Guidance for the Effective Management of Invasive Plants

Massachusetts Invasive Plant Advisory Group (MIPAG)

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Introduction

In Massachusetts, invasive plants have invaded a variety of habitats from grasslands to intact forests. Invasive plants threaten our native biodiversity by directly competing with native species, altering ecosystem processes, changing hydrological characteristics, and degrading gene pools through hybridization with native species. Due to the characteristics of invasive plants (e.g., high seed production, rapid growth), they may be better adapted to colonizing disturbed landscapes (including natural disturbances such as beaver activity, forest canopy openings or fire) and respond more quickly than native species to changes that result from global warming.

The Massachusetts Invasive Plant Advisory Group (MIPAG) is a voluntary collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape. MIPAG was instrumental in developing the Commonwealth's first list of invasive, likely invasive and potentially invasive plants that have now been prohibited from importation, sale or trade. MIPAG has also developed a list of early detection species for the Commonwealth. Refer to the MIPAG website http://www.massnrc.org/mipag/ and the Massachusetts Department of Agricultural Resources website http://www.mass.gov/eea/agencies/agr/farm-products/plants/massachusetts-prohibited-plant-list.html for information on the lists and definitions.

Management of invasive plant species may be possible, but collectively and individually they are a problem that requires long-term solutions. Not all invasive plants behave the same or are at the same stage of invasion within the state and/or region. Managing invasive plants demands a commitment to vigilance and some level of sustained action in perpetuity. Resources devoted to the management of invasive plants will never be sufficient to fund and staff all desirable management approaches; however, the cost of management decreases when invasive levels are lower. If we address invasive plants at the initial stages of an invasion when populations are low, the cost of maintaining a low level of invasion will be less than the control effort required to reduce a heavily invaded area to a lower level of invasion. Therefore, it is critical to find ways to identify priority species and populations and to target management efforts to areas of the greatest ecological significance so that available resources are allocated wisely.

Purpose

The purpose of this document is to provide guidance for landowners and land managers in developing specific plans for effective management of invasive plants. The guidance below is intended to work at any scale, from a small parcel of land to statewide. The main focus of the document is invasive plant control for ecological health, although other goals of invasive plant management (such as human health and aesthetics) are compatible with this methodology. Although we mention the importance of education and prevention below, the focus of this document is providing guidance on management.

Components of Invasive Plant Control

Education and Public Awareness

Although public awareness of the negative impacts of invasive species is increasing, education is crucial to the long-term success of efforts at prevention and management. Strategies to reduce the impacts of invasive species must communicate humans' role in facilitating their establishment and spread, their detrimental impacts on our native biota, and their effect on our enjoyment of the environment. One of the most effective ways to address invasive species issues is to inform people of how to avoid contributing to the problem and how they can reduce the threats posed by these species. Gardens and designed landscapes are particularly well suited to educating visitors and the public about the threat from invasive plants.

Prevention

Prevention should be driven by two main objectives: preventing the introduction and establishment of plants identified as "Potentially Invasive ", and preventing "Invasive" or "Likely Invasive plants" already present in the Commonwealth from invading high priority natural resource areas (see http://www.massnrc.org/mipag/ for definitions). Because human behavior is the primary cause of both intentional and unintentional invasive species spread and dispersal, a comprehensive prevention strategy should include a strong and well-publicized outreach and education component and policies to encourage the adoption of preventative measures by both the public and private sectors. Prevention should also include measures to detect invasions of plants so that they can be controlled early. This approach is known as early detection and rapid response (EDRR).

Management

Two main approaches exist for invasive plant management, "weed-based" and "site-based" (Table 1).

Weed-based management focuses on a particular species and is suitable for new invasions and small populations of species that have proven control methods. Management of these species may be important even outside of priority areas. Weed-based management relies heavily on the detection of new invasions before they become established in a region/state, and may be particularly useful in designed landscapes to prevent new species transported in horticultural material from establishing in minimally managed habitats.

