

National Park Service
U.S. Department of the Interior

Northeast Region
Philadelphia, Pennsylvania



Vegetation Classification and Mapping at Saugus Iron Works National Historic Site

Technical Report NPS/NER/NRTR—2008/123



ON THE COVER

Cattail Brackish Tidal Marsh, Reed-grass Tidal Marsh, and Northeastern Modified Successional Forest at Saugus Iron Works National Historic Site. Photograph by: NatureServe.

Vegetation Classification and Mapping at Saugus Iron Works National Historic Site

Technical Report NPS/NER/NRTR—2008/123

Ery F. Largay¹ and Lesley A. Sneddon¹

¹ NatureServe
11 Avenue de Lafayette, 5th Floor
Boston, MA 02111

September 2008

U.S. Department of the Interior
National Park Service
Northeast Region
Philadelphia, Pennsylvania

The Northeast Region of the National Park Service (NPS) comprises national parks and related areas in 13 New England and Mid-Atlantic states. The diversity of parks and their resources are reflected in their designations as national parks, seashores, historic sites, recreation areas, military parks, memorials, and rivers and trails. Biological, physical, and social science research results, natural resource inventory and monitoring data, scientific literature reviews, bibliographies, and proceedings of technical workshops and conferences related to these park units are disseminated through the NPS/NER Technical Report (NRTR) and Natural Resources Report (NRR) series. The reports are a continuation of series with previous acronyms of NPS/PHSO, NPS/MAR, NPS/BSO-RNR, and NPS/NERBOST. Individual parks may also disseminate information through their own report series.

Natural Resources Reports are the designated medium for information on technologies and resource management methods; "how to" resource management papers; proceedings of resource management workshops or conferences; and natural resource program descriptions and resource action plans.

Technical Reports are the designated medium for initially disseminating data and results of biological, physical, and social science research that addresses natural resource management issues; natural resource inventories and monitoring activities; scientific literature reviews; bibliographies; and peer-reviewed proceedings of technical workshops, conferences, or symposia.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report was accomplished under Cooperative Agreement 4560B0009, with assistance from the NPS. The statements, findings, conclusions, recommendations, and data in this report are solely those of the author(s), and do not necessarily reflect the views of the U.S. Department of the Interior, National Park Service.

Print copies of reports in these series, produced in limited quantity and only available as long as the supply lasts, or preferably, file copies on CD, may be obtained by sending a request to the address on the back cover. Print copies also may be requested from the NPS Technical Information Center (TIC), Denver Service Center, PO Box 25287, Denver, CO 80225-0287. A copy charge may be involved. To order from TIC, refer to document D-74.

This report may also be available as a downloadable portable document format file from the Internet at <http://www.nps.gov/nero/science/>.

Please cite this publication as:

Largay, E. F., and L. A. Sneddon. 2008. Vegetation Classification and Mapping at Saugus Iron Works National Historic Site. Technical Report NPS/NER/NRTR—2008/123. National Park Service. Philadelphia, PA.

Table of Contents

	Page
Figures	7
Tables	9
Appendixes	10
Executive Summary	11
Acknowledgments	12
Introduction	13
General Background	13
Park-specific Information	14
Project Area	15
Location and Regional Setting	15
Park Environmental Attributes and Site History	17
Materials and Methods	18
Planning and Scoping	18
Preliminary Data Collection and Review of Existing Information	18
Aerial Photo Acquisition and Processing	18
Photointerpretation	18
Field Data Collection and Classification	22
Vegetation Map Preparation	23
Accuracy Assessment	25
Results	26
Vegetation Classification and Characterization	26
Vegetation Association Descriptions	26
Vegetation Map Production	57

Table of Contents (Continued)

	Page
Accuracy Assessment	57
Project Deliverables	57
Discussion	60
Vegetation Classification and Characterization	60
Vegetation Map Production	62
Recommendations for Future Projects	62
Literature Cited	64

Figures

	Page
Figure 1. Location of Saugus Iron Works National Historic Site, Essex County, Massachusetts, on the Boston North, MA USGS 1:25,000 topographic quadrangle map.	16
Figure 2. Final USNVC alliance-level vegetation map from Agius (2003b).	20
Figure 3. Locations of the four vegetation plots sampled in Saugus Iron Works National Historic Site for vegetation classification and mapping.	24
Figure 4. Northeastern Modified Successional Forest in Saugus Iron Works National Historic Site (Plot SAIR.2). July 2007. NAD 1983 / UTM easting 335002, northing 4703675.	29
Figure 5. Northeastern Modified Successional Forest in Saugus Iron Works National Historic Site. In this image, this forest community occurs over a Skunk-cabbage - Orange Jewelweed Seep (Plot SAIR.3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.	29
Figure 6. Reed-grass Tidal Marsh in Saugus Iron Works National Historic Site (Plot SAIR.1). July 2007. NAD 1983 / UTM easting 334993, northing 4703655.	40
Figure 7. Reed-grass Tidal Marsh in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.	40
Figure 8. Cattail Brackish Tidal Marsh in Saugus Iron Works National Historic Site (Plot SAIR.4). July 2007. NAD 1983 / UTM easting 334954, northing 4703784.	45
Figure 9. Cattail Brackish Tidal Marsh in Saugus Iron Works National Historic Site (No Plot recorded at this location). July 2007. No UTM coordinates taken.	45
Figure 10. Skunk-cabbage - Orange Jewelweed Seep in Saugus Iron Works National Historic Site (Plot SAIR.3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.	50
Figure 11. Skunk-cabbage - Orange Jewelweed Seep in Saugus Iron Works National Historic Site (Plot SAIR. 3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.	50

Figures (Continued)

	Page
Figure 12. Central Atlantic Freshwater Subtidal River Bed and snapping turtle (<i>Chelydra serpentina</i>) in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.	55
Figure 13. Central Atlantic Freshwater Subtidal River Bed in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.	55
Figure 14. USNVC Vegetation Associations and Anderson Level II categories (modified) for Saugus Iron Works National Historic Site.	58

Tables

	Page
Table 1. Summary of key information for orthorectified photomosaic for Saugus Iron Works National Historic Site.	19
Table 2. Crosswalk of Agius (2003b) USNVC Alliance names to USNVC Association Local Names and Anderson Level II (modified) categories for Saugus Iron Works National Historic Site.	21
Table 3. Number of polygons and total mapped hectares within the park boundary for vegetation associations and Anderson Level II categories (modified) at Saugus Iron Works National Historic Site.	59
Table 4. Summary of products resulting from the Saugus Iron Works National Historic Site vegetation classification and mapping project.	59

Appendixes

	Page
Appendix A. Detailed information about the aerial photography and orthophoto acquired from MASS GIS.	68
Appendix B. Vegetation Classification of Saugus Iron Works National Historic Site prepared by Brad Agius (2003b).	70
Figure B1. Agius (2003b) Saugus Iron Works National Historic Site Final Alliance Level Vegetation Map based on the National Vegetation Classification System.	72
Table B1. Eight alliance level vegetation types present at Saugus Iron Works NHS.	73
Figure B2. The area (m ²) for each classification type at Saugus Iron Works NHS.	73
Appendix C. Photomosaic interpretation descriptions for vegetation map classes and Anderson Level II (modified) categories at Saugus Iron Works National Historic Site.	75
Appendix D. Vegetation plot sampling form.	77
Appendix E. Metadata for PLOTS 2.0 Database.	79
Appendix F. Plants observed in Saugus Iron Works National Historic Site during vegetation plot sampling, reconnaissance, and species list acquired from the park.	84
Appendix G. Dichotomous field key to the U.S. National Vegetation Classification (USNVC) associations of Saugus Iron Works National Historic Site.	88
Appendix H. Index of representative photographs of vegetation associations and classification plots at Saugus Iron Works National Historic Site.	90
Appendix I. Field definitions for local and global vegetation association descriptions.	91
Appendix J. Bibliography for USNVC global vegetation association descriptions.	102

Executive Summary

Vegetation classification and mapping was completed for Saugus Iron Works National Historic Site, creating a current digital geospatial vegetation database for the park. Six vegetation associations occurred within the park, and these were identified and described in detail. The associations were Northeastern Modified Successional Forest, Reed Canarygrass Eastern Marsh, Reed-grass Tidal Marsh, Cattail Brackish Tidal Marsh, Skunk-cabbage - Orange Jewelweed Seep, and Central Atlantic Freshwater Subtidal River Bed.

