

Invasive Plant Species and Habitat Management Plan

Saugus Iron Works National Historic Site

Saugus, Massachusetts



Prepared by Bill Fuchs with Contributors Gavin Gardner, Jeremy Bumagin,
Margie Brown, Rachel Vincent, Marc Albert, Kiah Walker, Sophie Gronbeck,
Michelle Lord, Aaron Erzinger, Lindsay Ashley, Emily Booth, Nicholas
Stevenson, Byron Edwards-Coope, Caitlyn Riley, Harley Monteiro, Samantha
Cirillo, and Elizabeth Bernbaum

National Park Service

Final June 2025

Introduction

This management plan provides strategic focus for invasive plant control by identifying the places and invasive species within Saugus Iron Works National Historic Site that are highest priority for invasive species treatment. This plan was created using the Invasive Plant Species and Habitat Management Planning Process developed by Art Gover at Penn State's Wildland Weed Management Unit (Gover 2016). This methodology was further refined by the NPS Northeast Temperate Network Inventory and Monitoring Team and Regional Invasive Plant Management Team and adapted to parks in the Metro Boston Area (Perles et al. 2021 and Shattelroe et al. 2023). The plan includes helpful references in the bibliography and detailed treatment information and prescriptions in appendices.

The invasive plant species and habitat management planning process is based on several important principles:

- Parks have finite resources that can only be directed to a small portion of potential natural resource needs.
- Park-specific data helps inform strategic decisions on how to allocate limited resources toward habitat management. Strategic habitat management is effective by protecting natural resources without wasted effort.
- Protecting the most ecologically significant sites within a park maximizes the benefit to park natural resources per person-hour expended on invasive species management.
- Inaction is more harmful than action. The decision NOT to manage invasive plant species has increasingly negative impacts on the park's natural resources.

This invasive plant species and habitat management plan for Saugus Iron Works National Historic Site:

- 1) Describes the process used to prioritize habitat management zones and invasive species treatments for the park
- 2) Identifies site specific priorities for invasive species management at the park, and
- 3) Provides detailed recommendations for the implementation of invasive species management within the park.

Invasive Plant Management at Saugus Iron Works

Saugus Iron Works National Historic Site (NHS) is located in Essex County in the Town of Saugus, Massachusetts, approximately ten miles north of Boston. The 12.58-acre park preserves the archaeological remains of the first integrated iron works in America (1646–ca.1670), the Iron Works House (ca.1689), and the reconstructed iron works (early 1950s). The park is situated on the east and west banks of the Saugus River at the upper end of the Saugus River estuary and contains natural habitats including river, riverbank, floodplain, mesic forest, marsh, and bordering vegetated wetland (Figures 1 and 2).

The invasive plant management program at Saugus Iron Works NHS focuses on minimizing natural and cultural resource damage caused by invasive plants; enhancing conditions for natural levels of biodiversity and native plant growth; and supporting approved park uses and functions.

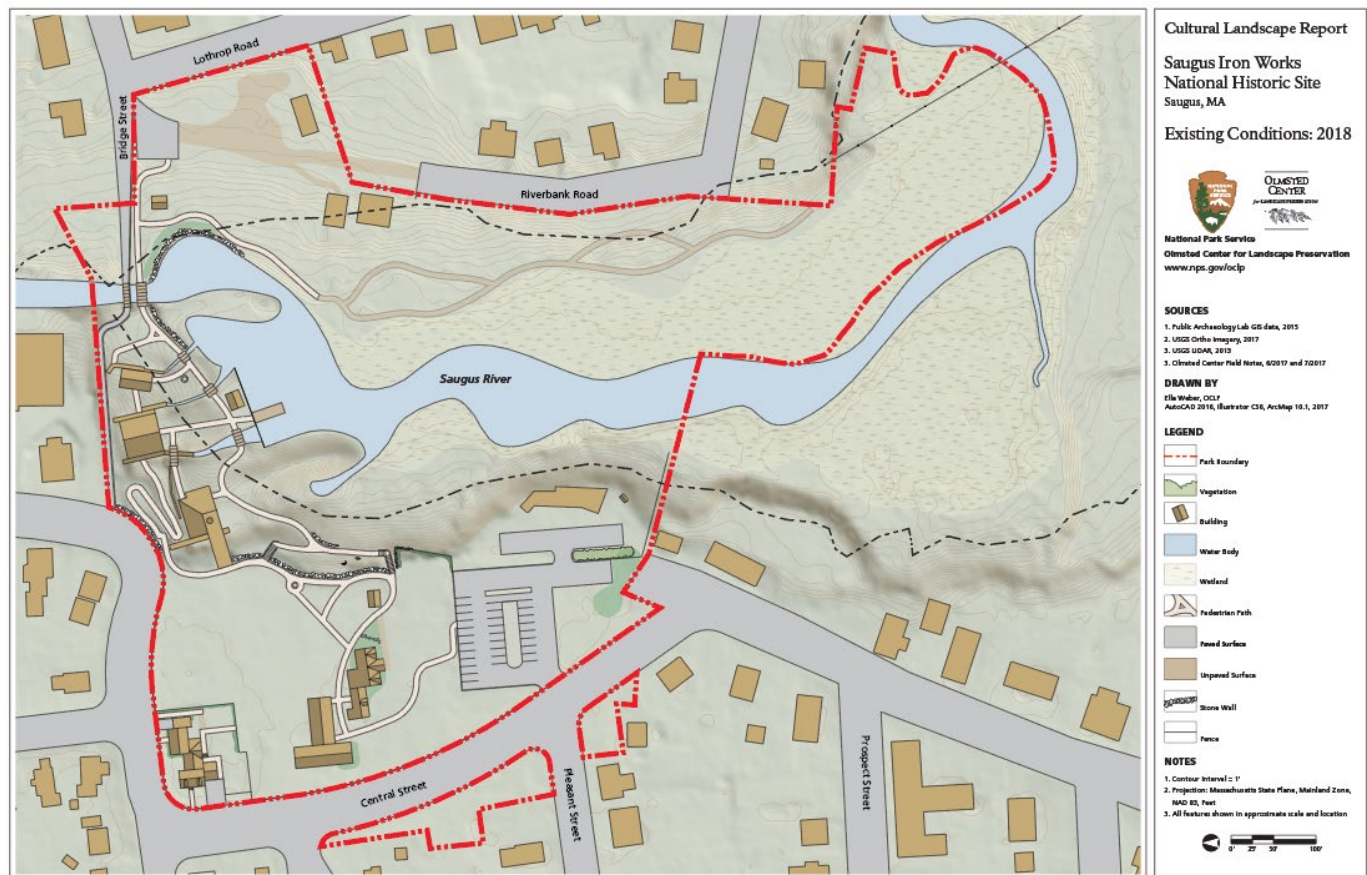


Figure 1. Saugus Iron Works National Historic Site property map showing large parcel and two small parcels totaling 12.58 acres (NPS OC). Lack of invasive plant management would result in the decline of park’s habitats, biodiversity, and the integrity of key cultural resources. The strategic prescriptions presented in this report direct park invasive plant resources to the areas of the park where invasive species management will most benefit the park’s natural and cultural resources.



Figure 2. Aerial photograph of Saugus Iron Works NHS (Modified from Google Earth, 6/2/2024).

Previous major invasive plant control projects occurred in the 1970s and early 2000s. In ca. 1973, a logging operation removed large invasive trees including Tree-of-Heaven (*Ailanthus altissima*) and Norway Maple (*Acer platanoides*) to restore historic viewsheds and reduce invasive species. In 2007, a major restoration project included dredging the Saugus River and bordering vegetated wetlands to remove dense, well established, colonies of phragmites / common reed (*Phragmites australis*). Subsequent restoration planting dramatically shifted habitats within the park toward more natural levels of native plant population density and diversity (Figure 3).

Saugus NHS has benefited from more than two decades of sustained invasive plant management. A biological technician hired in the late 2000s/early 2010s initiated a regular program of invasive plant control that focused on controlling invasive shrubs and tree seedlings and saplings in the Nature Trail and Surrounding Forest and controlling phragmites in the Saugus River corridor. Biological technicians from Saugus Iron Works NHS and the National Park Service's Metro-Boston Invasive Plant Management Team have been actively controlling invasive plants in the park since 2016. The Metro team includes staff, interns, and volunteers from Saugus Iron Works NHS, as well as Boston Harbor Islands National and State Park, Minute Man National Historical Park, and Frederick Law Olmsted National Historic Site. Presently, invasive plant management continues in all areas of the park and is led by the park's Natural Resource Program Manager.

Table 1 lists invasive plant species documented with Saugus Iron Works NHS in 2024. In most areas of the park the percent cover of invasive plants has been dramatically reduced and many invasive plant populations have been reduced to near control threshold levels. Ongoing treatment will continue to reduce invasive plant percent cover and population density and maintain controlled species at or below threshold levels.

This plan is intended to be updated regularly to respond to evolving site conditions and management priorities. Updates will include progress on containing priority invasive species in habitat management zones, detection of novel invasive plant species, rapid response, and re-evaluating park priorities in light of staffing and funding levels.



Figure 3. View looking northwest to the historic forge, warehouse, and wharf reconstruction. The habitat management zones in this area are the West Campus and Open West Bank (NPS OCLP, CLI, 2018).

Table 1. Invasive plant species recorded at Saugus Iron Works NHS, 2024 with treatment thresholds.

Scientific Name	Common Name	Treatment Threshold
<i>Acer platanoides</i>	Norway Maple	Present outside WC. Non-landscape tree in WC
<i>Ailanthus altissima</i>	Tree of Heaven	Present in park
<i>Allaria petiolata</i>	Garlic Mustard	Present in park
<i>Arctium minus</i>	Burdock	Second-year plants (seed producing plants) present
<i>Artemesia vulgaris</i>	Common Mugwort	Population density greater than one plant per square meter
<i>Berberis thunbergii</i>	Japanese Barberry	Present in park
<i>Celastrus orbiculatus</i>	Oriental Bittersweet	Present in park
<i>Centaurea stoebe</i>	Spotted Knapweed	Present in park
<i>Cirsium vulgare</i>	Bull Thistle	Present in park
<i>Disacus fullonum</i>	Wild Teasel	Present in park
<i>Euonymus alatus</i>	Winged Euonymus	Mature plants capable of producing seeds in park
<i>Euphorbia esula</i>	Leafy Spurge	Present in park
<i>Frangula alnus</i>	Glossy Buckthorn	Present in park
<i>Hesperis matronalis</i>	Dames Rocket	Population density greater than one plant per three square meters
<i>Iris pseudacorus</i>	Yellow Iris	Present in park
<i>Ligustrum spp.</i>	Privet	Present in park
<i>Lonicera japonica</i>	Japanese Honeysuckle	Present in park
<i>Lonicera spp.</i>	Shrub Honeysuckle	Plants producing seeds present in park
<i>Lythrum salicaria</i>	Purple Loosestrife	Population density of greater than one plant per five square meters
<i>Phalaris arundinacea</i>	Reed Canary Grass	Present in park
<i>Phragmites australis</i>	Common Reed Phragmites	Population density of greater than one plant per five square meters
<i>Ranunculus repens</i>	Creeping Buttercup	Population density of greater than one plant per square meter in the EC or WC
<i>Reynoutria japonica</i>	Japanese Knotweed	Present in park
<i>Rhamnus cathartica</i>	Common Buckthorn	Present in park
<i>Rosa multiflora</i>	Multiflora Rose	Present in park
<i>Rumex crispus</i>	Curly Dock	Present in park
<i>Securigera varia</i>	Crown Vetch	Population density of greater than one plant per square meter
<i>Verbascum thapsus</i>	Greater Mullein	Population density of greater than one plant per five square meters in the EC or WC

Invasive Plant Management Directives and Guidance

Invasive non-native plants (invasive plants) are plants occurring outside their natural range whose presence is likely to or has caused economic or environmental harm, or harm to human, animal or plant health (Executive Order 13751, 2016). The National Park Service Organic Act (16 U.S.C. 123, and 4), the legislation that created the National Park Service (NPS), directs the NPS to conserve park resources unimpaired:

The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

NPS Management Policies identify invasive plants as an impairment and directs that they be managed if their presence threatens natural or cultural resources, or human health or safety, and if control is feasible. Executive Order #13112 on Invasive Species further instructs all non-defense agencies, including the National Park Service, to control invasive nonnative and not permit new infestations.