Site-based management focuses on managing populations in specific areas where we have a feature that we want to protect (e.g. rare species, priority community). A site-based approach could involve managing an invasive plant across an entire property or site, or just within the priority community type.

Table 1. Comparison of weed-based and site-based management.

	Weed-based	**Site-based**
Purpose	-Prevent new weed species from becoming entrenched in natural areas.	-Protect important sites from any invasive species that may be threatening important resources (such as rare species)

Scale	-Greater than one site. Look at entire region or statewide.	-A defined area.
Species focus	-Species that are newly naturalized in or newly invading the region/state; or with very confined populations.	-Those necessary to protect the place. Often widespread weeds.
Sites	-All infestations within a region, on sites of any quality and ownership.	-Infestations within the place; plus buffers and seed sources outside of it.
Success when…..	-The species is eradicated or contained within the region.	-The native species or natural community responds in a desired way (e.g., regeneration).
Other activities	-Public awareness -Control on sale/spread -Surveillance	-Public awareness -Integrate management with other threat management -Survey places with high biodiversity value.

Control Quickstart Checklist

- ✓ ID what natural resources you care about.
- ✓ Determine which invasive species threaten these resources?
- ✓ Research what it will take to control these species.
- ✓ Develop a realistic goal.
- ✓ Seek adequate resources.
- ✓ Implement management
- ✓ Monitor and document outcomes.
- ✓ Reevaluate based on experiences.

Once a weed-based or site-based management approach is chosen, we recommend using an "integrated vegetation management" approach as management of established invasive plants is impossible on the large-scale due to constraints of time, funds, staff, and effective (and practical) management methods. Integrated vegetation management incorporates an ecosystem based management strategy with the long-term goal of reducing levels of invasive species or preventing new invasions. This approach integrates a combination of techniques including biological control, habitat manipulation, manual control, mechanical removal, chemical control and cultural practices to ensure long term prevention of invasive plant species in site-specific situations. The most effective invasive weed management projects consider: species involved, adjacent lands, climate, terrain, size of infestation, and available resources. As a result, the type of management strategy and method(s) may vary dramatically from project to project.

Steps for developing a successful management project are detailed below. A case study in Appendix B illustrates how a project might be implemented.

1. Identify the most significant natural resource values to protect or enhance.
2. Decide which invasive species pose the greatest threat to these natural resources.
3. Know your foe: research what it will take to manage the target species.
4. Develop a realistic management goal.
5. Evaluate your resources relative to the goal.
6. Implement management.
7. Monitor and document outcomes.
8. Reevaluate the project time frame based on experiences (develop and refine best management practices).

1. Identify the most significant natural resource values to protect or enhance.

Prioritization of our management efforts is essential to maximizing our ability to protect biodiversity with the limited financial, staff and other resources available. Beyond early detection efforts, management of invasive plants should focus on those species that are threatening rare species or priority community types, or landscapes that are currently free of invasive plants or other disturbances (e.g. large undisturbed forested areas). This is a more site-based management effort and the goal might be the maintenance of invasive species at a level that will not impact the resource.

- ✓ Are there rare species or priority community types? How is the land protected? Are other values at risk (e.g. scenic, human health, cultural, historic)? Are there other threats that may be increasing invasive plant levels (e.g. deer population levels). Use BioMap2 and other resources available at the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) website. You may have to do additional inventory or seek outside expertise (Table 2).

- ✓ Prioritize populations for management based on the significance of the resource, the existence of effective management methods, the invasiveness of the species and distribution/abundance at the site, and the potential for long-term management.