The most abundant vegetation community at Saugus Iron Works National Historic Site was Reed-grass Tidal Marsh, which covered 18% of the entire site. This invasive herbaceous marsh community occurred adjacent to the eastern bank of the Saugus River on saturated muck soils. The strain of common reed (*Phragmites australis*) presumed to occur in the park is not native to North America and is an indicator of disturbance. Cattail Brackish Tidal Marsh was another marsh community at this site, and was dominated by the native narrowleaf cattail (*Typha angustifolia*). This community occurred on both sides of the Saugus River. The one forest community, Northeastern Modified Successional Forest, covered 15% of the site, and was also dominated by a nonnative invasive, Norway maple (*Acer platanoides*).

A map depicting the locations of vegetation communities was created, following the USGS/NPS Vegetation Mapping Program protocols (TNC and ESRI 1994 a,b,c). Vegetation types are associations classified using the U.S. National Vegetation Classification to provide a regional and global context for the park's vegetation. A dichotomous field key was developed for associations to assist with field recognition and classification. This project documents the associations of Saugus Iron Works National Historic Site based on 2005 aerial photography, 2004 field sampling, and 2007 field verification.

Keywords: vegetation association, vegetation classification, vegetation mapping, Saugus Iron Works National Historic Site.

Acknowledgments

The National Park Service is gratefully acknowledged for funding of this project. We also would like to thank Brad Agius, formerly a seasonal employee of the Northeast Temperate Network, who completed surveys of nonnative invasive species and a draft vegetation map at Saugus Iron Works National Historic Site. Marc Albert, Saugus Iron Works National Historic Site Natural Resource Management Specialist, and former Natural Resource Manager, Daniel Noon, provided useful information and review for this project. Fred Dieffenbach, from the Northeast Temperate Network, provided us with a boundary file for Saugus Iron Works National Historic Site. Beth Johnson of the NPS provided support as well as helpful project oversight. Kate Miller and Brian Mitchell from the Northeast Temperate Network, in addition to Beth Eastman and Perver Baran from North Carolina State University, contributed a significant amount of time reviewing and improving the final deliverables for this project. Mary Russo and Kristin Snow of NatureServe provided essential data management services for the vegetation descriptions. Jon Hak, also of NatureServe, developed the orthomosaic for this project. LiLi Margolin assisted with field work. We would also like to thank Stephanie Perles and Gregory Podniesinski (PA Natural Heritage) who provided us with NPS vegetation mapping sample final reports. In an effort to achieve consistency from state to state, sections of the text in this report were adopted from previously completed NPS vegetation mapping reports (e.g., Perles et al. 2006) with permission. The contributions of all these individuals and anyone not mentioned are greatly appreciated.

Introduction

General Background

One of the goals of the National Park Service's Inventory and Monitoring Program is to provide the information and expertise needed by park managers for effective, long-term management of the natural resources held in trust (NPS 2003). The program recommends that 12 basic natural resource inventories be developed for each park that contains significant natural resources. These inventories provide crucial baseline information needed for appropriate park natural and cultural resource stewardship. A map of each park's vegetation based on aerial photography less than five years old is one of the 12 inventories recommended by the program (NPS 2003). To ensure that vegetation mapping is standardized across the National Park Service (NPS), NatureServe (building on initial efforts by The Nature Conservancy), the Federal Geographic Data Committee, and the Ecological Society of America Vegetation Subcommittee developed a protocol for creating vegetation maps in national parks. This protocol was adopted by the United States Geological Survey (USGS)/NPS Vegetation Mapping Program as the standard (TNC and ESRI 1994 a,b,c) and has been implemented at Saugus Iron Works National Historic Site by NatureServe.

The goal of the mapping effort at Saugus Iron Works National Historic Site was to produce an up-to-date digital geospatial vegetation database for the park and to provide an updated plant species list, a dichotomous key to associations, and descriptions of the associations in the park. Baseline information on vegetation composition and rarity is critical to developing park management goals relating to native plant communities (also referred to as associations), nonnative plant and animal species, effects of deer browse and other disturbances, as well as desired conditions. The identification and description of associations also provide habitat information important to understanding associated organisms, including animals, protozoa, bacteria, and fungi. A map of vegetation may allow inferences about the location and abundance of species that are characteristic of each association.

This report also describes the park's vegetation in the context of a national and regional vegetation classification. NatureServe (building on initial work of The Nature Conservancy), the Federal Geographic Data Committee, and the Ecological Society of America Vegetation Subcommittee, developed the United States National Vegetation Classification System (USNVC) in order to standardize vegetation classification and facilitate the comparison of vegetation types throughout the United States and internationally. Utilizing a hierarchical structure (Grossman et al. 1998), the USNVC is a systematic approach to classifying existing natural vegetation using physiognomy and floristics.

The basic unit of vegetation classification in the USNVC is the *association*. An association is defined as a plant community type that is relatively homogeneous in composition and structure and occurs in a uniform habitat. For example, Cattail Brackish Tidal Marsh is a common association in the North Atlantic Coast regions of the United States. Associations are also assigned global rarity ranks that indicate their conservation status and relative risk of extirpation (Grossman et al. 1998). Associations from the USNVC are often equivalent to or related to communities in state-specific vegetation classifications such as the Classification of the Natural

Communities of Massachusetts (Swain and Kearsley 2001). Therefore, USNVC associations can be crosswalked with communities in state classifications.

Several associations that share one or more dominant or characteristic species can be grouped to form an *alliance*. Alliances are generally more wide-ranging geographically than associations, covering more broadly similar habitats and species composition (Sneddon et al. 1996). For example, the Cattail Brackish Tidal Marsh association mentioned previously is grouped with other similar cattail-dominated associations into the (Narrowleaf Cattail, Southern Cattail) Tidal Herbaceous Alliance. Although in most cases there are multiple associations comprising an alliance, an association with a unique species composition or environmental niche may be the single member of that alliance.

One level above alliance is the *formation*, representing vegetation types that share a common vegetation structure and leaf phenology within broadly defined environmental factors (Grossman et al. 1998). For example, Tidal Temperate or Subpolar Grassland is a common formation that encompasses numerous herbaceous types in the northeastern and midwestern United States, including the (Narrowleaf Cattail, Southern Cattail) Tidal Herbaceous Alliance mentioned above.