Park Invasive Plant Management Planning Priorities

Invasive plants threaten the natural and cultural resources of Saugus Iron Works NHS. The invasive plants reduce native biodiversity, alter habitat structure, suppress native plant growth and regeneration, degrade wildlife habitat, damage infrastructure and pose significant threat of ongoing impairment to the property's native species biodiversity, use, infrastructure, and historic/cultural landscapes.

The park has adopted the following approach to managing invasive plant species:

- 1) Strategically manage invasive plants to protect the park's habitats, native biota, natural processes, historic and cultural resources, and recreational and operational uses
- 2) Use best management practices to limit the introduction and spread of invasive plant seeds and other plant materials by workers, volunteers, visitors, and equipment
- 3) Educate park staff, volunteers, visitors, and others on the impacts of invasive plants and the benefits of invasive plant control, and
- 4) Partner with other organizations and individuals to support invasive plant control in the park and surrounding areas.

As described in the introduction, the project team used the Habitat and Invasive Species Management Planning Process developed by Art Grover of the Penn State Wildland Weed Management Program as our basic decision-making tool and supplemented it with previous treatment records and experiences. This tool is site specific and considers the threats posed by each invasive species, the effort required to control each invasive species and restore native vegetation, and the ecological, cultural, and outreach value of each habitat or area within the park and uses this information to develop a prioritized list of species and habitats/areas for treatment.

Gover's decision-making tool gives highest priority for invasive plant control and habitat management to:

- Sensitive and ecologically significant habitats and species
- Invasive plant species with high potential for spread and where control is feasible and practicable
- Invasive plant species populations with small numbers of individuals and/or novel species/newly established populations, and
- Invasive plants that damage infrastructure or interfere with park operations or recreational use.

Saugus Iron Works NHP also developed site specific priorities that will also be used to guide invasive plant control within the park. These park specific priorities include:

- 1) Treating invasive plants in sensitive natural areas and habitats, areas of high cultural or historic value, and areas of high recreational use value
- 2) Treating established invasive plant populations that have high probability of expanding and/or colonizing new areas
- 3) Treating invasive plants with low numbers of individuals on the site where the invasive species has high potential for invasive behavior
- 4) Preventing the introduction/reintroduction/redistribution of invasive plants within the property
- 5) Restoring disturbed areas to natural levels of biodiversity within Saugus Iron Works NHS habitats managed as natural areas, and
- 6) Documenting current/pre-treatment conditions and monitoring invasive plant management treatment locations to inform future management and treatment actions.

Based on these criteria high priority habitats/areas for invasive plant management include:

- Mesic forest adjacent to the Nature Trail
- Riverbank habitats
- River and bordering vegetated wetlands.
- High visitor and programmatic use areas
- Cultural landscapes

Within these habitats/areas of the park treatment and control of invasive plants will focus on high priority species (species likely to have the highest impact on resources and invasive species that can be controlled or eradicated).

Invasive plant control is a long-term process. Seeds in the soil (the “seed bank”) typically remain viable for five to ten years, so if treatment is stopped before the seed bank is exhausted germinating invasive plant seeds will repopulate previously treated areas and any of these plants that reach maturity will produce seeds that will lead to increased invasive plant population density and recharge the seed bank.

Low density invasive plant populations can be spot treated opportunistically. Denser invasive plant populations are generally best controlled by working from the margins of the population toward the center. This approach minimizes the impact on surrounding vegetation, helps reduce seed spread outside of the original infestation area, and reduces population density.

Preventing the Movement and Spread of Invasive Species

Best management practices to limit the effort required to control invasive plants include preventing the introduction of new invasive species to the park and preventing the movement of established invasive species within the park.

Park staff and volunteers, contractors, visitors and equipment routinely move through the park. Each of these are possible vectors for transporting invasive plant seeds to the park from areas outside the park or within the park on their clothing, shoes, or automobiles.

Park staff and volunteers routinely work controlling invasive plants, maintaining trails, and maintaining lawns and landscaping on the property. These activities create a high probability of workers, and their clothing, shoes, or equipment transporting invasive plant seeds or other propagules throughout the property.

All invasive plant control planning and activities and all other operations at Saugus Iron Works NHS should incorporate best management principles and practices to limit or prevent the unintended spread of invasive plants such as those listed by California Invasive Plant Control (Cal-IPC) and Play Clean Go.

Overall prevention principles (*Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers*, Cal-IPC. 2012) include:

- Plan activities to reduce the potential for invasive plant introduction and spread
- Use best management practices to limit the spread of invasive plant seeds and other plant materials by workers, volunteers, and equipment
- Reduce soil and vegetation disturbance when possible and when disturbance does take place mitigate the disturbance (mulch, seed or plant) and monitor disturbed areas
- Maintain desired plant communities, and
- Practice early detection and rapid response (EDRR) to detect novel species and populations of invasive plants and control them as small populations.

Play Clean Go (<https://playcleango.org/>) recommends that individuals working and engaging in recreational activities (including recreational use and invasive species control) in natural areas do the following:

- Remove plants, animals and mud from boots, clothing, gear, pets, and vehicle before entering and leaving work sites, or when moving between sites (e.g. control sites and disposal sites) on the island
- Clean gear (including tools, carts, equipment) before entering and leaving a work site, or moving between sites within the property
- Stay on designated roads and trails, and
- Use certified or local materials such as mulch and grass for mulching.

At minimum Saugus Iron Works NHS best management practices should include:

- Staff, volunteers, and interns controlling invasive plants should use boot/shoe scrapers or brushes to remove seeds and soils that may contain seeds from their footwear before entering other areas of the park (Figure 4)
- Staff, volunteers, and visitors walking or working in areas with high invasive plant population densities or treating invasive plants should inspect their clothing and remove clinging seeds and other plant materials
- The wheels and undercarriage of carts, wagons, golfcarts and other vehicles should be inspected and cleaned (especially in muddy conditions) to remove seeds and soils and limit transport of invasive plant seeds and plant materials
- When cutting invasive plants, all cut materials should be stockpiled in pre-determined areas that are easy for workers to access during disposal, easy to monitor over time, at distance from sensitive habitats, and where invasive plants that germinate, root, or resprout can be treated, and
- When cutting invasive plants with viable seeds, seeds and seed heads should be cut off the plants and placed in dark or black plastic bags and the bags sealed. The sealed bags can be solarized to

kill the seeds and/or disposed of in a controlled waste receptacle where invasive seeds will not be spread further.

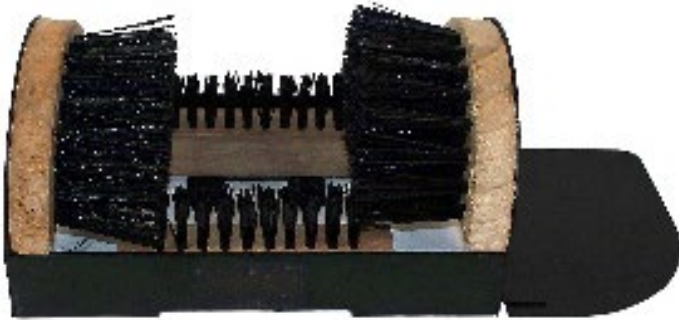


Figure 4. A boot scraper with brushes to remove seeds and soils before moving to other areas.

Refer to *Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers* (Cal-IPC. 2012) for more guidance and <https://playcleango.org/> for more information.

Trails support ease of access and use of the park by humans and animals. Trail use can result in the accidental transportation of significant numbers of invasive plant seeds on shoes, clothing, equipment, animal fur, and animal feces into trail areas, which are then deposited on the trails and trail margins. The transport of these seeds results in the growth of dense stands of invasive plants along trail margins, as was historically seen at Saugus Iron Works NHS.

In summary, reducing invasive plant populations and invasive plant seed production along trails and trail margins is a best management practice. This strategy is especially effective in reducing the spread of invasive plants when adjacent areas do not support dense populations of invasive plants. Best management practices to control invasive plants along trail corridors include:

- Actively control invasive plants along trails and trail margins
- Install and maintain boot/shoe cleaning stations at trailheads to remove soil containing seeds from footwear before people use trails
- Educate the public on the importance of cleaning boots and shoes with informational signs
- Clean equipment (including tires and undercarriage of wheeled equipment) before and after use on trails
- Do not transport or dispose of uncontained invasive plant material or debris on or near trails, and
- Limit or prohibit new trail construction to avoid facilitating transport of invasive species seeds or propagules into new areas.

Invasive Plant Management Techniques

Invasive plant management techniques are usually classified into the following categories:

- A.** Manual
- B.** Mechanical
- C.** Chemical
- D.** Biological

Each treatment is described in greater detail below.

A. Manual Treatment

Manual treatment uses hand tools (or just hands) to remove part or all of an invasive plant. Examples include hand pulling, digging, and cutting (hand pruners, loppers, etc.). These methods remove biomass from the treated plant (or remove the plant entirely) and can be effective in stressing the plant by forcing it to regrow using stored energy, preventing or limiting reproduction by removing stems, flowers or seed heads, and decreasing the plant's ability to compete with surrounding vegetation. Mechanical reduction can be paired with chemical treatment of regrowth to further stress and weaken the treated plant.

Unless all or most of the root system is removed from the ground most manually treated plants will resprout later in the growing season or during the next growing season. Three or more manual treatments per year for several to many years are usually required to kill individual plants. Furthermore, the timing of the cutting can hinder plants ability to store carbohydrates for regrowth.

Manual treatment has the advantage of being relatively easy to carry out using tools that are familiar to many people and are relatively safe to use (except chainsaw use), being highly selective (treats individual plants or small number of plants at a time) and creating relatively little soil disturbance. Disadvantages include being highly labor and time intensive and requiring multiple years of treatment to be effective. Another potential disadvantage is disturbing the soil if the root system is large. Manual treatment can be quite effective in reducing or preventing seed formation and spread.