Table 2: Resources for invasive plant management

Information need	**Who**	**What**	**Website**
Rare species and communities, intact & resilient ecosystems & landscapes	Mass. Natural Heritage and Endangered Species Program & The Nature Conservancy	BioMap2	http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/land-protection-and-management/biomap2/
Invasive species distributions and documentation resources	IPANE, EDDMapS, Outsmart Invasives	Online databases and other data management tools	https://www.eddmaps.org/ipane/ http://www.eddmaps.org/ http://masswoods.net/outsmart
Decision making on whether to manage or not	The Nature Conservancy (NY); TTOR	An Invasive Plant Management Decision Analysis Tool (TNC); Invasive Plant Guidelines (TTOR)	http://www.conservationgateway.org/News/Pages/control-or-not-control-in.aspx http://www.thetrustees.org/assets/documents/what-we-care-about/Invasives-Plant-Guidelines-Final_Sep08.pdf
Invasive Species Priorities	MA Invasive Plant Advisory Group	Lists of Invasive species, early detection list	http://www.massnrc.org/mipag/ http://www.mass.gov/eea/agencies/agr/farm-products/plants/massachusetts-prohibited-plant-list.html
GIS resources	Mass GIS	Open space and other layers	http://www.mass.gov/mgis/massgis.htm
Monitoring	Bureau of Land Management	Book: Measuring and Monitoring Plant Populations	http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf
Resources specific to landowners	The Nature Conservancy (VT)	Landowner Guide	http://www.vtinvasives.org/plants/prevention-and-management/tools-resources

2. Decide which invasive species pose the greatest threat to these natural resources.

Do an inventory and create a map of problem areas. Correctly identifying the extent of the invasive plants is critical to evaluating whether resources are adequate for control. Use available lists such as the MIPAG list of invasive species or MIPAG early detection (EDRR) list to decide which species to manage (Table 2). Consult outside expertise if needed to identify other species.

3. Know your foe: research what it will take to manage the target species.

There are multiple ways to manage invasive species including mechanical (pulling), chemical (herbicide), burning (prescribed fire or propane torching). Research the best method to manage the plant(s) identified, determine the likelihood of successful management, and whether there are unacceptable non-target impacts. Talk to experts, hire a vegetation control company, and do web searches to help identify the best methods and to determine what amount of invasive species would allow the site to continue to function ecologically. If there are wetlands or priority habitats for rare species on the property, permits and management plans may be required. Consult your Conservation Commission and the Massachusetts Natural Heritage and Endangered Species Program before undertaking a management project.

4. Develop a realistic management goal.

What is the goal for the management project? Do you intend to try to eradicate, suppress, or contain the invasive plant (see Appendix A for definitions)? What is the vision for the native community once the invasive plants are gone? Are there other threats (deer numbers, forest pests and pathogens, socio-political issues etc.) that may prevent reaching the goal? Since it may be impossible to get total control with available resources, will suppression or containment still enable a meaningful result?

5. Evaluate your resources relative to the goal.

Managing an invasive species problem at a site usually takes more than one year and may be needed into the foreseeable future. Make sure adequate resources are available for several years of management before you start to avoid wasting time and money. We realize that forecasting funding availability beyond a couple of years is often difficult; however, it could be worthwhile to identify potential funding sources. You may have to decide you cannot do the project if inadequate resources are available.

6. Implement management.

When implementing management, treat the smallest or satellite infestations first and work towards the larger or core infestations. Keep uninfested areas free of weeds! Also note the need for careful disposal of removed invasives to prevent infestation of the disposal site or transport of propagules on equipment, footwear, etc.

If you decide to apply herbicides you will need to be licensed unless you are applying herbicides on land you own. The Pesticide Program of the Massachusetts Department of Agricultural Resources conducts the testing, licensing, recertification and auditing of pesticide applicators in the Commonwealth of Massachusetts. The Department issues four types of pesticide licenses. The pesticide license that you need depends on several factors, including the types of pesticides you will be using in your work and where you will be applying those pesticides.

7. Monitor and Document Outcomes.

Before implementing management, set up a simple monitoring protocol to determine whether the work is successful. Depending on the species, use photography, written descriptions, or possibly a more scientific protocol. During management efforts, keep track of costs, hours spent (if using volunteers), herbicide used etc. Make plans to re-monitor the site the next growing season after each application to assess success.