The USNVC has been revised and refined since 1998, and is managed by NatureServe in collaboration with the network of Natural Heritage Programs. The classification is housed in the Biotics database and is updated regularly (NatureServe 2007). The upper levels of the USNVC were adopted as a standard by the Federal Geographic Data Committee to support the production of uniform statistics on vegetation at the national level (FGDC 1996). The USGS/NPS Vegetation Mapping Program adopted the alliance level, and, where possible, the association level, as the mapping unit for national parks.

Park-specific Information

Saugus Iron Works National Historic Site is a 5.1 ha (12.6 ac) park located in the town of Saugus, Massachusetts, in the temperate northeastern United States. The National Park Service designated it as a National Historic Site in 1968, and it is the site of the first integrated iron works in North America, which operated from 1646–1668. The park occurs on the banks of the Saugus River, at the head of the tide, and includes a reconstructed blast furnace, forge, rolling mill, and a restored seventeenth century house. The park continues to be managed for historic character, scenic beauty, native biodiversity, and education. A long history of past land use and disturbance has made the site susceptible to invasion by exotic invasive plant species.

In 2003, NatureServe ecologists worked closely with former National Park Service employee Brad Agius to conduct a field survey and produce a draft map of the vegetation of Saugus Iron Works National Historic Site. Additional field work was completed in 2004, with a subsequent visit in 2007. A shapefile of the park's boundary, developed in 2003 by the former Saugus Iron Works National Historic Site Natural Resource Manager, Daniel Noon, was obtained in 2007 from the National Park Service Northeast Temperate Network. All maps in this report used that shapefile to depict the park's boundary. The final vegetation map was completed in 2007.

Project Area

Location and Regional Setting

Saugus Iron Works National Historic Site is situated on the banks of the Saugus River in Saugus, Massachusetts, approximately 16.1 km (10 mi) northeast of Boston (Figure 1). It is located in Essex County on the Boston North, 1:25,000 USGS topographic quadrangle map. This area of the country occurs within the Boston Basin subsection within the North Atlantic Coast Ecoregion (Keys et al. 1995).

The Boston Basin is generally composed of marshlands and rolling uplands dissected by a network of tidally influenced streams and rivers. In the area of Saugus Iron Works National Historic Site, the majority of the surrounding land is developed, but where it is forested, the land generally supports White Pine - Oak Forest.

The predominant forest in the park is Northeastern Modified Successional Forest, a broadly defined forest type characterized by a number of early successional tree species and an herbaceous layer supporting many exotic species. This forest type reflects the altered composition caused by a variety of land uses. It is likely that this forest type is a degraded example of the Northern Red Oak - Yellow Birch / Cinnamon Fern Forest, which is typically characterized by a variable mixture of native trees, most commonly northern red oak (*Quercus rubra*), with red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), ferns such as cinnamon fern (*Osmunda cinnamomea*) and New York fern (*Thelypteris novaboracensis*), and occurs on transitional soils between wetlands and uplands on gentle slopes or valley bottoms.

Narrowleaf cattail (*Typha angustifolia*) marshes, nonnative invasive common reed (*Phragmites australis*) marshes, and salt marshes dominated by cordgrasses (*Spartina* spp.) are abundant in the area. The extent of remaining forest and native marsh cover is extremely fragmented and heavily invaded by invasive plant species, such as common reed (*Phragmites australis*) in the wetlands and Norway maple (*Acer platanoides*) in the upland forests.

The tidally influenced Saugus River is a natural resource for a wide variety of plants, animals, and other organisms that depend on the river, riparian woodlands, and surrounding marshes as important habitat (NPS 2006). The current tidal regime is partially restricted by road crossings and narrowed culverts. Currently, sixteen species of nonnative invasive plants can be found within Saugus Iron Works National Historic Site (Agius 2003a). Common reed, purple loosestrife (*Lythrum salicaria*), Norway maple, and multiflora rose (*Rosa multiflora*) dominate many natural and cultural areas within the park.



Figure 1. Location of Saugus Iron Works National Historic Site, Essex County, Massachusetts, on the Boston North, MA USGS 1:25,000 topographic quadrangle map.

Park Environmental Attributes and Site History

Many environmental factors, such as geology, topography, soils, and hydrology, as well as past land uses, affect the types and distribution of vegetation within Saugus Iron Works National Historic Site. The location for the original mill at Saugus Iron Works National Historic Site was specifically chosen because of the environmental setting of the site. It is located at the head of the tide on the Saugus River, at the contact point between two different bedrock types, Dedham granite and Lynn Volcanics. The intersection of these rock types formed a relatively steep gradient in the river that was harnessed for water power for the iron works in the seventeenth century (Wall et al. 2004).

The upland soil types at Saugus Iron Works National Historic Site include Merrimac-Urban land complex on the west side of the river and Hollis-Urban land-Rock outcrop complex on the east side. The fine, sandy, loam soils of the Merrimac-Urban land complex occur on broad outwash plains and terraces and are interspersed with developed urban areas. The Hollis-Urban land-Rock outcrop complex consists of well-drained soil with a shallow depth to bedrock and exposed rocky outcrops interspersed with urban land (Fuller and Francis 1984). The predominant soil in the Saugus River floodplain areas is poorly drained muck.

The Saugus River flows in a south-southeasterly direction through the center of the site and continues for 4.8 km (3 mi) to the outlet of the river at Lynn Harbor and the Atlantic Ocean. The northwestern section of the park contains the developed portion of the site with buildings, parking areas, maintained lawns, and managed successional fields. The areas on the property that contain natural and altered vegetation extend on either side of the Saugus River and along the eastern and southeastern sides of the site.

Over the last four centuries, man-made tidal restrictions, such as bridge crossings, have been constructed along the Saugus River downstream of the park, including a now mostly degraded weir at Hamilton Street that was built in 1954 to artificially raise the water level for historic interpretation of the Iron Works. In addition, a series of dams were constructed upstream beginning in the 17th century. The most recent of these was the Prankers Pond dam, which was breached in 1957, resulting in a substantial increase in sediment entering the tidal portion of the river (Albert, pers. comm., 2008). Restricted tidal flushing, upstream sedimentation, flooding, and ice scour all influence the vegetation dynamics at the site.

In 2007–2008 the park is implementing the project “Restore Saugus River Turning Basin and Dock.” The project includes the removal of 1.5 ha (3.75 ac) of contaminated sediments and wetland vegetation that will be replaced by 0.63 ha (1.57 ac) of diverse native brackish tidal marsh and 0.88 ha (2.18 ac) of open water and intertidal mudflat. The project also includes the removal of the abandoned Hamilton Street weir (Albert, pers. comm., 2008).

Materials and Methods

Planning and Scoping

NatureServe ecologist Lesley Sneddon met with Saugus Iron Works National Historic Site former Natural Resource Specialist Daniel Noon, and former Northeast Temperate Network employee Brad Agius to review existing information. Brad Agius was nearing completion of an exotic species inventory for the park and had generated a draft vegetation map in the course of his work. Using this baseline data, we conducted a short reconnaissance during the scoping meeting and generated a list of USNVC associations that were seen. NatureServe ecologist Lesley Sneddon determined sample locations and conducted subsequent field work with field assistant LiLi Margolin. Four plots were required to document the vegetation of this small park. An additional field visit was conducted by Lesley Sneddon and NatureServe ecologist Ery Largay to collect additional GPS data and ground photographs.

Preliminary Data Collection and Review of Existing Information

Previous studies conducted at Saugus Iron Works National Historic Site were obtained from the park's natural resource manager and reviewed for information pertinent to the park's vegetation. These reports included an invasive plant vegetation map and report prepared by the National Park Service and a preliminary vegetation map and classification for the site (Agius 2003a, b).