When treating annual or biennial invasive plants manual treatments should be focused on removing plants or flower heads before seed production. If this is not possible, treatment should include collecting and bagging seed heads for off-site disposal to prevent seed release. Both of these strategies should lead to reduced reproduction and, eventually, decreasing invasive plant population density.

When treating perennial invasive plants manual treatment should focus on the adult plants (plants with the highest potential for producing large numbers of seeds). Larger individuals frequently produce exponentially more seeds than smaller individuals and so the largest individuals should normally be targeted for control.

Manual treatment will be one of the most common type of treatments used by park staff, interns, youth workers, and volunteers at Saugus Iron Works NHS.

B. Mechanical Treatment

Mechanical treatment is the use of mechanized tools (string trimmers, push mowers, and chainsaws) or heavy equipment to remove some or all of an invasive plant. Examples include large mechanical cultivators and mowers, bulldozers, excavators, backhoes, and chippers. These methods have the advantage of being efficient in the use of labor and time and being effective in removing large amounts of unwanted plant biomass. Disadvantages include difficulty transporting equipment to work sites, requirements for a skilled operator, the possibility of creating large areas of disturbed soils, and the potential for requiring expensive equipment and trained operators. Mechanical treatment will rarely be used at Saugus Iron Works NHS.

C. Chemical treatment

Chemical treatment is the use of herbicides or other chemicals to control or kill invasive plants. These methods have the advantage of having a high rate of effectiveness (killing or damaging target plants), being efficient in the use of time and labor, creating little or no soil disturbance. Disadvantages include requiring a state licensed applicator to apply herbicides, possibility of impacting non-target plants, and safe chemical storage requirements. Chemical storage considerations include use of an approved pesticide locker, security, adequate space, an up-to-date inventory of contents, and temperature regulation.

There are many opportunities for chemical treatment of invasive plant species at Saugus Iron Works NHS. Chemical treatment is especially appropriate for woody species (ex. Buckthorn, shrub honeysuckle, multiflora rose, oriental bittersweet, etc.) and species that form dense stands or monocultures (ex. Japanese knotweed), when treating invasive plants in areas where ground disturbance is undesirable (phragmites, purple loosestrife, etc.), or where physical treatment is generally ineffective (Canada thistle, phragmites, buckthorn, etc.).

Chemical treatment with systemic herbicides (herbicides that are absorbed by the plant and translocated through tissues by the plant) are generally more effective than contact herbicides (chemicals that damage tissues on contact) in killing invasive plants and are recommended for use at the park.

Saugus Iron Works NHS regularly uses herbicides to control invasive plants. To facilitate this work, the park:

- Supports park staff in obtaining and maintaining state pesticide applicator certification
- Works with other parks with licensed pesticide applicator staff to treat invasive plants, and
- Executes contracts for herbicide application for small or large projects.

D. Biological Controls

For widely distributed invasive plants, biological controls (also known as biocontrols) are often an effective management option. Biocontrols are host-specific insects or pathogens that feed on only one invasive plant species. The biocontrols weaken the target invasive plant, limiting its spread and its ability

to displace nearby native plants. The use of biocontrols is strictly regulated and guided by federal and state laws, an International Code of Best Practices, and specific protocols that are all designed to ensure the safety and effectiveness of biocontrol programs.

The biological control of purple loosestrife (*Lythrum salicaria*) illustrates how biocontrols can successfully reduce the abundance of highly invasive species to a tolerable level at which they co-exist within native plant communities. From the mid-1990s until the mid-2010s, the Massachusetts Division of Ecological Restoration (DER), Massachusetts Audubon, and partner organizations released two species of loosestrife beetles (*Galerucella californiensis* and *Galerucella pusilla*) that have limited the spread and abundance of purple loosestrife. These beetles were not released at Saugus Iron Works NHS but in the region and have independently colonized the park wetlands and are likely helping keep purple loosestrife in check within the property.

Psyllid insects to control Japanese knotweed (*Reynoutria japonica*) are another biocontrol that would be beneficial at Saugus Iron Works NHS. These insects are currently being released at many field sites in the northeastern US, including in national park units (but not at Saugus Iron Works NHS).

Other biocontrols may become available or may colonize the park from releases in the adjacent areas. Saugus Iron Works NHS has no plans to introduce biocontrols within the park at this time.

Restoring disturbed areas to natural levels of biodiversity within habitats managed as natural areas

Controlling invasive plants often creates substantial changes in local conditions by creating soil surface disturbance, reducing soil moisture, increasing light penetration at the soil surface and into the soil, or reducing percent vegetative cover. These conditions are often favorable for invasive plant seed germination and plant growth. Once invasive plant regeneration or novel invasive plant colonization in treated or otherwise disturbed sites is managed, establishing native plant populations is a critical component of the park's invasive plant management program. Appendix A lists existing and potential native tree, shrub, and herbaceous species likely to colonize within Saugus Iron Works NHS.

E. Native Plant Conservation and Restoration

The long-term goal of this invasive plant management program is to restore the natural areas within the park to natural levels of native plant biodiversity and density. Methods to achieve this goal will include:

- natural regeneration within treatment sites and disturbed areas
- planting native species in treatment sites, disturbed areas, and other areas, and
- seeding using native plant seeds in treatment sites, disturbed areas, and other sites.

F. Natural Regeneration

Natural regeneration of native plant cover occurs when there is a sufficient native seed source, native seed bed, or other native plant sources (roots, stolons, etc.), or high enough existing native plant cover to both occupy an area and compete with new invasive plant growth including seedlings, previously treated/resprouting invasive plants, or existing untreated invasive plants.

Natural regeneration is often the method of choice in invasive plant control areas where a high percent cover of native plant species remains after invasive plant control treatment.

G. Planting or Seeding Native Plants

When natural regeneration is not adequate to provide ground cover planting or seeding with native species is a best management practice to limit colonization of disturbed areas by invasive plants. Native plantings should be wild-types (not ornamental varieties) and, when possible, should be locally sourced from stock from the park or from similar local habitats. New plantings may require supplemental care including watering and selective pruning or clearing around the new planting to reduce competition for light and other resources.

Planting native plants in areas where invasive species have been removed or habitats have been otherwise disturbed will help restore habitats dominated by native species. Appendix A provides native species that are generally recommended for restoration use at Saugus Iron Works NHS. The specific species used for restoration (including species from this list or other species) will depend on the specific site and site conditions, goals of the restoration, and the level of effort needed to support the restoration plantings.

Documenting current/pre-treatment conditions and monitoring invasive plant management treatment locations to inform future actions

At Saugus Iron Works NHS, the park has detailed documentation of invasive plant populations detected and treated throughout the past two decades. The park's pesticide use log and geo-referenced polygons recorded in the National Invasive Species Information Management System (NISIMS) chronicle previous treatments. Park staff continues to evaluate treatment efficacy and site changes. This documentation includes photographs taken from established photo points, estimates of invasive plant population density, and mapping of the extent of the invasive plant infestation and planned treatment area.

As part of this plan, the park will continue to prioritize site documentation and annually monitoring invasive plant populations (photographs, map infested areas, map treatment areas, estimate population density). The park will continue to submit data through NISIMS. In addition, the park will revisit and update this plan, evaluate treatment efficacy, and record changing conditions at the park. This documentation will both inform future management decisions and can be used in educational programs, fund raising efforts, and annual reporting.

H. Early Detection/Rapid Response

Early detection followed by rapid response is the most cost-effective and ecologically strategic method to control invasive species. The goal of early detection/rapid response (EDRR) is to stop the spread of new and emerging invasive species before they become locally established. Routine monitoring facilitates the early detection of novel invasive species and treatment before these species become established improves chances of eradication.

Table 2 contains a watch list of invasive species for early detection and rapid response. These species are either not yet established within the park but are likely to invade given their regional distribution or are found locally in the area surrounding the park but are not yet present in the park.

The early detection watch list should be updated annually based on the changing distribution of local and regional invasive plant species and should be used as guide for monitoring the site. Annual early detection and rapid response surveys of the park should be conducted during field operations.

The early detection watch list can be distributed to staff, volunteers partner agencies, interested neighbors, and outside researchers conducting field work in and around the park.

Table 2. Watch list species for early detection and rapid response surveys at Saugus Iron Works NHS

These species are not currently found at Saugus Iron Works NHS or have been found and eradicated. If found, initiate EDRR protocol described in Section VII of this Invasive Plant Strategy and Habitat Management Plan.

Common Name	Scientific Name
black swallowwort	<i>Cynanchum louiseae</i>
pale swallowwort	<i>Cynanchum rossicum</i>
Canada thistle	<i>Cirsium arvense</i>
Chinese yam	<i>Dioscorea oppositifolia</i>
Datura, Jimson weed	<i>Datura stramonium</i>
giant hogweed	<i>Heracleum mantegazzianum</i>
Japanese stiltgrass	<i>Microstegium vimineum</i>
Kudzu	<i>Pueraria montana</i>
mile-a-minute weed	<i>Persicaria perfoliate</i>
porcelain-berry	<i>Ampelopsis brevipedunculata</i>
tree of heaven	<i>Ailanthus altissima</i>
wild chervil	<i>Anthriscus sylvestris</i>
wine raspberry	<i>Rubus phoenicolasius</i>

Compliance

Completing compliance under the Massachusetts wetland protection act, the Federal Clean Water Act, the federal Historic Preservation Act, National Archeological Protection Act, and other state and federal laws may be required to implement this plan. All compliance will be documented in NPS Planning, Environment, and Public Comment (PEPC) system.

Strategically Treat Invasive Plants

Strategic treatment of invasive plants at Saugus Iron Works NHS will be guided by the principles of integrated pest management as outlined in “A National Road Map for Integrated Pest Management” (2018). This document defines integrated pest management (IPM) as “. . .a sustainable, science-based, decision-making process that combines biological, cultural, physical and chemical tools to identify, manage and reduce risk from pests and [utilizes] pest management tools and strategies in a way that minimizes overall economic, health and environmental risks” and states that “IPM uses knowledge of pest and host biology, as well as biological and environmental monitoring, to respond to pest problems with management tactics and technologies designed to:

- Prevent unacceptable levels of pest damage
- Minimize the risk to people, property, infrastructure, natural resources and the environment
- Reduce the evolution of pest resistance to pesticides
- Utilize best management practices to achieve pest management goals, and
- Defines pests (including invasive plants) as “. . .any organism (microbes, plants or animals) that poses economic, health, aesthetic or environmental risk.”

Invasive Plant Species and Habitat Management Planning

The Invasive Plant Species and Habitat Management Planning Process involves three steps: (A) define habitat management zones, (B) prioritization, and (C) prescription. These steps are described below:

I. Habitat Management Zones (HMZ) for Saugus Iron Works NHS

The park defined seven Habitat Management Zones (HMZ) within Saugus Iron Works NHS that are illustrated in Figure 5. Habitat management zones are discrete areas of the park that are ecologically, culturally, and/or operationally valuable and where invasive species management is feasible. Park HMZs were delineated based on four criteria:

- Areas containing high priority invasive species
- Location of sensitive species and plant communities
- Freshwater wetlands and bordering habitat, and

- Current landscape management practices and operational uses.

