCUE – High-value site has good native diversity or resilience and/or good restoration potential if invasives removed or controlled (e.g. mature forest with garlic mustard invasion, high quality wetland with purple loosestrife).

REDUCE - Several years of sustained effort needed. Overall annual reduction of 25-50% per year. Prevent seed set or other reproduction, remove mature plants, and/or shrink patch as goals. Site may be of lower ecological value than "rescue" sites, but are still important for invasive plant removal. (Restoration of site could shift goal from "reduce" to "rescue" over time.)

CONTAIN - Prevent population from spreading further especially along available pathways (e.g. off-site population where access not allowed to control at source).

AESTHETICS - Control where appearance is important. Ecological concerns may be secondary at this site.

Management Intensity (annual effort at a specified site)

WATCH – Annual or seasonal surveys needed to ensure that area is not invaded by important invasive plants.

SWEEP - "Hiking with herbicide." Cover lots of ground where density of invasives relatively low (e.g. forest with scattered patches of barberry).

MOP-UP - Seasonal (or follow up 1-2 months after treatment) to continue mapping, treat missed plants, resprouts, rootsprouts, seedlings.

STANDARD - Labor-intensive but still selective effort characteristic of early stages of control program.

HEAVY - Intensive and relatively nonselective level effort to control large scale infestations or especially pernicious new or existing infestations (e.g. controlling a new stand of giant hogweed).