Aerial Photo Acquisition and Processing

High-quality existing photography developed by MassGIS was used as the base for the vegetation map (MassGIS 2007). A true color orthophoto mosaic was developed from a set of digital 1:5,000 scale medium resolution true color aerial images that are considered the new "base map" for the Commonwealth of Massachusetts by MassGIS and the Executive Office of Environmental Affairs (EOEA). The photography for the entire commonwealth was captured in April 2005 when deciduous trees were mostly bare and the ground was generally free of snow. The image type is 4-band (RGBN) natural color (Red, Green, Blue) and Near infrared in 8 bits (values ranging 0–255) per band format. Key information for the mosaic is summarized in Table 1. Appendix A contains additional detailed information regarding the aerial photography acquired from MASS GIS.

Photointerpretation

Aerial photograph interpretation is the act of examining aerial photographs to identify vegetation types (Avery 1978). Using the 2005 Saugus Iron Works National Historic Site true color digital orthophoto mosaic, ecologists at NatureServe developed the final association-level map. The orthophoto mosaic was initially examined onscreen in ArcGIS 9.1 (ESRI 1992–2007). Digital topographic quadrangle maps, soil, and geology layers were also examined in ArcGIS 9.1. Using information gathered from the orthophoto mosaic and the topographic maps, as well as vegetation sampling, field reconnaissance, vegetation plot data, and analysis of a preliminary USNVC Alliance-level vegetation map and classification for the site (Agius 2003b, Figure 2, Appendix B), polygons representing different associations and land uses were identified. These polygons were digitized onscreen using ArcGIS 9.1.

Table 1. Summary of key information for orthorectified photomosaic for Saugus Iron Works National Historic Site.

Title of metadata record:	Saugus Iron Works National Historic Site True Color Orthorectified Photomosaic (ERDAS MrSID formats)
Publication date of mosaic (from metadata):	June 28, 2006
Date aerial photography was acquired:	April 9 through April 17, 2005 (leaf-off)
Vendor that provided aerial photography:	Sanborn Colorado L.L.C.
Scale of photography:	1:5,070 m, pixel resolution of 45 cm
Type of photography:	True Color; leaf-off conditions
Archive location of air photos, airborne GPS/IMU files, camera calibration certificate, and hard copy flight report:	Mass GIS, Massachusetts Executive Office of Environmental Affairs
Scanning specifications:	Image type is 4-band (RGBN) natural color (Red, Green, Blue) and Near infrared in 8 Bits (values ranging 0-255) per band format.
Archive location of mosaic and metadata:	Mass GIS, Massachusetts Executive Office of Environmental Affairs
Format(s) of archived mosaic:	MrSID (20:1 compression)

To produce a USNVC association-level vegetation map that satisfied the standards of the USGS/NPS Vegetation Mapping Program, the alliance-level vegetation map developed by Agius (2003b) was edited and refined onscreen in ArcGIS 9.1. The Agius (2003b) vegetation map was not developed following the USGS/NPS Vegetation Mapping Program standards and therefore could not be used as the final vegetation classification map. Polygons that represented vegetation were readily attributed to existing associations in the U.S. National Vegetation Classification (Table 2). Polygons that represented intensive land uses were attributed with names modified from the Anderson Level II categories (Anderson et al. 1976). Because Saugus Iron Works National Historic Park is a small park with only 21 polygons, the mapping did not rely entirely on aerial photograph interpretation, but also incorporated lines sketched onto a hard-copy map on site.

Many of the polygons developed by Agius (2003b) to depict alliances were very small patches, much less than the 0.5 ha (1.24 ac) standard minimum map unit size for USGS/NPS Vegetation Mapping Program projects. At the request of the park natural resource management specialist, Skunk-cabbage - Orange Jewelweed Seep and Reed Canarygrass Eastern Marsh polygons were adopted and slightly adapted based on field and photo observation from Agius (2003b) to provide complete biodiversity information for the park, despite the small size of the communities. Their locations and acreages should be considered approximate. Likewise, the approximate location of the Central Atlantic Freshwater Subtidal River Bed is demarcated as a

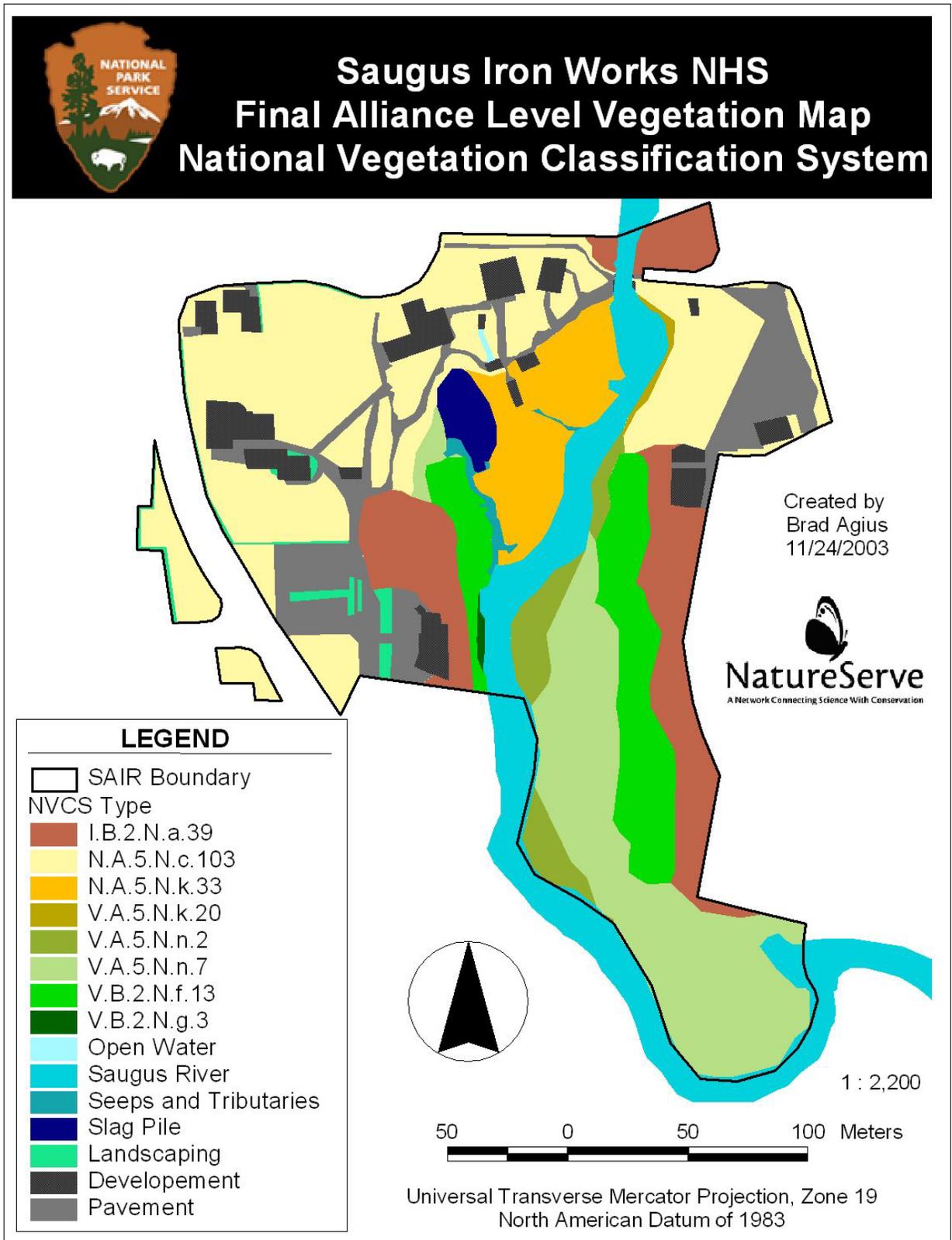


Figure 2. Final USNVC alliance-level vegetation map from Agius (2003b).