These criteria and zones were developed during site visits and discussion with park management, invasive species control team members, and others.

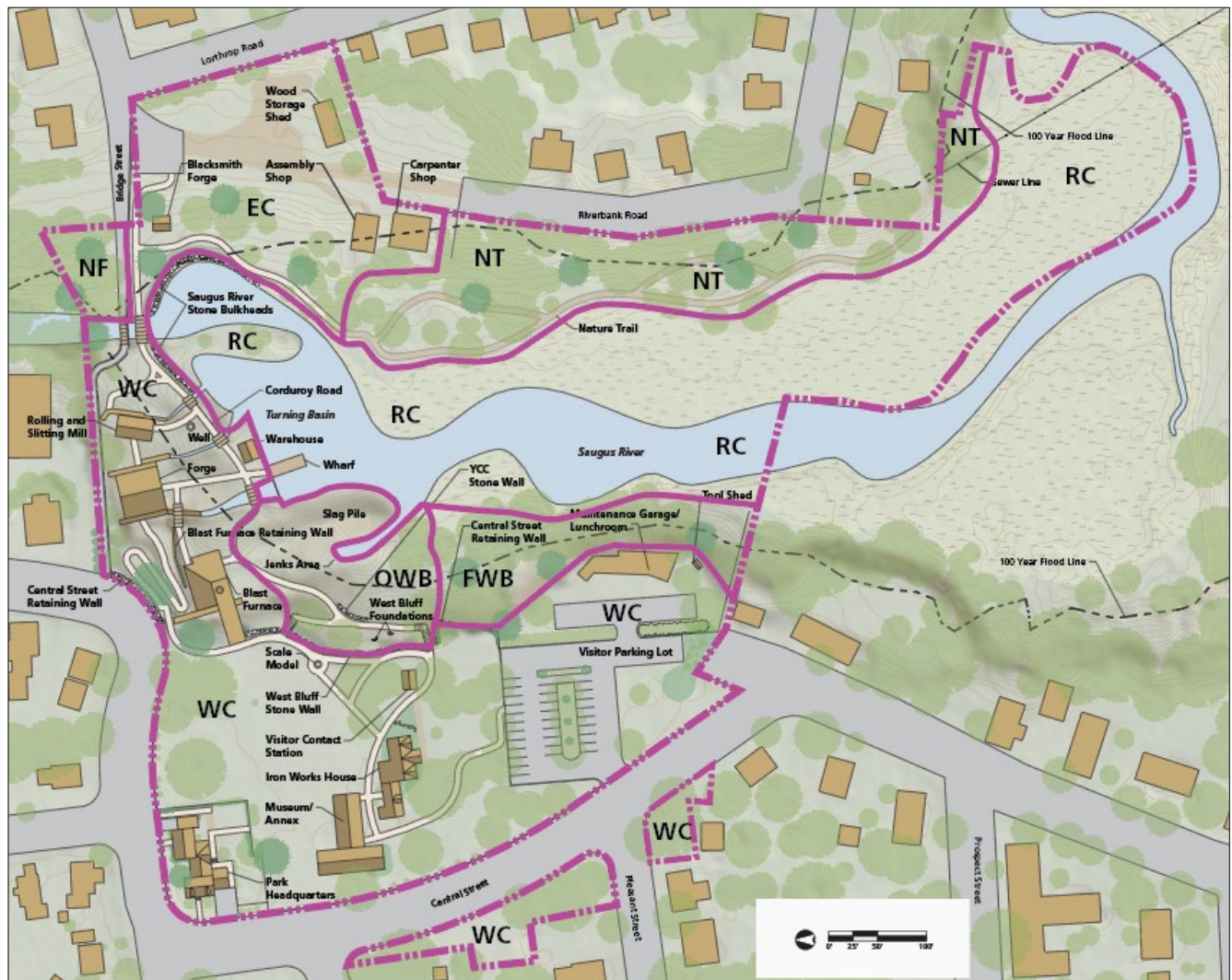


Figure 5. Habitat Management Zones (HMZ) for the treatment of invasive plants within the 12.58-acre Saugus Iron Works NHS (Overlay on map prepared by NPS OCLP, 2018).

- 1) Nature Trail and surrounding forest (NT), spans approximately 2 acres
- 2) River Corridor and bordering vegetated wetlands (RC), spans approx. 3 acres
- 3) Open West Bank (OWB), spans approximately 1 acre
- 4) Forested Westbank (FWB), spans approximately 1 acre
- 5) Northern woodland (north of Bridge Street) (NF), spans approximately 0.1 acre
- 6) East Campus (EC), spans approximately 1 acre
- 7) West Campus (WC), spans approximately 4.5 acres

1) Nature Trail and Surrounds (NT)

The Nature Trail and Surrounds area spans about two acres and includes the narrow strip of land surrounding the nature trail between the east bank of the Saugus River and the park's eastern boundary. The area contains mesic forest habitat with some of the highest percent cover of native species in the park and is the only area in the park where the canopy layer, shrub layer, and herb layer are all primarily composed of native species (Figure 6). Native species in the canopy layer include hickory (*Carya sp.*) and oak (*Quercus sp.*) with some boxelder (*Acer negundo*) and occasional white pine (*Pinus strobus*) and American beech (*Fagus grandifolia*).

Management goals for this this zone include maintaining natural levels of biodiversity and habitat stratification, controlling invasive plants, maintaining maintenance access to the boundary fence, and maintaining safe recreational use of the nature trail (Figure 7).

This area is a high priority for invasive species control. This area is also a high priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park along the trail through this area.



Figure 6. Nature Trail and Surrounds looking north along the Nature Trail. Forest of mixed hardwoods and trail with stone border to east and stone retaining wall to west (NPS, Fuchs, 2024).



Figure 7. View across the Saugus River to the Nature Trail and surrounds, which is the forested area in the upper left of the photograph. Looking southeast from the west side of the Saugus River with River Corridor and Open West Bank areas in the foreground (NPS, 2022).

2) Saugus River Corridor and Bordering Vegetated Wetland Zone (RC)

The Saugus River Corridor spans about three acres and includes the Saugus River and its Bordering Vegetated Wetland zone (BVW) within the park (Figure 8). This section of river forms the upper reach of the Saugus River Estuary. Tidal range (difference of river depth) is commonly three to four feet but is highly variable. The BVW zone is defined by elevation and plant composition and is perennially wet.

Water flow within the Saugus River upstream of the park is influenced by precipitation and by retention or release of water from impoundments controlled by the City of Lynn Water Department. Within the park the height of the Saugus River varies dependent on the stage of tide, amount of precipitation, amount of storm surge, and the volume of water being held or released in upstream impoundments. The riverbed has exposed mud flats at low tide with water only in the main channel. At high tide, water fills the Turning Basin and flats along the Nature Trail, Industrial Site, and other low-lying areas. Sea level rise and increased storm surge due to climate change are predicted to cause regular flooding, habitat alteration, changes to recreational use, and damage to cultural landscapes and historic resources.

The Saugus River and BVW within the park were dredged by the National Park Service in 2007 to remove contaminated sediment deposited following an upstream dam failure (1957) and to remove the dense stand of phragmites that had colonized the sediment. A weir in the river just downstream of the park that restricted tidal flow upriver was removed in 2009. As a result, tidal flow and variation in river salinity increased within the park boundary, often creating tidally controlled brackish conditions in the river in the park (Figures 9 and 10).

Phragmites and purple loosestrife (*Lythrum salicaria*) are the most common invasive plants in this zone and are actively controlled in BVW. Curly pondweed (*Potamogeton crispus*) has been documented in the river during historical species inventories but was not identified during the most recent survey.



Figure 8. Panoramic photograph of Saugus River and bordering vegetated wetlands looking west from the east bank of the river (NPS, Fuchs, 2024).

Following the dredging project, the project team planted native species to reestablish emergent BVW plant communities in the tidal wetlands bordering the main channel of the river. The plantings were partially successful. Since that time, stable plant communities have been established in all habitats within the river corridor.

The Saugus River and slag pile within Saugus Iron Works NHP is under an “Activity and Use Limitation” (DEP Release Tracking Nos. 3-125511, 3-13248) which identifies public uses where the frequency and/or intensity of contact with subsurface soils and sediments on a continuing basis is likely (i.e. repeated and regular digging or wading the river/mud flats). While invasive species control activities are infrequent (several times per year), teams should conduct job hazard analysis before working in this area. Protocols include reviewing treatment approaches, minimizing contact with sediments, and wearing proper PPE (waterproof boots or waders). Post treatment protocols including washing after contact during and after invasive plant management activities in this zone.

This area is a high priority for invasive species control (Figures 11 and 12). This area is also a high priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park from upstream, downstream by tidal inundation, or flooding.



Figure 9. View of the Saugus River before the 2007 dredging project. Dredging removed accumulated sediments and Phragmites that filled the turning basin except for the main channel of the river (NPS, SAIR 10037, 2002).



Figure 10. Similar view of the Saugus River at high tide after the 2007 dredging project (2022) that restored the Turning Basin, removed contaminated sediments, and removed Phragmites and other invasive plants (NPS, Fuchs, 2022).



Figure 11 (left). Aerial photograph of Saugus Iron Works NHP and surrounding properties showing the Saugus River flowing through the park at mid tide.

Figure 12 (right). Enlarged section of Figure 11 showing exposed mud flats at low tide (MassGIS, MassMapper, 2021, <https://maps.massgis.digital.mass.gov/MassMapper/MassMapper>).

3) Open West Bank (OWB)

The open west bank spans about one acre and includes open meadow (wet and dry), shrubland, flood plain between the Saugus River and the flat upland of the west campus, and the slag pile (Figure 13). Management goals for this area include preserving open habitat for pollinators, restoring a diversity of native species, habitat stratification, controlling invasive plants, preserving water quality, maintaining views of the cultural landscape and historic structures (industrial site, blacksmith shop, turning basin, slag pile), supporting interpretive and educational programming, and maintaining safe passage and recreational use.

Vegetation on the slag pile is actively managed to prevent colonization by invasive and native wood vegetation that could damage the structure of the slag pile and to control other invasive plants. Herbaceous native vegetation is currently fostered on the slag pile to help stabilize the slag in place while options for managing long-term stabilization are considered.

The open west bank vegetation is managed in an upper and lower area, which is bisected by the trail in this area. The upper section of the open west bank has upland soils and vegetation and is managed to preserve meadow habitat by annual control of woody plants (vines, shrubs, and trees). The lower section of the open west bank (below the trail) has upland soils and vegetation at the higher elevations and wetland soils and vegetation in the lower section where the area approaches the Saugus River.



Figure 13. Upper East Bank looking north from the Blast Furnace. This part of the HMZ is managed to retain native grasses and wildflowers, including milkweed, to support pollinators (NPS, Fuchs, 2022).