Document invasion locations and management implemented. Consider the use of a publically available database. MIPAG is recommending the use of EDDMapS http://www.eddmaps.org/ as a database of invasive locations and management for the Commonwealth. Smartphone apps such as Outsmart Invasives can help you document invasive plant locations in the field http://masswoods.net/outsmart.

8. Reevaluate the project time frame based on experiences (develop and refine best management practices).

Based on information collected in number 7 above and available resources re-evaluate the management project every year to determine whether to continue on, change course, or stop the project. For example a rapid increase in the number of infestations of invasive plants at a site may make control extremely difficult unless control efforts can keep up with the new infestations (Howell 2012).

Learning to Live with Invasive Species We Cannot Manage

In many instances, invasive plants are too widespread to be feasibly managed, except in selected situations where the impact is significant and the management costs acceptable. Despite our best efforts, invasive plant management may not be successful in all situations where it is attempted. So what can be done when faced with invasive plants that cannot be adequately managed in valued conservation areas? Four general approaches may help (Randall 2008).

1. Provide native species with refugia from invasive species or otherwise mitigate their harmful effects (e.g. protecting isolated sites or deer exclosures).
2. Manage/restore ecosystem processes that favor natives (e.g. fire, hydrology).
3. Identify individuals/populations of native species with increased abilities to compete with or persist alongside the invasive species and use propagules in restoration efforts.

4. Change the conservation goal from restoration of a pre-existing community to the 'rehabilitation' of a portion of that community or even to a 'new' mixed community of native and non-native species with desirable ecosystem functions and properties possible.

References

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Rejmánek M. and M. J. Pitcairn. 2002. When is eradication of exotic pest plants a realistic goal? *In* C. R. Veitch, M. N. Clout, [eds.]. *Turning the tide: the eradication of invasive species,* 249-253. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland.

Appendix A

DEFINITIONS

Eradication
The goal of eradication is to eliminate all individuals and the seed bank from an area with low likelihood of needing to address the species in the future. The term eradication in its strict definition applies only to the scale of a continent or island. However, eradication tactics are often applied at smaller project scales.

Eradication is considered successful when no plants are recovered from the initial infested area for three consecutive years (Rejmánek and Pitcairn 2002). Eradication is practical only for small-scale infestations, generally in the introduction phase. Eradication of infestations < 1 ha (2.47 acres) in gross area (area over which the weed is distributed) were shown to have the highest likelihood of success in California Only one-third of infestations between 1 and 100 ha were successfully eradicated (Rejmánek and Pitcairn 2002). Thus early detection of an invasive species when the infestation is small can mean the difference between a successful eradication project and implementing a containment strategy that usually means an infinite financial and time commitment.

Containment and Exclusion
The goal of containment is to prevent an infestation which cannot be eliminated from spreading into an uninfested portion of the project area (Hulme 2006, Brooks and Lusk 2008). Containment may involve methods that prevent reproduction and dispersal, treating the perimeter of a large infestation, and/or eliminating small satellite infestations. Containment is most effective with species that spread slowly, move short distances, and for which effective barriers can be established (Hulme 2006).

Exclusion is the reverse of containment: the goal is to eliminate any occurrences within the project area and/or prevent the invasive species from spreading into the project area from the surrounding landscape.

Suppression
The goal of suppression is to reduce an invasive plant population in size, abundance, and/or reproductive output (i.e., density, cover, seed production) below the threshold needed to maintain a species or ecological process (Brooks and Lusk 2008). Suppression should only be undertaken if there is a clear conservation outcome that can be attained with an effective use of resources.