Table 2. Crosswalk of Agius (2003b) USNVC Alliance names to USNVC Association Local Names and Anderson Level II (modified) categories for Saugus Iron Works National Historic Site.

Agius (2003b) Legend	2003 USNVC Alliance Name	Total Area (ha) of polygons in Agius map	USNVC Association Local Name or Anderson Level II (modified) category used in final map	Comments
I.B.2.N.a.39	<i>Quercus rubra</i> – (<i>Acer saccharum</i>) Forest Alliance	0.6	Northeastern Modified Successional Forest	Polygons preserved in final vegetation map
N.A.5.N.c.103	<i>Dactylis glomerata</i> – <i>Rumex acetosella</i> Herbaceous Alliance	1.4	Mixed Urban or Built Up Land	Anderson category more appropriate classification
N.A.5.N.k.33	<i>Typha</i> Spp. – (<i>Schoenoplectus</i> Spp., <i>Juncus</i> Spp.) Seasonally Flooded Herbaceous Alliance	0.3	Cattail Brackish Tidal Marsh	Misclassified unit in Agius (2003b) map; classified as Cattail Brackish Tidal Marsh
V.A.5.N.k.20	<i>Phalaris arundinacea</i> Seasonally Flooded Herbaceous Alliance	0.02	Reed Canarygrass Eastern Marsh	Agius (2003b) line work adopted for final vegetation map
V.A.5.N.n.2	<i>Typha</i> (<i>angustifolia</i> , <i>domingensis</i>) Tidal Herbaceous Alliance	0.2	Cattail Brackish Tidal Marsh	Polygons preserved in final vegetation map
V.A.5.N.n.7	<i>Phragmites australis</i> Tidal Herbaceous Alliance	0.8	Reed-grass Tidal Marsh	Polygons preserved in vegetation map
V.B.2.N.f.13	<i>Symplocarpus foetidus</i> – <i>Caltha palustris</i> Saturated Herbaceous Alliance	0.4	Skunk-cabbage – Orange Jewelweed Seep	Agius (2003b) line work adopted and slightly adjusted for final vegetation map
V.B.2.N.g.3	<i>Peltandra virginica</i> – <i>Pontederia cordata</i> Tidal Herbaceous Alliance	0.0074	Not applicable	Not observed at SAIR during plot sampling or validation visits

very small polygon on the vegetation map. One of the limitations of mapping at such a small scale includes higher GPS error. The Agius (2003b) report describes the methods used in this preliminary USNVC Alliance vegetation mapping and classification effort and the report text is included in Appendix B. The spatial files from this effort are available from the NPS Northeast Temperate Network Data Manager.

Descriptions of the photo signatures for the vegetation types and Anderson Level II modified land use / land cover classes used in photointerpretation and mapping at Saugus Iron Works National Historic Site are included in Appendix C.

Field Data Collection and Classification

All vegetation plot sampling followed the USGS/NPS Vegetation Mapping Program protocols (TNC and ESRI 1994b). After review of the USNVC Alliance map developed by Agius for Saugus Iron Works National Historic Site (2003b) and reconnaissance of the vegetation at the site, we concluded that four plots would be sufficient to capture the range of vegetation types and their distribution at this small (5.1 ha [12.6 ac]) park. Areas classified as Anderson Level II (modified) categories were not sampled.

Field Survey

Within each polygon selected for sampling, a plot was established in an area that was most representative of the existing vegetation (Mueller-Dombois and Ellenberg 1974). All vegetation data were collected following NatureServe's accepted natural heritage sampling protocols (Sneddon 1993, modified by Strakosch-Walz 2000), with 20×20-m plots in the forest stand and 5×5-m plots in herbaceous vegetation.

The plot sampling data form used in this project is included as Appendix D. Abbreviated instructions for completing this form and definitions of the fields can be found in the NBS/NPS Vegetation Mapping Program: Field Methods for Vegetation Mapping manual (TNC and ESRI 1994b). The vegetation was visually divided into eight strata: emergent trees (variable height), tree canopy (variable height), tree subcanopy (>5 m in height), tall shrub (2–5 m), short shrub (<2 m), herbaceous, non-vascular, and vines. The percent cover was estimated for each species in each stratum using “real cover”¹ rather than pre-determined cover classes. Specimens of plants that were not identifiable in the field were collected for later identification. In addition to floristic information, the following environmental variables were recorded at each plot: slope, aspect, topographic position, hydrologic regime, soil stoniness, average soil texture, and soil drainage. Any unvegetated area of the plot was characterized by the exposed substrate. Notes were taken on the plot representativeness of the surrounding vegetation and any other significant environmental information, such as landscape context, stand health, recent disturbance, or evidence of historic disturbance. The vegetation profile and topographic position were sketched in cross-section to represent the location and setting of the plot. A digital photograph of each

¹ Real cover was the method of choice in this project because it eliminates the ambiguity inherent at percentages close to the transition between classes, thus avoiding the potential error of up to 50% in classes 25–50% and 50–75%, for example. It is important to note that the implied precision of “real cover” is misleading, however, because the reading is an estimate and can include considerable error.

plot was also taken. The location of each plot was recorded with a Garmin GPSMAP 60CSX global positioning system (GPS) unit, set to Universal Transverse Mercator Zone 19 North, North American Datum 1983, meters. The GPS unit was WAAS (Wide-Area Augmentation System) enabled and provided real-time differential correction.

Plot sampling was conducted in July 2004. In total, four plots were sampled at Saugus Iron Works National Historic Site (Figure 3).

Vegetation Classification and Characterization

Data from the four vegetation plots were entered into the NatureServe PLOTS 2.0 Database System on a Microsoft Access platform. Metadata for PLOTS is included in Appendix E. In the PLOTS 2.0 database, species were assigned standardized codes based on the PLANTS 3.5 database developed by the Natural Resources Conservation Service in cooperation with the Biota of North America Program (USDA, NRCS 2006). The common and scientific names of plants observed during the vegetation plot sampling and reconnaissance are listed in Appendix F. Some tree and shrub seedlings and immature herbaceous plants could only be identified to the genus level and are therefore listed as such in the appendix.

Each plot was readily classified to an existing USNVC association and no formal data analysis was conducted. Detailed information was included in a description of the vegetation as it occurs in the park (“local information”) as well in a description of the vegetation as it occurs across the natural range (“global information”).

A park-specific dichotomous key was created for the vegetation associations for use by park natural resource managers and others (Appendix G). A dichotomous key is a tool for identifying unknown entities, in this case, associations. It is structured by a series of couplets, two statements that describe different, mutually exclusive characteristics of the associations. Choosing the statement that best fits the association in question usually leads the user to the correct association. However, the dichotomous key should be used in conjunction with the detailed association descriptions to confirm that the association selected with the key is appropriate.