In the upper open west bank, the most abundant invasive plants are oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), burdock (*Arctium minus*), curly dock (*Rumex crispus*), and mugwort (*Artemisia vulgaris*). Also prevalent is crown vetch (*Securigera varia*), which grows on the upper and lower west bank.

Desirable native species in the upper West Bank HMZ are mature dispersed trees and native meadow grasses and forbs. Common milkweed (*Asclepias syriaca*) is fostered here as habitat for monarch butterflies. All woody vegetation except the mature trees is controlled in this area (Figure 14).

In the lower west bank, the most abundant invasive plants include Japanese knotweed (*Reynoutria japonica*), Norway maple (*Acer platanoides*), oriental bittersweet, multiflora rose, burdock, curly dock, dame's rocket (*Hesperis matronalis*), purple loosestrife, and phragmites. Also prevalent is crown vetch. Native species in the lower bank area include black walnut (*Juglans nigra*), ash (*Fraxinus sp.*) and boxelder seedlings and saplings--which are common near the forested west bank. Native willow (*Salix sp.*), dogwood (*Cornus sp.*), button bush (*Cephalanthus occidentalis*) and other native shrubs and small trees on the lower slope are controlled for height to maintain views of the slag pile and industrial site from the east campus and trail to the industrial site from the east campus.

This HMZ is a high priority for invasive species control. This area is also a high priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park in this area via seeds carried on visitor or staff shoes or clothing, flooding or runoff.



Figure 14. Invasive plant control in the lower Open West Bank HMZ. Members of the Future Leaders Program hand cut invasive plants and place the plant waste in large cloth bags for removal and disposal (Panoramic photograph NPS, Fuchs, 2024).

4) Forested West Bank (FWB)

The forested west bank spans about two acres and includes the area above the river corridor and floodplain, south of the open bank area, and below and west of the west campus area (Figure 15). Much of this habitat management zone is composed of steep, erosive slopes that often exceed the angle of repose. These slopes were created by the placement of fill to allow construction the portion of Central Street that formerly passed through the property (prior to the establishment of the park). Maintaining these slopes and limiting sloughing, erosion into the Saugus River, and slope collapse (and subsequent damage to the maintenance garage and parking area) have been limiting factors for invasive plant management in this area. Management goals for this zone include restoring natural levels of biodiversity and habitat stratification, controlling invasive plants, preserving water quality, limiting impact of sea level rise and increased storm surge contributing to erosion of the base of the slope, and preventing erosion and slumping in all areas of the slope.

The canopy layer trees in this zone are a mix of non-native and native trees. An invasive non-native is Norway maple, while a non-invasive non-native is horse chestnut (*Aesculus hippocastanum*). Native species include box elder maple and black walnut. Similarly, understory trees and shrubs are predominantly non-native invasive species include winged euonymus (*Euonymus alatus*), barberry (*Berberis sp.*), multiflora rose, and oriental bittersweet. One native species present is dogwood. The upper slope (drier soils) has large areas of bare soil/leaf litter. The lower slope soils are generally moist to wet and includes several invasive understory plants including Japanese knotweed, burdock, curly dock, and



Figure 15. Forested West Bank HMZ looking south from the Open West Bank HMZ. showing the steep slopes mature trees, and limited understory typical of much of this HMZ (NPS, Fuchs, 2024).

garlic mustard (*Allaria petiolate*) with a high percent cover. A native species in this area is spotted touch-me-knot or Jewelweed (*Impatiens capensis*).

Canopy level trees protect the slope from erosion by breaking the force of heavy rainfall and distributing rain across the slope. Any tree removal or replacement must take this into account to prevent erosion or catastrophic slope failure. Selective thinning to allow light penetration to support development of shrub and groundcover layers of vegetation may be effective in allowing the eventual elimination of Norway maple from the slope.

Runoff from the main parking area runs from an outflow pipe into a stone lined channel to the Saugus River (Figure 16). This runoff has the potential to carry invasive plant seeds to the lower section of this HMZ. There is currently little or no recreational use of this area of the park. Because increased use would likely accelerate erosion on the slope public use of this area is discouraged.

This HMZ is a medium priority for invasive species control treatments. This area is also a medium priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park in this area via flooding or runoff.



Figure 16. The stone lined channel running down the Forested West Bank area to the Saugus River carries storm water from the parking lot to the Saugus River (NPS, Fuchs, 2022).

5) Northern Woodland (NF)

The forested woodland area spans about 0.1 acre and is on the west side of the Saugus River and west of Bridge Street (Figure 17). The area includes a paved pathway and pedestrian bridge that links Bridge Street and Central Street, a rapidly flowing, channelized section of the Saugus River, and mesic forest and floodplain habitat that is highly disturbed and heavily infested with invasive trees, shrubs, and herbaceous plants. This habitat management zone is located within the park's legislative boundary but is outside of the park's boundary fence. Other than routine park and visitor use of the public access bridge and walkway this habitat management zone receives relatively little attention from park staff or visitors aside from occasional invasive plant control (primarily multiflora rose, Japanese knotweed, and oriental bittersweet) and water quality monitoring by the NPS and the USGS.

Management goals for this area include restoring natural levels of biodiversity and habitat stratification, controlling invasive plants, preserving water quality, and minimally maintaining the area so it is safe for occasional passage and recreational use.

The tree canopy layer is primarily composed of Norway Maple. The shrub/vine layer consists mostly of multiflora rose, buckthorn, shrub honeysuckle (*Lonicera sp.*), oriental bittersweet, and Japanese honeysuckle (*Lonicera japonica*). The surface layer contains abundant Japanese knotweed and garlic mustard. Large areas of bare soil persist within this HMZ.

This area is a medium priority habitat management zone for invasive species treatment because of the high percent cover of invasive plants in all trophic zones, despite the low level of public use and awareness associated with the HMZ. This area is also a medium priority for monitoring for watch list species as there is potential of invasive plant seeds entering other parts of the park from this area.



Figure 17. View of the Northern Woodland HMZ looking south along the Saugus River towards the East Campus HMZ showing the canopy of mature Norway maple trees and sparsely vegetated understory typical of the high foot traffic areas in this HMZ (NPS, Fuchs).

6) East Campus (EC)

The east campus (east of the Saugus River) spans about 1 acre and is a managed landscape area that includes pedestrian entrance to the park, walkways, the blacksmith shop and associated lawn, a small parking lot, an unpaved access road, facilities storage and work areas, the carpentry and assembly shops, additional lawn area, and planted trees and shrubs (Figure 18). Management goals for this zone include maintaining the cultural landscape, preserving conditions suitable for safe park operations and public uses, and transitioning non-native landscape trees and plantings to native species.

Most invasive plant control in this area is part of the general landscape/mowing maintenance of the area. This area does not contain high quality natural habitat. It is part of the Saugus River floodplain and includes regulatory wetland resources under the Massachusetts Wetland Protection Act. Invasive plants are generally not included landscape plantings. Other than routine maintenance of the landscape and removal of invasive landscape shrubs this area is a low priority for invasive species control treatments. Most invasive plant in this area are controlled by routine mowing and landscape maintenance activities (Figures 19 and 20).

This area is a high priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park on vehicles and visitor and staff clothing and footwear. Routine surveillance of the east campus should detect any novel species or the expansion of existing invasive species and allow for rapid response and control.



Figure 18. View of the East Campus HMZ from the bridge over the Saugus River looking southeast with the Saugus River in the foreground (NPS, Fuchs, 2024).



Figure 19. View across the East Campus HMZ looking northwest to the West Campus HMZ Industrial Site (left background) and Northern Woodland HMZ (right background). The East Campus HMZ is largely open lawn or soil with scattered mature trees, buildings, and storage areas (NPS, Fuchs, 2025).



Figure 20. East Bank HMZ. Maintenance storage area (NPS, Fuchs, 2025).

7) West Campus (WC)

The West Campus (west of the Saugus River) spans about 4.5 acres and is a managed landscape area of three discontinuous parcels. The area includes the main entrance and parking lot to the park, maintenance garage and office area, Iron Works House, park offices, surrounding lawns and gardens, and the reconstructed iron works industrial site (Figures 21 through 24). The west campus habitat management zone consists entirely of heavily managed lawn, gardens, walkways, buildings, and parking areas typical of urban park public access areas. Management goals for this zone include maintaining the cultural landscape, preserving conditions suitable for safe park operations and public uses, and transitioning non-native landscape trees and plantings to native species.

Most invasive plant control in this area is part of the general landscape/mowing maintenance of the area. This area does not contain high quality natural habitat. Like all areas in the park, this area includes regulatory wetland resources (riverfront area, buffer zone) under the Massachusetts Wetland Protection Act.



Figure 21 (upper left). West Campus HMZ, upper lawn and visitor use area including the Iron Works House and museum (NPS, Fuchs, 2023).

Figure 22 (upper right). West Campus lawn and Industrial Site with historic reconstructions of iron works buildings (NPS, Fuchs, 2024).

Figure 23 (lower left): Main park entrance and parking area (NPS, Fuchs, 2023).

Figure 24 (lower right): Maintenance garage, storage and parking (NPS, Fuchs, 2024).

Invasive plants including Norway Maple, barberry, and winged euonymus are included in landscape plantings and are targeted for removal and replacement with native species as opportunity allows. Mature Norway maples will remain on site until they senesce. Invasive shrubs will be removed as part of the invasive plant management program. Other than routine maintenance of the landscape and removal of invasive landscape shrubs this area is a low priority for invasive species control treatments. Most invasive plant in this area are controlled by routine mowing and landscape maintenance activities.

This area is a high priority for monitoring for watch list species as there is a high likelihood of invasive plant seeds entering the park on vehicles and visitor and staff clothing and footwear. Routine surveillance of the west campus should detect any novel species or the expansion of existing invasive species and allow for rapid response and control.

J. Prioritization of Invasive Plant Species for Treatment

To prioritize invasive plant treatment actions, the project team collected and analyzed existing data on the invasive plant species present at Saugus Iron Works NHS and surrounding areas, including:

- Invasive species treatment records via NISIMS (2016–present).
- NPS monitoring data.
- iNaturalist observations within the park and surrounding area.
- Organizations including the Massachusetts Natural Heritage and Endangered Species Program (MNH&ESP), Massachusetts Invasive Plant Advisory Group (MIPAG), Massachusetts Department of Agricultural Resources (MDAR), Native Plant Trust, Massachusetts Audubon Society, and others.

From this data, the team identified the non-native species known to occur in the seven habitat management zones (HMZs), then categorized the species into three groups:

- 1) Highly invasive species that are known to cause significant negative ecological impacts were given high priority for treatment (e.g., Japanese knotweed, common buckthorn, Japanese honeysuckle, phragmites, and others).
- 2) Other invasive species known to cause some ecological impact that grow in the HMZs were categorized as “regular” invasive species with a lower level of priority for treatment (dames rocket, greater mullein, and others).
- 3) Weedy non-native species (dandelions, greater celandine, and others) that are present but rarely competitively exclude native species or cause other significant ecological harm. These species were excluded from prioritization for treatment.