Appendix B

INVASIVE PLANT MANAGEMENT CASE STUDY

The town of Marshland has a significant acreage of town-owned marshes and riparian corridors, some of which have been designated by Massachusetts Natural Heritage and Endangered Species Program's (MNHESP) as BioMap2 Core Habitats and Critical Natural Landscapes, with several occurrences of rare plants and wildlife. Over the years, town residents have observed that larger and larger areas of these wetlands are being overrun with invasive plants, most noticeably by *Phragmites* and purple loosestrife, and have voiced their concern to Marshland's Conservation Commission. In response, the Commission allocated some funds for a survey of the invasive species with the goal of managing the 'worst' infestations. The Commission hired a botanical consultant, supported in the field by trained volunteers, to document and map the invasive plant populations on Marshland's wetlands and to develop a site-based management strategy based on several resource values and feasibility criteria:

1) size and quality of the wetland habitat
2) presence of rare species and outstanding habitats
3) invasive threats/impacts to rare species and habitats
4) probability of infestation to continue to spread in wetland
5) logistical and financial practicality of management

Survey Results

The consultant surveyed and mapped ten wetlands. Five of the wetlands were so overrun with invasive plants or were generally degraded that they were excluded from management consideration. The remaining five wetlands were also invaded, but had resources worth protecting. All of these wetlands are included in the MNHESP's BioMap2.

Wetland 1 is a narrow 1500-foot riparian corridor with an over story of red maple, American elm, and swamp white oak. There is a historic record of a rare plant, winged monkey flower, and wood turtles have occasionally been observed in the stream corridor woodlands. Glossy buckthorn and garlic mustard have invaded much of the forest understory, scattered patches of Japanese knotweed occur at intervals along the stream banks, and oriental bittersweet covers many trees on the upper edges of the stand.

Wetland 2 is a 10-acre beaver meadow with a diverse mix of native species, including a large population of the state-listed bristly crowfoot. American bitterns have been observed in the wetland in the past ten years. The lower end of the wetland has a dense one-acre patch of *Phragmites*, and purple loosestrife is thinly scattered throughout the meadow. A small, but spreading patch of reed canary grass has invaded the upper end of the meadow.

Wetland 3 is a 2.5 acre forested swamp with a mix of mature red maple, yellow birch, black ash, and hemlock on a rich substrate. No rare species have been found here, but it has a good diversity of native plants. Japanese barberry and multiflora rose infest much of the surrounding upland forest and now cover almost an acre of this swamp community.

Wetland 4 is a 6-acre woodland/shrub swamp with a mix of young red maple, tupelo, and Atlantic white cedar, as well as dense patches of highbush blueberry, sweet pepperbush, and winterberry. The community is classified as an Inland Atlantic White Cedar swamp, a rare community. Glossy buckthorn is abundant and well established in the stand, and Morrow's honeysuckle occurs patchily throughout. One side of the swamp borders private property, where the owner has planted burning bush and several Norway maples—these have seeded into this side of the community.

Wetland 5 is a 1.5-acre open meadow with seepages running through it. It has a diverse mix of native grasses, sedges, tall wildflowers, and scattered clumps of shrubs including willow, swamp dogwood and speckled alder. A low open patch of the meadow has small populations of fringed gentian and pendulous bulrush, both watch-listed species, as well as an historic record of adder's-tongue fern. The meadow's diversity of flora attracts a wide variety of butterflies and odonates (inventory still to be done). Japanese barberry and multiflora rose are scattered on the meadow periphery, and a large population of Japanese stiltgrass was recently discovered along a roadside within 200 feet of the meadow.

Management Recommendations

When presented with the results of the survey, Marshland appropriated $7,000 for invasive management of the wetlands which must be spent within one calendar year. Considering that this small sum would have to cover administration, permitting, professional applicator time, and supplies, the consultant decided that in one year at most three of the wetlands could be managed for invasive plants. The consultant emphasized to the town that although one year of treatment will start to substantially control the invasive plants in several of the wetlands as recommended below, a second year of control at a similar cost will be needed to maintain the results of the first year. Some resources will also be needed to organize volunteers to do long-term monitoring and to continue with manual removals for at least five years.