Vegetation Map Preparation

Following the vegetation data review, the preliminary USNVC alliance-level vegetation map by Agius (2003b) was further edited and refined to develop an association-level vegetation map. Using ArcGIS 9.1, polygon boundaries were drawn onscreen based on the plot data and additional field observations. Each polygon was attributed with the name of an USNVC association or an Anderson Level II (modified) land use/land cover map class based on plot data, field observations, aerial photography signatures, and topographic maps. The shapefile was projected in Universal Transverse Mercator Zone 19 North, North American Datum 1983, meters, in ArcGIS 9.1.



Figure 3. Locations of the four vegetation plots sampled in Saugus Iron Works National Historic Site for vegetation classification and mapping.

Accuracy Assessment

Two sources of potential error in the vegetation map include: 1) horizontal positional accuracy, in which a location on the photomosaic does not accurately align with the same location on the ground due to errors in orthorectification or triangulation; and 2) thematic accuracy, in which the vegetation type assigned to a particular location on the map does not correctly represent the vegetation at the same location in the park due to mapping error. The USGS/NPS Vegetation Mapping Program protocols (TNC and ESRI 1994c) were followed to assess the positional accuracy of the Saugus Iron Works National Historic Site orthophotomosaic.

Positional Accuracy Assessment

MassGIS quality assurance for the aerial photography included rigorous independent checks of the spatial accuracy using other datasets of significantly higher accuracy, and field work that included the capture of highly accurate GPS points that were compared to the same locations appearing on the deliverables. MassGIS also assessed the visual quality and appearance of the images (MassGIS 2007). See Appendix A for more detailed information.

Thematic Accuracy Assessment

An accuracy assessment was not conducted for this small park because every possible land unit at the scale of the minimum mapping unit (0.5 ha [1.24 ac]) was visited, therefore completing a minimum map unit census.

Results

Vegetation Classification and Characterization

The associations of Saugus Iron Works National Historic Site were classified based on the data collected in the plot sampling and additional associations observed in the field that were below the minimum map unit size (0.5 ha [1.24 ac]) and in most cases were too small for a standard plot. The classification survey yielded six distinct vegetation types: Northeastern Modified Successional Forest, Reed-grass Tidal Marsh, Cattail Brackish Tidal Marsh, Skunk-cabbage - Orange Jewelweed Seep, Reed Canarygrass Eastern Marsh, and Central Atlantic Freshwater Subtidal River Bed.

The most expansive vegetation community at the site is Reed-grass Tidal Marsh, covering 18% of the property. Northeastern Modified Successional Forest covers 1% of the site and has inclusions of Skunk-cabbage - Orange Jewelweed Seep beneath the canopy. Cattail Brackish Tidal Marsh covers 11% of the site, while the Saugus River and tributary, which includes small examples of the Central Atlantic Freshwater Subtidal River Bed association, cover 6% of the overall area. Developed Areas, including lawn and landscaped areas as well as developed land supporting buildings and structures, cover 50% of the site. A very small inclusion of Reed Canarygrass Eastern Marsh occurs within this map class in the northeastern portion of the site along the Saugus River.

Vegetation Association Descriptions

Detailed local descriptions for six associations were written based on the plot data, photographs of each plot, and the ecologists' field experiences at Saugus Iron Works National Historic Site. Local information is accompanied by information about the association across the range ("global information").

Vascular plant species nomenclature within the local and global descriptions follows the nationally standardized list of Kartesz (1999), with very few exceptions. This nomenclature differs from PLANTS 3.5 in only a very few cases, and when this difference occurs, synonymy is indicated parenthetically in the local description information. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990, 1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts. English names for associations and alliances use NatureServe Central Ecology-accepted names and may differ slightly from PLANTS 3.5 common names that are used within the local description information and throughout the rest of the report.

Additional information, including a list of the plants found during the vegetation plot sampling and known to occur in the park, can be found in Appendix F. Representative photographs of sampled associations are provided after each description. An index of these photos is included as Appendix H. Definitions of the fields in the vegetation descriptions are provided in Appendix I. A bibliography for the sources cited in the global vegetation descriptions from the USNVC is provided in Appendix J.

COMMON NAME (PARK-SPECIFIC): NORTHEASTERN MODIFIED SUCCESSIONAL FOREST

SYNONYMS

USNVC English Name: Black Cherry - Tuliptree - Red Maple - White Ash Forest

USNVC Scientific Name: *Prunus serotina* - *Liriodendron tulipifera* - *Acer rubrum* - *Fraxinus americana* Forest

USNVC Identifier: CEGL006599

LOCAL INFORMATION

Environmental Description: This successional forest occurs along the northern boundary of the park and in linear strips along the eastern and western sides of the Saugus River. Stands are separated from the river by a narrow, linear forest seep community and narrow leaf cattail (*Typha angustifolia*) and common reed (*Phragmites australis*) communities. The sampled stand occurs on a gentle northwest-facing lower slope with well-drained stony soil. The unvegetated surface is dominated by leaf litter (80% cover) with some large rocks (40%), small rocks (5%), wood (20%) and bare soil (2%). Evidence of disturbance includes the presence of many exotic plant species. A north/south-oriented nature trail runs through the stand. There are many forest gaps present in this community from past cutting. Suburban and park development border these successional stands.

Vegetation Description: The moderately dense (70% cover) tree canopy, 15–20 m tall, is dominated by (from highest to lowest cover) *Acer platanoides* (Norway maple), *Carya alba* (mockernut hickory), *Fagus grandifolia* (American beech), *Prunus serotina* (black cherry), and *Quercus rubra* (northern red oak). *Ulmus rubra* (slippery elm) is minor in the canopy. The tall-shrub and sapling layer is sparse but dominated by *Viburnum dentatum* (southern arrowwood), *Prunus serotina* (black cherry), and the exotic *Rosa multiflora* (multiflora rose). Other shrubs present include *Hamamelis virginiana* (American witchhazel), *Smilax rotundifolia* (roundleaf greenbrier), and *Prunus virginiana* (chokecherry). There is no short-shrub layer. The herbaceous layer (60%) is weedy and dominated by *Poa pratensis* (Kentucky bluegrass) with lesser amounts of *Chelidonium majus* (celandine), *Solanum dulcamara* (climbing nightshade), *Solidago rugosa* (wrinkleleaf goldenrod), *Alliaria petiolata* (garlic mustard), *Impatiens capensis* (jewelweed), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's nightshade), and *Arisaema triphyllum* (Jack in the pulpit), among others. Vines cover 10% and include *Celastrus orbiculatus* (oriental bittersweet), *Toxicodendron radicans* (eastern poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis labrusca* (fox grape).

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer platanoides</i> (Norway maple), <i>Carya alba</i> (mockernut hickory), <i>Fagus grandifolia</i> (American beech), <i>Prunus serotina</i> (black cherry), <i>Quercus rubra</i> (northern red oak)
Herb (field)	Graminoid	<i>Poa pratensis</i> (Kentucky bluegrass)

Characteristic Species: *Poa pratensis* (Kentucky bluegrass), *Rosa multiflora* (multiflora rose).

Other Noteworthy Species:

<u>Species</u>	<u>GRank</u>	<u>Type</u>	<u>Note</u>
<i>Acer platanoides</i> (Norway maple)	-	plant	exotic
<i>Alliaria petiolata</i> (garlic mustard)	-	plant	exotic
<i>Celastrus orbiculatus</i> (oriental bittersweet)	-	plant	exotic
<i>Chelidonium majus</i> (celandine)	-	plant	exotic
<i>Ipomoea cairica</i> (mile a minute vine)	-	plant	exotic
<i>Poa pratensis</i> (Kentucky bluegrass)	-	plant	exotic
<i>Rosa multiflora</i> (multiflora rose)	-	plant	exotic
<i>Solanum dulcamara</i> (climbing nightshade)	-	plant	exotic
<i>Sorbus aucuparia</i> (European mountain ash)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	SNA	.	.	[not crosswalked]	.