The team evaluated the level of infestation of invasive species in each HMZ, the potential detrimental impacts of these species, the difficulty of managing these invasives, and restoration effort required in each habitat. Treatment recommendations are a result of consideration of all of these inputs and are intended to provide strategic direction for managers to best protect high priority sites within the property. Based on these considerations the park identified three levels of prioritization listed below and in Table 3.

Highest Priority

- Nature Trail and Surrounds (NT),
- River Corridor and surrounding Bordering Vegetated Wetlands (RC)
- Open West Bank meadow and shrub areas (OWB)

Medium Priority

- Forested West Bank woodland (FWB)
- Northern Forest woodland, north of Bridge Street (NF)

Lowest Priority

- East Campus (EC)
- West Campus (WC)

Table 3. Treatment Priorities by Habitat Management Zones and Invasive Plant Species

Red = Highest Priority; Orange = Medium Priority; Yellow = Low priority; White = none of this species in this HMZ. Numbers ranging from 0 to 5 indicate priority for management. Specific treatments are listed in Appendix B. Stewardship Index (0-2) rates ecological value of the HMZ. Outreach Index (0-2) rates how other stakeholders value the HMZ.

Habitat Management Zone	Nature Trail and Surrounds (NT)	River Corridor and BVW (RC)	Open West Bank (OWB)	Forested West Bank (FWB)	North Forest, N of Bridge Street (NF)	East Campus (EC)	West Campus (WC)
Stewardship Index	2	2	2	1	1	0	0
Outreach Index	2	2	2	1	1	0	0
Invasive Species							
Norway maple	4	5	4	4	4	4	4
exotic shrubs	4	4	4	4	4	4	4
multiflora rose	4	4	4	4	4	4	4
Japanese barberry	4	0	0	4	0	4	4
common buckthorn	4	0	0	5	0	0	0
exotic biennials	3	4	3	3	3	3	3
winged euonymus	4	0	0	3	3	0	4
privet	0	0	0	4	4	0	4
shrub honeysuckle	0	0	0	5	4	4	4
yellow flag iris	0	4	0	0	0	0	0
bull thistle	0	0	4	0	0	0	3
common teasel	3	0	4	0	0	0	3
Oriental bittersweet	3	3	3	3	3	3	3
woody vines	3	3	3	3	3	3	3
garlic mustard	3	0	3	3	3	3	3
tree-of-heaven	3	0	0	0	0	0	0
Japanese honeysuckle	3	0	0	0	3	0	0
Japanese knotweed	0	3	2	0	0	0	0
Phragmites	0	3	0	0	0	0	0
purple loosestrife	0	3	0	0	0	0	0
dames rocket	0	0	3	3	0	0	0
spotted knapweed	0	0	0	0	0	0	3
crownvetch	0	0	2	0	0	0	2
reed canary grass	0	0	2	0	0	2	0

Table 4. Ranked Treatment Priority of Invasive plants at Saugus Iron Works NHS, 2024.

Scientific Name	Common Name	Treatment Priority
<i>Reynoutria japonica</i>	Japanese Knotweed	1
<i>Lonicera japonica</i>	Japanese Honeysuckle	2
<i>Allaria petiolata</i>	Garlic Mustard	3
<i>Phragmites australis</i>	Common Reed /Phragmites	4
<i>Lythrum salicaria</i>	Purple Loosestrife	5
<i>Rosa multiflora</i>	Multiflora Rose	5
<i>Disacus fullonum</i>	Wild Teasel	6
<i>Celastrus orbiculatus</i>	Oriental Bittersweet	7
<i>Frangula alnus</i>	Glossy Buckthorn	8
<i>Arctium minus</i>	Burdock	9
<i>Centaurea stoebe</i>	Spotted Knapweed	10
<i>Rumex crispus</i>	Curly Dock	11
<i>Acer platanoides</i>	Norway Maple	12
<i>Ailanthus altissima</i>	Tree of Heaven	13
<i>Rhamnus cathartica</i>	Common Buckthorn	14
<i>Phalaris arundinacea</i>	Reed Canary Grass	15
<i>Berberis thunbergii</i>	Japanese Barberry	16
<i>Euphorbia esula</i>	Leafy Spurge	16
<i>Ligustrum spp.</i>	Privet	17
<i>Artemesia vulgaris</i>	Common Mugwort	18
<i>Securigera varia</i>	Crown Vetch	19
<i>Lonicera spp.</i>	Shrub Honeysuckle	20
<i>Hesperis matronalis</i>	Dames Rocket	21
<i>Euonymus altas</i>	Winged Euonymus	22
<i>Cirsium vulgare</i>	Bull Thistle	23
<i>Iris pseudacorus</i>	Yellow Iris	24
<i>Verbascum thapsus</i>	Greater Mullein	25
<i>Ranunculus repens</i>	Creeping Buttercup	26

K. Prescriptions for Invasive Plant Treatment

Prescriptions for each invasive plant species present at Saugus Iron Works NHS are listed in Appendix B. The prescriptions specify **who** will be doing the work, **how** the invasives will be managed, and **when** the management should be conducted for priority invasive species and priority habitat management zones listed in Table 3. Additional information on invasive species present at Saugus Iron Works is included in Appendix C.

Other invasive species not specified by this plan or with lower priority may be treated while crews are in the habitat management zones targeting higher priority species. Thus, species with lower ranks (e.g., 4, 5, 6) in Table 3 can also be treated when operationally efficient. For example, all invasive shrubs should be treated at the same time within a priority zone, even if the various shrub species received different priority rankings.

Invasive management prescriptions that use herbicides require a certified pesticide applicator, someone who has completed the required trainings and licensure to use herbicides. All invasive plant treatments should be recorded through NISIMS. All pesticide use should also be recorded in a daily pesticide use log and reported to the Massachusetts Department of Agricultural Resources.

Bibliography

- Cal-IPC. 2012. Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd ed.). Cal-IPC Publication 2012-03. California Invasive Plant Council, Berkeley, CA. Available at www.cal-ipc.org.
- Executive Office of the President. 2016. Executive Order 13751 of December 5, 2016: Safeguarding the Nation from the Impacts of Invasive Species. Federal Register 81 FR 88609, page 88609-88614 (6 pages), Document Number 2016-29519.
<https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species>
- Gawler, S. C., R. E. Zaremba, and Cogan Technology, Inc. 2017. Vegetation mapping inventory project: Saugus Iron Works National Historic Site, Massachusetts. Natural Resource Report NPS/MIMA/NRR—2017/1450. National Park Service, Fort Collins, Colorado.
- Gover, A. 2016. Introduction to the Habitat and Invasive Species Management Planning Process. Pennsylvania State University Wildland Weed Management.
<https://plantscience.psu.edu/research/projects/wildland-weed-management>.
- Miller, K. M., B. J. McGill, A. S. Weed, C. E. Seirup, J. A. Comiskey, E. R. Matthews, S. Perles, and J. Paul Schmit. 2020. Long-term trends indicate that invasive plants are pervasive and increasing in eastern national parks. Ecology. 31(2): e02239. 10.1002/eap.2239.
<https://doi.org/10.1002/eap.2239>
- Perles, Stephanie, N. Stevenson, M. C. Brown, A. L. Fox, K. M. Miller, and C. E. Seirup. Invasive Plant Species and Habitat Management Plan for Minute Man National Historical Park. 2021.
- Shattelroe, Marietta, M. Albert, R. S. Vincent, A. Van Boer, N. Stevenson, K. M. Miller, C. E. Seirup, S Perles, and E. Booth. 2023. Invasive Plant Species and Habitat Management Plan for Boston Harbor Islands National Recreation Area.
- Swain, P. C. and J. B. Kearsley. 2001. Classification of the Natural Communities of Massachusetts. Version 1.3. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- Tierney, G., B. Mitchell, K. Miller, J. Comiskey, A. Kozlowski, and D. Faber-Langendoen. 2014. Northeast Temperate Network long-term forest monitoring protocol: 2014 revision. Natural Resource Report NPS/NETN/NRR—2014/805. National Park Service, Fort Collins, Colorado
- United States Department of Agriculture. 2018. A National Road Map for Integrated Pest Management Revised September 21, 2018. <https://www.usda.gov/sites/default/files/documents/IPM-Road->

Map-FINAL.pdf

United States Department of the Interior, National Park Service, Region 1 Inventory and Monitoring Division. 2020. NPS Region 1 Invasive Plant Tool. Inventory & Monitoring Division - NPS Region1 Invasive Plants Tool 12-2020.pdf - All Documents (sharepoint.com)
(<https://doimsp.sharepoint.com/sites/nps-nrss-imdiv/Northeast%20Region/Forms/AllItems.aspx?id=%2Fsites%2Fnps%2Dnrss%2Dimdiv%2FNortheast%20Region%2FEastern%20Invasive%20Species%2FNPS%20Region1%20Invasive%20Plants%20Tool%5F12%2D2020%2Epdf&parent=%2Fsites%2Fnps%2Dnrss%2Dimdiv%2FNortheast%20Region%2FEastern%20Invasive%20Species>)

APPENDIX A: Native Species Recommended for Saugus Iron Works NHS

Appendix A-1. Native woody species recommended for use in restoration at Saugus Iron Works NHS

Layer	Species	Wetland Edge	Upland
Canopy	<i>Acer rubrum</i> (red maple)	X	X
	<i>Acer saccharinum</i> (silver maple)	X	X
	<i>Betula alleghaniensis</i> (yellow birch)	X	X
	<i>Betula papyrifera</i> (white birch)	X	X
	<i>Betula populifolia</i> (gray birch)	X	X
	<i>Pinus strobus</i> (white pine)		X
	<i>Quercus alba</i> (white oak)	X	
	<i>Quercus coccinea</i> (scarlet oak)		X
	<i>Quercus palustris</i> (pin oak)	X	
	<i>Quercus rubra</i> (red oak)	X	X
	<i>Quercus velutina</i> (black oak)		X
Subcanopy	<i>Carpinus caroliniana</i> (American hornbeam/ musclewood)	X	X
	<i>Juniperus virginiana</i> (Eastern redcedar) in sunny areas		X
	<i>Cornus sericea</i> (red-osier dogwood)	X	X
	<i>Salix nigra</i> (black willow)	X	
	<i>Sassafras albidum</i> (sassafras)		X
Shrub	<i>Alnus incana</i> (speckled alder)	X	
	<i>Cephalanthus occidentalis</i> (buttonbush)	X	
	<i>Clethra alnifolia</i> (sweet pepper bush)	X	
	<i>Cornus amomum</i> (silky dogwood)	X	
	<i>Cornus racemose</i> (gray dogwood)		X
	<i>Rhus typhina</i> (staghorn sumac)		X
	<i>Rubus allegheniensis</i> (common blackberry)		X
	<i>Rubus occidentalis</i> (black raspberry)		X
	<i>Spiraea alba</i> (white meadowsweet)	X	X
	<i>Vaccinium corymbosum</i> (highbush blueberry)	X	X

Appendix A-2. Native herbaceous and graminoid species recommended for use in restoration at Saugus Iron Works NHS