Wetland 1: Defer management. The invasive plant populations are too widespread and abundant to manage on the available budget, and may not be impacting the one known rare species (wood turtle) in the community. However, if volunteers are available, cut the knotweed repeatedly and follow up for 3 to 5 years.

Wetland 2: Control. With a team of three professional applicators assisted by volunteers, cut the *Phragmites* stems and apply a wetland approved glyphosate herbicide to the cut stems. Cut and bag the flowering heads of the purple loosestrife, and swipe the stems with an herbicide-soaked glove. Pull the reed canary grass or use glove (hand-wick) treatment. Time estimate: 3-4 days with three licensed applicators and volunteers.

Wetland 3: Control. Use the cut-stem treatment for larger shrubs, and use a hand-held spray applicator to treat the stems that are too small for cut-stem treatment, avoiding to the fullest possible extent damage to non-target flora. Time estimate: 1-2 days with two licensed applicators.

Wetland 4: Defer Management. Even though this is a listed community, it is not an "outstanding" example of its type, and the invasive populations are too widespread and well-established for management within the existing budget constraints.

Wetland 5: Control. Treat the invasive shrubs (one licensed applicator) on the wetland periphery with cut-stem treatment (large stems) and hand held sprayer (small stems). Because there are many grasses

and sedges in the community, apply a wetland-formulated triclopyr herbicide, which does not affect monocots (sedges and grasses). Recruit volunteers to pull and/or weed-whack the stiltgrass on the road right-of-way. Time estimate: 1 day with one licensed applicator, 1 day volunteer team controlling the stiltgrass.

Management Results and Recommendations for Next Steps

For the three wetlands where control was implemented results were good, but more treatment is needed. If funds are more limited for next year, prioritize work in Wetlands 2 and 5 due to the presence of rare species and communities. Results in wetland 3 may be difficult to maintain if funds are not available to control the invasive plants in the adjacent upland. Document any continued treatment and decisions made. Details on results and next steps for specific wetlands are below:

Wetland 1: If volunteers continue to be available, cut the knotweed repeatedly and follow up for 3 to 5 years. Assess size of knotweed patch each year to document progress.

Wetland 2*:* About 75% of the *Phragmites* stand was treated, and the mortality of the treated stems was greater than 90%. The inflorescences of all mature loosestrife were cut and bagged, and all of the reed canary grass was pulled or treated with herbicide. A monitoring survey the following growing season indicated that ¼ acre of *Phragmites* remained as well as thinly scattered purple loosestrife stems and a small number of reed canary grass stems. Two days in year 2 with two applicators assisted by two or three volunteers should be enough to treat all the remaining *Phragmites*, purple loosestrife, and reed canary grass. In the third year and beyond, local volunteers can monitor the habitat, document results, and pull all new or remaining stems.

Wetland 3: Time limitations and the density of the invasive plants resulted in incomplete control of the site. Most of the larger multiflora rose and barberry stems were treated, but monitoring indicates that hundreds of small ones remain. For the next year, two days with two applicators should be enough to treat the remaining barberry and multiflora stems, primarily by the hand-wick treatment. Because of the likelihood of recruitment from seed and some missed stems, a third year of mop-up herbicide treatment will be necessary. In the third year and beyond, volunteers can monitor the wetland. Funds should also be sought to control the barberry and multiflora on the adjacent uplands.

Wetland 4: This site was not treated in the first year due to budget and time limitations. However, it is a state-listed natural community and funds should be sought to control the glossy buckthorn here for at least three years, with three applicators working an average of three days per year.

Wetland 5: All of the multiflora rose and Japanese barberry were treated, resulting in 90+ % mortality when monitored the second year. Volunteers pulled and weed-whacked most of the Japanese stiltgrass near the meadow, but a few more scattered patches were later found along the roadway.
In the second year, one applicator for one-half day can check and treat any barberry and multiflora rose sprouts. The applicator and volunteers can also pull and whack the stiltgrass along the roadway. In the third year and beyond, volunteers can monitor and control the wetland as well as continue to monitor the stiltgrass.