Crosswalk Note: The state classification describes natural vegetation communities and does not include semi-natural and cultural vegetation communities. Northeastern Modified Successional Forest is a semi-natural forest community and does not receive a state conservation rank in MA.

Local Range: This association occurs along the eastern and western sides of the Saugus River and along the northern boundary of the park.

Classification Comments: Prior to disturbance and invasion by *Acer platanoides* (Norway maple), *Rosa multiflora* (multiflora rose), *Poa pratensis* (Kentucky bluegrass), and many other exotic invasive species, this forest community was likely an Upland/Wetland Transitional Forest (CEGL006000), dominated by *Quercus rubra* (northern red oak), *Carya alba* (mockernut hickory), *Fagus grandifolia* (American beech), and *Prunus serotina* (black cherry), with *Osmunda cinnamomea* (cinnamon fern) dominant in the herb layer. Should the park consider restoring this upland forest, the target community should be the original forest type, Upland/Wetland Transitional Forest, *Quercus rubra* - *Betula alleghaniensis* / *Osmunda cinnamomea* Forest (CEGL006000).

Other Comments: This forest community contains under its canopy small, linear inclusions of Skunk-cabbage - Orange Jewelweed Seep. Plot SAIR.3 for example marks the location of a Skunk-cabbage - Orange Jewelweed Seep under a Northeastern Modified Successional Forest canopy.

Local Description Authors: M. Russo and E. Largay.

Plots: SAIR.2.

Saugus Iron Works National Historic Site Inventory Notes: Additional herbaceous species that were outside of the plot include *Phytolacca americana* (American pokeweed), *Hypericum perforatum* (common St. Johnswort), and *Bidens frondosa* (devil's beggartick). Figures 4 and Figure 5 depict this association at the park.



Figure 4. Northeastern Modified Successional Forest in Saugus Iron Works National Historic Site (Plot SAIR.2). July 2007. NAD 1983 / UTM easting 335002, northing 4703675.



Figure 5. Northeastern Modified Successional Forest in Saugus Iron Works National Historic Site. In this image, this forest community occurs over a Skunk-cabbage - Orange Jewelweed Seep (Plot SAIR.3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	Prunus serotina - Acer rubrum - Amelanchier canadensis - Quercus spp. Forest Alliance (A.237)
Alliance (English name):	Black Cherry - Red Maple - Canada Serviceberry - Oak species Forest Alliance
Association	Prunus serotina - Liriodendron tulipifera - Acer rubrum - Fraxinus americana Forest
Association (English name)	Black Cherry - Tuliptree - Red Maple - White Ash Forest
Ecological System(s):	Central Appalachian Dry Oak-Pine Forest (CES202.591). Northeastern Interior Dry-Mesic Oak Forest (CES202.592).

GLOBAL DESCRIPTION

Concept Summary: This early successional woody vegetation of the northeastern United States occurs on sites that are becoming reforested after having been cleared for agriculture.

Environmental setting varies but, generally, sites are dry-mesic to mesic, with small seepage inclusions in some examples. Physiognomy of this vegetation is highly variable, ranging from closed forest, open forest, tall dense shrubland; to more open tall shrubland. Early successional woody species dominate the canopy in a widely variable mix, depending on geographic location. Tree species often include some combination of *Prunus serotina* (black cherry), *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), *Robinia pseudoacacia* (black locust), and *Acer rubrum* (red maple). Other associates can include *Juglans nigra* (black walnut), *Sassafras albidum* (sassafras), *Betula populifolia* (gray birch), *Juniperus virginiana* (eastern redcedar), *Acer negundo* (boxelder), *Acer saccharinum* (silver maple), *Ailanthus altissima* (tree of heaven), *Ulmus americana* (American elm), *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Amelanchier* (serviceberry) spp., *Pinus strobus* (eastern white pine), and *Populus grandidentata* (bigtooth aspen). Other woody species may contribute to the canopy or form a tall-shrub layer, including *Lindera benzoin* (northern spicebush) and *Carpinus caroliniana* (American hornbeam). The low-shrub layer, if present, is usually characterized by *Rubus* (blackberry) spp. such as *Rubus flagellaris* (northern dewberry), *Rubus allegheniensis* (Allegheny blackberry), *Rubus phoenicolasius* (wine raspberry), or *Rubus hispidus* (bristly dewberry). This layer is often dominated by exotic species such as *Lonicera tatarica* (Tatarian honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Rhamnus cathartica* (common buckthorn), *Crataegus* (hawthorn) spp., *Rosa multiflora* (multiflora rose), and *Berberis thunbergii* (Japanese barberry). The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin. Common species include *Ageratina altissima* var. *altissima* (white snakeroot), *Polygonum persicaria* (spotted ladysthumb), *Impatiens capensis* (jewelweed), *Glechoma hederacea* (ground ivy), *Polystichum acrostichoides* (Christmas fern), *Calystegia sepium* ssp. *sepium* (hedge false bindweed), *Galium aparine* (stickywilly), *Oxalis stricta* (common yellow oxalis), *Polygonum virginianum* (jumpseed), *Dennstaedtia punctilobula* (eastern hayscented fern), *Arisaema triphyllum* (Jack in the pulpit), *Allium vineale* (wild garlic), and *Veronica officinalis* (common gypsyweed), among many others. The invasive species *Alliaria petiolata* (garlic mustard), *Microstegium vimineum* (Nepalese browntop), and *Polygonum caespitosum* (oriental ladysthumb) can be abundant in this disturbed forest type. Vines can be absent or abundant. In stands with high vine cover, the vegetation structure can be altered by the weight of

the vines pulling down trees and shrubs. Common vines include *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison ivy), *Vitis labrusca* (fox grape), and the invasive vines *Celastrus orbiculatus* (Oriental bittersweet) and *Lonicera japonica* (Japanese honeysuckle). These forests are often young and resulted from the colonization of old agricultural fields by woody species. Recent disturbance or abundant invasive species give these forest stands a weedy character. It is unlikely that these stands will succeed to a natural plant community dominated by native species.

Environmental Description: This vegetation occurs on sites that have been cleared for agriculture or otherwise heavily modified in the past. Generally sites are dry-mesic and may have small seepage inclusions in some examples. Occasionally this type may occur in former agricultural bottomlands, in which case the soils may be temporarily flooded or saturated.