Species Name	Common Name	Sun	Semi Shade	Shade	Benefitting Organisms	Cost & Sources
<i>Agrostis perennans</i>	Autumn bentgrass	X	X		Bird, Mammal	\$14.00/lb seed (Ernst Seed)
<i>Andropogon gerardii</i>	Big Bluestem	X			Bird, Mammal, Pollinator habitat	\$14.00/lb seed (Ernst Seed)
<i>Andropogon glomeratus</i>	Bushy Bluestem	X			Bird, Insect, pollinator habitat	\$100.00/lb seed (Ernst Seed)
<i>Asclepias syriaca</i>	Common Milkweed	X			Insect, pollinator food	~\$5.00/plant (Prairie Nursery)
<i>Asclepias tuberosa</i>	Butterfly Milkweed	X			Insect, pollinator food	\$7.00/plant (American Meadows)
<i>Aster laevis</i>	Smooth Blue Aster	X			Mammal, pollinator food	\$5.00/plant (Prairie Nursery)
<i>Bouteloua curtipendula</i>	Side-oats Grama'	X			Bird, Mammal	\$12.00/lb seed (Ernst Seed)
<i>Carex appalachica</i>	Appalachian Sedge		X	X		
<i>Carex crinita</i>	Fringed Sedge	X	X			
<i>Carex eburnea</i>	Bristle-leaved Tickseed	X	X	X	Insect, pollinator food	
<i>Comptonia peregrina</i>	Sweet Fern	X	X		Bird, Insect, pollinator habitat	~\$8.00/plant (Prairie Nursery)
<i>Coreopsis verticillata</i>	Thread-leaved Tickseed	X	X			
<i>Elymus virginicus</i>	Virginia Wildrye		X		Bird, Mammal, pollinator habitat	
<i>Eupatorium hyssopifolium</i>	Hyssop-leaved Boneset	X			Bird	
<i>Eupatorium perfoliatum</i>	Boneset Thoroughwort		X		Bird, Insect, pollinator food	
<i>Eurybia divaricata</i>	White Wood Aster			X	Insect, pollinator food	
<i>Eutrochium maculatum/ Eupatorium maculatum</i>	Spotted Joe-Pye Weed	X			Insect, pollinator food	~\$5.00/plant (Prairie Nursery)
<i>Festuca rubra</i>	Red fescue	X				
<i>Ionactis linariifolius</i>	Stiff Aster	X	X	X	Mammal, pollinator food	
<i>Panicum virgatum</i>	Switchgrass	X	X		Bird, Insect, pollinator habitat	
<i>Pycnanthemum incanum</i>	Hoary Mountainmint	X	X		pollinator food	

<i>Pycnanthemum tenuifolium</i>	Narrow Leaf Mountainmint	X	X		Bird, Insect, pollinator food	\$140.00/lb seed (Ernst Seed)
<i>Rudbeckia hirta</i>	Black-eyed Susan	X			Bird, Mammal, pollinator food	
<i>Rudbeckia triloba</i>	Brown-eyed Susan	X			Bird	~\$5.00/plant (Prairie Nursery)
<i>Schizachyrium scoparium</i>	Little Bluestem	X	X		Bird, Mammal, pollinator habitat	\$37.95/lb seed (American Meadows)
<i>Solidago caesia</i>	Blue-stemmed Goldenrod	X	X		Bird, Insect, pollinator food	~\$5.00/plant (Prairie Nursery)
<i>Solidago juncea</i>	Early Goldenrod	X	X	X	pollinator food	\$280.00/lb seed (Ernst Seed)
<i>Solidago nemoralis</i>	Gray Goldenrod	X	X	X	Bird, Insect, pollinator food	\$360.00/lb seed (Ernst Seed)
<i>Solidago odora</i>	Licorice Goldenrod		X	X	Bird, pollinator food	\$320.00/lb seed (Ernst Seed); \$5.00/plant (Prairie Nursery)
<i>Sorghastrum nutans</i>	Indian Grass	X			Bird, Mammal, pollinator habitat	
<i>Symphotrichum leave</i>	Smooth American Aster	X			Insect, pollinator food	\$3.95/seed packet (American Meadows)
<i>Symphotrichum novae-angliae</i> , <i>Aster novae-angliae</i>	New England Aster	X	X		Bird, Mammal, pollinator food	~\$5.00/plant (Prairie Nursery)
<i>Symphotrichum novi-belgii</i>	New York American Aster	X			Insect, pollinator food	
<i>Tradescantia ohiensis</i>	Ohio Spiderwort		X		pollinator food	~\$5.00/plant (Prairie Nursery)
<i>Verbena hastata</i>	Blue Vervain	X	X		pollinator food, Bird seed	\$4.25/pkt (Wildseedproject.net) \$1.10 /plug (NEWP)
<i>Vernonia noveboracensis</i>	New York Ironweed	X			Pollinator	\$4.25/pkt (Wildseedproject.net) \$1.45 /plug (NEWP)
<i>Veronicastrum virginicum</i>	Culver's Root	X	X		Insect, pollinator food	~\$5.00/plant (Prairie Nursery)

APPENDIX B: Treatment Prescriptions and Calendars

Appendix B-1. Recommended Treatment Calendar for Priority Invasive Plant Species, Saugus Iron Works NHS

Month	Monthly Treatment Priorities
January	Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem*
February	Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem*
March	Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem*
April	Garlic mustard-hand pull second-year plants, foliar spray dense populations [NT, OWB] Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem*
May	Garlic mustard-hand pull second-year plants, foliar spray dense populations [NT, OWB] Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem*
June	Survey for novel invasives Garlic mustard-hand pull, foliar spray dense populations [NT, OWB] Japanese honeysuckle-foliar or cut stem [NT] Invasive trees, shrubs, and woody vines-hand pull seedlings [NT, RC, OWB]*
July	Japanese knotweed- hand cut, cut stem, or foliar spray [RC, OWB] Garlic mustard-hand pull, foliar spray dense populations [NT, OWB] Japanese honeysuckle-foliar or cut stem [NT] Phragmites-cut stem [RC, OWB] Purple loosestrife- cut stem [RC, OWB] Wild teasel-hand pull or foliar spray [NT, RC, OWB, EC] Burdock-foliar spray [NT, OWB, WC] Curly Dock- foliar spray, hand cut and bag seed heads [NT, WC] Yellow Iris-hand pull or foliar spray [RC, EC]
August	Survey for novel invasives Japanese knotweed- hand cut, cut stem, or foliar spray [RC, OWB] Garlic mustard-hand pull, foliar spray dense populations [NT, OWB] Japanese honeysuckle-foliar or cut stem [NT] Phragmites-cut stem [RC, OWB] Purple loosestrife- cut stem [RC, OWB] Wild teasel-hand pull or foliar spray [NT, RC, OWB, EC] Burdock-foliar spray [NT, OWB, WC] Curly Dock- foliar spray, hand cut and bag seed heads [NT, WC]
September	Survey for novel invasives Japanese knotweed- hand cut, cut stem, or foliar spray, hand cut and bag seed heads [RC, OWB] Garlic mustard-hand pull, foliar spray dense populations, hand cut and bag seed heads [NT, OWB] Japanese honeysuckle-foliar spray or cut stem [NT] Phragmites-cut stem [RC, OWB] Wild teasel-foliar spray, hand cut and bag seed heads [NT, RC, OWB, EC] Burdock-foliar spray, had cut and bag seed heads [NT, OWB, WC] Curly Dock- foliar spray, hand cut and bag seed heads [NT, WC]
October	Survey for novel invasives Japanese honeysuckle-foliar spray or cut stem [NT] Phragmites-hand cut and bag seed heads [RC, OWB] Purple loosestrife-hand cut and bag seed heads [RC] Wild teasel-hand cut and bag seed heads [NT, RC, OWB, EC] Burdock-hand cut and bag seed heads [NT, OWB, WC]
November	Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem.*
December	Invasive trees, shrubs and woody vines [NT, RC, OWB]-cut stem.*
Notes	* Invasive trees, shrubs and vines include: Norway maple, Ailanthus, common and glossy buckthorn, Japanese barberry, privet, winged euonymus, multiflora rose, and oriental bittersweet.
	Habitat Management Zones: NT: Nature Trail and surrounding forest, RC: River Corridor, OWB: Open West Bank, FWB: Forested West Bank, NF: Northern Forest, EC: East Campus, WC: West Campus.

Appendix B-2. Treatment Options for Invasive Plant Species, Saugus Iron Works NHS

Species	HMZ	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
bull thistle	OWB WC					Foliar (Broadleaf), targeted removal		Cut and bag seed heads, targeted removal					
common buckthorn	FWB NT	Cut stem herbicide, hand cut		Hand cut		Cut stem herbicide, hand cut							
phragmites	RC						Cut stem herbicide, hand cut						
common teasel	NT WC					Targeted removal, foliar spray		Targeted removal, cut & bag seed heads, cut stem, foliar spray		Targeted removal, cut & bag seed heads			
crown vetch	OWB				Cut (mow), foliar spray								
dames rocket	FWB OWB				Hand pull		Hand pull, cut and bag seed heads						
garlic mustard	NT OWB FWB NF EC WC				Hand pull second year plants, foliar spray dense stands of first year plants			Hand pull second year plants, hand cut and bag seed heads					
Japanese barberry	NT FWB EC WC	Hand cut, cut stem herbicide						Hand cut, cut stem herbicide, cut and bag seeds.					
Japanese honeysuckle	NT	Hand cut, cut- stem herbicide		Hand cut, cut-stem herbicide, foliar spray								Hand cut, cut-stem herbicide	
	RC	Hand cut, cut-stem herbicide		Hand cut, cut-stem herbicide, foliar spray								Hand cut, cut-stem herbicide	
	OWB						Hand cut, cut-stem herbicide, foliar spray						
	NF	Hand cut, cut-stem herbicide		Hand cut, cut-stem herbicide, foliar spray								Hand cut, cut-stem herbicide	
Japanese knotweed	RC				Hand cut, cut-stem herbicide, foliar spray								

Species	HMZ	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
multiflora rose	OWB												Hand cut, cut stem herbicide	
	NF	Hand cut, cut-stem herbicide		Hand pull, hand cut,		Hand cut, cut stem herbicide, foliar spray, cut and bag seeds						Hand cut, cut stem herbicide		
	OWB													
	FWB													
	NF													
EC														
WC														
Norway maple	NT	Hand pull seedlings, hand cut, cut stem herbicide		Hand cut,		Hand pull seedlings, hand cut, cut stem herbicide, foliar spray				Hand pull seedlings, hand cut, cut stem herbicide				
	RC													
	OWB													
	FWB													
	NF													
EC														
WC														
Asian bittersweet	NT	Hand pull seedlings, hand cut, cut stem herbicide		Hand pull, hand cut,		Hand pull seedlings, hand cut, cut stem herbicide, foliar spray				Hand pull seedlings, hand cut, cut stem herbicide				
	RC													
	OWB													
	FWB													
	NF													
EC														
WC														
Privet	FWB	Hand cut, cut-stem herbicide		Hand pull, hand cut,		Hand cut, cut-stem herbicide, foliar spray, cut and bag seeds						Hand cut, cut-stem herbicide		
	NF													
	WC													
purple loosestrife	RC						Hand cut, cut-stem herbicide		Hand cut, cut-stem herbicide, cut and bag seed heads		Hand cut, cut & bag seed heads			
reed canarygrass	OWB		Pre-emergent herbicide			Cut (mow), foliar herbicide			Cut (mow),cut and bag seed heads, foliar herbicide		Cut and bag seed heads			
	WC													
shrub honeysuckle	FWB	Hand cut, cut-stem herbicide		Hand pull, hand cut,		Hand cut, cut-stem herbicide, foliar spray, cut and bag seeds						Hand cut, cut-stem herbicide		
NF														
spotted knapweed	WC				Targeted removal, foliar spray				Targeted removal, foliar spray, cut and bag seed heads		Targeted removal, cut and bag seed heads			
tree-of-heaven	NT	Hand pull cut-stem herbicide								Hand pull cut-stem herbicide				
winged euonymus	NT	Hand cut, hand pull, cut-stem herbicide					Hand cut, hand pull, cut-stem herbicide							
	NF													
	FWB													
	WC													
yellow flag iris	RC						Hand pull, foliar spray		Hand pull, foliar spray, cut/bag seed heads					

Appendix B-3. Treatment Calendar Sorted by Area at Saugus Iron Works NHS

HMZ	Species	Timing*																							
		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
East Campus	garlic mustard						Foliar spray dense stands of first-year plants. Hand pull second-year plants.					Hand pull second-year plants. Hand cut and bag seed heads.													
	Japanese barberry	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads					Cut-stem herbicide, hand cut, hand cut and bag seed heads												
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads					Cut-stem herbicide, hand cut, hand cut and bag seed heads												
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut				Cut-stem herbicide, hand cut																
	Oriental bittersweet	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																	
	reed canary grass							Foliar spray, hand cut and bag seed heads																	
Forested West Bank	common buckthorn	cut-stem herbicide			Hand cut			Cut-stem herbicide																	
	dames rocket							Hand pull, hand cut and bag seed heads																	
	garlic mustard					Foliar spray dense stands of first-year plants. Hand pull second year plants. Hand cut and bag seed heads.																			
	Japanese barberry	Cut-stem herbicide			Hand cut					Cut-stem herbicide															
	multiflora rose	Cut-stem herbicide			Hand cut					Cut-stem herbicide															
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut					Cut-stem herbicide, hand cut															
	Oriental bittersweet	Cut-stem herbicide			Hand pull seedlings, hand cut					Cut-stem herbicide															
	Privet	Cut-stem herbicide			Hand pull seedlings, hand cut					Cut-stem herbicide															
	shrub honeysuckle	Cut-stem herbicide			Hand pull seedlings, hand cut					Cut-stem herbicide															
	winged euonymus	Cut-stem herbicide			Hand pull seedlings, hand cut					Cut-stem herbicide															

HMZ	Species	Timing																									
		J		F		M		A		M		J		J		A		S		O		N		D			
Nature Trail and Surrounds	common buckthorn	Cut-stem herbicide			Hand cut				Cut-stem herbicide																		
	common teasel								Targeted removal, foliar spray					Targeted removal, cut and bag seed heads, foliar spray			Targeted Removal, cut and bag seed heads										
	garlic mustard							Foliar spray dense stands of first-year plants. Hand pull second-year plants.						Hand pull second-year-plants. Hand cut and bag seed heads.													
	Japanese barberry	Cut-stem herbicide, hand cut			Hand pull, hand cut				Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																		
	Japanese honeysuckle	Hand cut, hand pull, Cut-stem herbicide			Hand cut, Hand pull, Cut-stem herbicide, foliar spray																		Hand cut, hand pull, Cut-stem herbicide				
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut				Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																		
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut				Cut-stem herbicide, hand cut																		
	Oriental bittersweet	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut				Cut-stem herbicide																		
	tree-of-heaven	Hand pull, cut-stem herbicide, basal bark herbicide			Hand pull seedlings				Hand pull, cut-stem herbicide, basal bark herbicide, foliar herbicide					Hand pull, cut-stem herbicide, basal bark herbicide													
	winged euonymus	Cut-stem herbicide			Hand pull seedlings, hand cut				Cut-stem herbicide																		

HMZ	Species	Timing																													
		J		F		M		A		M		J		J		A		S		O		N		D							
North of Bridge Street	garlic mustard							Foliar spray dense stands of first-year plants. Hand pull second year plants.						Hand pull second year-plants. Hand cut and bag seed heads.																	
	Japanese honeysuckle	Hand cut, hand pull, Cut-stem herbicide			Hand cut, Hand pull, Cut-stem herbicide, foliar spray																		Hand cut, hand pull, Cut-stem herbicide								
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																							
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut						Cut-stem herbicide, hand cut																				
	Oriental bittersweet	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																							
	privet	Cut-stem herbicide			Hand pull seedlings, hand cut						Cut-stem herbicide																				
	shrub honeysuckle	Cut-stem herbicide			Hand pull seedlings, hand cut						Cut-stem herbicide																				
	winged euonymus	Cut-stem herbicide			Hand pull seedlings, hand cut						Cut-stem herbicide																				
Open West Bank	bull thistle							Targeted removal, foliar spray						Targeted removal, hand cut, cut and bag seed heads																	
	common teasel							Targeted removal, foliar spray						Targeted removal, cut and bag seed heads, foliar spray		Targeted Removal, cut and bag seed heads															
	crownvetch							Cut (mow), foliar spray																							
	dames rocket							Hand pull			Hand pull, cut and bag seed heads																				
	garlic mustard							Foliar spray dense stands of first-year plants. Hand pull second year plants.						Hand pull second year-plants. Hand cut and bag seed heads.																	
	Japanese knotweed							Hand cut, cut-stem herbicide, foliar herbicide						Hand cut, cut and bag seeds, Cut-stem or foliar herbicide if actively growing (leaves and stems green)																	
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																							
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut						Cut-stem herbicide, hand cut																				
	Oriental bittersweet	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																							
	reed canary grass							Cut (mow), foliar herbicide																							

HMZ	Species	J		F		M		A		M		J		J		A		S		O		N		D
River and BVW	phragmites											Hand cut, cut -stem herbicide												
	Japanese knotweed							Hand cut, cut-stem herbicide, foliar herbicide				Hand cut, cut and bag seeds, Cut-stem or foliar herbicide if actively growing (leaves and stems green)												
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut				Cut-stem herbicide, hand cut															
	Asian bittersweet	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																
	purple loosestrife											Hand cut, cut -stem herbicide			Hand cut, cut-stem herbicide, hand cut and bag seed heads									
	yellow flag iris											Hand pull, foliar spray			Hand pull, foliar spray, cut and bag seed heads									
West Campus	bull thistle									Targeted removal, foliar spray			Targeted removal, hand cut, cut and bag seed heads											
	common teasel									Targeted removal, foliar spray			Targeted removal, cut and bag seed heads, foliar spray		Targeted Removal, cut and bag seed heads									
	Crown vetch									Cut (mow), foliar spray														
	garlic mustard							Foliar spray dense stands of first-year plants. Hand pull second year plants.				Hand pull second year-plants. Hand cut and bag seed heads.												
	Japanese barberry	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																
	multiflora rose	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																
	Norway maple	Cut-stem herbicide, hand cut			Hand pull seedlings, hand cut				Cut-stem herbicide, hand cut															
	Asian bittersweet	Cut-stem herbicide, hand cut			Hand pull, hand cut			Cut-stem herbicide, foliar spray, hand cut, hand cut and bag seed heads																
	privet	Cut-stem herbicide			Hand pull seedlings, hand cut				Cut-stem herbicide															
	spotted knapweed							Targeted removal, foliar spray			Targeted removal, hand cut or mow, cut and bag seed heads, foliar spray													
	winged euonymus	Cut-stem herbicide			Hand pull seedlings, hand cut				Cut-stem herbicide															

Appendix C: Species-Specific Invasive Plant Treatment Narratives

Japanese Knotweed (*Reynoutria japonica*)

The stands of Japanese knotweed occur on the open west bank HMZ, forested west bank HMZ, and within the river corridor HMZ e Without treatment these populations of Japanese knotweed will continue to expand and become progressively more difficult to control. The populations are located in a variety of terrain including on the steep slopes, in wetlands, and on uneven ground which creates challenges for treatment. The recommended treatment method is to cut or mow the knotweed multiple times during the early and mid-growing season to cause the plants to expend much of the energy stored in their root systems and then allow the plants to regrow in the late summer/early fall to the height of approximately three feet and then apply a foliar herbicide treatment. Serial cut stump treatments may also be used to reduce population/stand density. Manual and mechanical treatments such as hand cutting or mowing are adequate to prevent seed formation but will generally not control knotweed population or prevent the population from continuing to expand.

Canada Thistle (*Cirsium arvense*)

Canada Thistle is not present at SAIR but is capable of invading almost all habitats in the park and thistle seeds are spread widely by the wind and by birds. For this reason, Canada thistle is listed in Table 2 as a Watch Species. Thistles that are in flower or in seed (late summer-fall) are a very high priority targets for treatment. Individual flower heads can produce hundreds or thousands of seeds which are widely distributed on the wind.

Hand pulling Canada thistle in the early growth season and continuing pulling throughout the growing season may be an effective manual control. In the late summer flowering thistles display distinctive purple flowers and later white tufted seedheads that are easily visible at distance.

Multiflora Rose (*Rosa multiflora*)

Multiflora rose is widely distributed and is one of the most invasive species within the park. There are many large stands of multiflora rose that are successfully excluding native species and many individual plants that are well distributed in all habitats of the park.

Foliar herbicide treatment with a Glyphosate or Triclopyr based herbicide or repeated cut stump treatment with an oil-based herbicide (ex. Pathfinder II, Garlon 3A) effectively controls multiflora rose over time. Treatment should be planned to continue one to three times annually until control thresholds are met.

Mugwort (*Artemisia vulgaris*)

Common mugwort is found in disturbed habitats along roads, trails, banks, and mowed areas throughout the park. Cutting during other invasive plant control, lawn maintenance, or trail maintenance operations provides some control of mugwort. Foliar treatment is effective.

Curly Dock (*Rumex crispus*)

Curly dock is found in disturbed habitats on the slag pile and along pathways, roads, banks, stone walls, and mowed areas throughout the park. Pulling, cutting during other invasive plant control, lawn maintenance, or trail maintenance operations may provide adequate control on curly dock in most areas. Where incidental control is not adequate cut-stem or foliar herbicide treatment is effective.

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife invades all types of freshwater wetlands within the park. Freshwater wetlands including rivers, ponds, marshes, vernal pools, and bordering vegetated wetlands are all sensitive habitats and high priorities for purple loosestrife treatment. Treatments include serial cutting throughout the growing season to reduce stored plant resources and prevent seed formation, cutting and bagging seedheads, hand pulling where ground disturbance or archeological resources are not prohibitive issues, and cut-stem or foliar herbicide treatment with herbicide by a state licensed applicator.