Vegetation Description: Early successional woody species dominate the canopy in a widely variable mix, depending on geographic location. Tree species often include some combination of *Prunus serotina* (black cherry), *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), *Robinia pseudoacacia* (black locust), and *Acer rubrum* (red maple). Other associates can include *Juglans nigra* (black walnut), *Sassafras albidum* (sassafras), *Betula populifolia* (gray birch), *Juniperus virginiana* (eastern redcedar), *Acer negundo* (boxelder), *Acer saccharinum* (silver maple), *Ailanthus altissima* (tree of heaven), *Ulmus americana* (American elm), *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Amelanchier* (serviceberry) spp., *Pinus strobus* (eastern white pine), and *Populus grandidentata* (bigtooth aspen). Other woody species may contribute to the canopy or form a tall-shrub layer, including *Lindera benzoin* (northern spicebush) and *Carpinus caroliniana* (American hornbeam). The low-shrub layer, if present, is usually characterized by *Rubus* (blackberry) spp. such as *Rubus flagellaris* (northern dewberry), *Rubus allegheniensis* (Allegheny blackberry), *Rubus phoenicolasius* (wine raspberry), or *Rubus hispidus* (bristly dewberry). This layer is often dominated by exotic species such as *Lonicera tatarica* (Tatarian honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Rhamnus cathartica* (common buckthorn), *Crataegus* (hawthorn) spp., *Rosa multiflora* (multiflora rose), and *Berberis thunbergii* (Japanese barberry). The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin. Common species include *Ageratina altissima* var. *altissima* (white snakeroot), *Polygonum persicaria* (spotted ladythumb), *Impatiens capensis* (jewelweed), *Glechoma hederacea* (ground ivy), *Polystichum acrostichoides* (Christmas fern), *Calystegia sepium* ssp. *sepium* (hedge false bindweed), *Galium aparine* (stickywilly), *Oxalis stricta* (common yellow oxalis), *Polygonum virginianum* (jumpseed), *Dennstaedtia punctilobula* (eastern hayscented fern), *Arisaema triphyllum* (Jack in the pulpit), *Allium vineale* (wild garlic), and *Veronica officinalis* (common gypsyweed), among many others. The invasive species *Alliaria petiolata* (garlic mustard), *Microstegium vimineum* (Nepalese browntop), and *Polygonum caespitosum* (oriental ladythumb) can be abundant in this disturbed forest type. Vines can be absent or abundant. In stands with high vine cover, the vegetation structure can be altered by the weight of the vines pulling down trees and shrubs. Common vines include *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison ivy), *Vitis labrusca* (fox grape), and the invasive vines *Celastrus orbiculatus* (Oriental bittersweet) and *Lonicera japonica* (Japanese honeysuckle).

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple), <i>Fraxinus americana</i> (white ash), <i>Liriodendron tulipifera</i> (tuliptree), <i>Prunus serotina</i> (black cherry), <i>Robinia pseudoacacia</i> (black locust)
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tall shrub/sapling	Broad-leaved deciduous tree	<i>Carpinus caroliniana</i> (American hornbeam)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush), <i>Rosa multiflora</i> (multiflora rose)
Herb (field)	Forb	<i>Alliaria petiolata</i> (garlic mustard), <i>Polygonum persicaria</i> (spotted ladysthumb)
Herb (field)	Graminoid	<i>Microstegium vimineum</i> (Nepalese browntop)

Characteristic Species: *Acer rubrum* (red maple), *Alliaria petiolata* (garlic mustard), *Berberis thunbergii* (Japanese barberry), *Elaeagnus umbellata* (autumn olive), *Fraxinus americana* (white ash), *Juglans nigra* (black walnut), *Liriodendron tulipifera* (tuliptree), *Microstegium vimineum* (Nepalese browntop), *Polygonum persicaria* (spotted ladysthumb), *Prunus serotina* (black cherry), *Robinia pseudoacacia* (black locust), *Rosa multiflora* (multiflora rose), *Rubus allegheniensis* (Allegheny blackberry).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This vegetation is currently described from Pennsylvania, New York, and New Jersey but is of broader distribution in the northeastern U.S.

States/Provinces: CT, DE, MA, NJ, NY, PA.

Federal Lands: NPS (Allegheny Portage Railroad, Boston Harbor Islands, Delaware Water Gap, Fort Necessity, Friendship Hill, Gateway, Gettysburg, Johnstown Flood, Morristown, Sagamore Hill, Saratoga, Saugus Iron Works, Upper Delaware, Valley Forge, Weir Farm); USFWS (Erie, Great Meadows?, Prime Hook).

CONSERVATION STATUS

Rank: GNA (ruderal) (29 Nov 2004).

Reasons: This vegetation is modified by human activity and not of conservation concern.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: This vegetation is broadly defined and varies widely in composition across its range, presenting a classification challenge at the alliance level.

Similar Associations:

- *Juglans nigra* / *Verbesina alternifolia* Forest (CEGL007879).
- *Liriodendron tulipifera* - *Quercus* spp. Forest (CEGL007221)—is more strongly dominated by *Liriodendron* and is generally in a later successional state as evidenced by taller trees and more closed canopy.
- *Prunus serotina* - *Sassafras albidum* - (*Fraxinus americana*) / *Juniperus virginiana* Forest (CEGL004133).
- *Robinia pseudoacacia* Forest (CEGL007279).

Related Concepts: Information not available.

SOURCES

Description Authors: L. A. Sneddon, mod. S. C. Gawler and E. Largay.

References: Eastern Ecology Working Group n.d., Ehrenfeld 1977, Fike 1999, NRCS 2001b, NRCS 2004, Perles et al. 2006c, Perles et al. 2007, Soil Conservation Service 1987.

COMMON NAME (PARK-SPECIFIC): REED CANARYGRASS EASTERN MARSH

SYNONYMS

USNVC English Name: Reed Canarygrass Eastern Herbaceous Vegetation

USNVC Scientific Name: *Phalaris arundinacea* Eastern Herbaceous Vegetation

USNVC Identifier: C EGL006044

LOCAL INFORMATION

Environmental Description: This marsh community occurs in a very small patch directly adjacent to the Saugus River in the northeast corner of the park. The substrate consists of 0.5 m of muck.

Vegetation Description: *Phalaris arundinacea* (reed canarygrass) dominates this community. Scattered individuals of *Lythrum salicaria* (purple loosestrife), *Typha angustifolia* (narrowleaf cattail), *Sium suave* (hemlock waterparsnip), and *Agrostis stolonifera* (creeping bentgrass) are also present.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Phalaris arundinacea</i> (reed canarygrass)

Characteristic Species: *Phalaris arundinacea* (reed canarygrass).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	S4*	F	.	Low-Energy Riverbank	Swain and Kearsley 2001
MA	S4*	I	.	Shallow emergent marsh	Swain and Kearsley 2001

Local Range: One small patch of this community occurs in the northeastern corner of the park along the rivershore. Additional examples occur outside of the park to the south along the Saugus River.

Classification Comments: The species *Phalaris arundinacea* (reed canarygrass) is native to the United States and Canada, but is now more widely distributed and abundant because of introductions from both local and European populations, so as a natural vegetation type, its status is unclear.

Other Comments: None.

Local Description Authors: E. Largay.

Plots: None.

Saugus Iron Works National Historic Site Inventory Notes: The extent of this small patch community is very limited at the park (0.02 ha [0.05 ac]). Because it is below the minimum map unit size (0.5 ha [1.24 ac]) it was not sampled and a photograph of this community is not available. At the request of the Saugus Ironworks National Historic Site Natural Resource Management Specialist, to illustrate the vegetation diversity of this small urban refuge, NatureServe adopted (and slightly modified) the polygon line work for this association as it is depicted in the Agius (2003b) vegetation map. Polygon locations and extent should be considered approximate based on this adaptation to the vegetation map.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
Alliance	<i>Phalaris arundinacea</i> Seasonally Flooded Herbaceous Alliance (A.1381)
Alliance (English name)	Reed Canarygrass Seasonally Flooded Herbaceous Alliance
Association	<i>Phalaris arundinacea</i> Eastern Herbaceous Vegetation
Association (English name)	Reed Canarygrass Eastern Herbaceous Vegetation
Ecological System(s):	Central Interior Highlands and Appalachian Sinkhole and Depression Pond (CES202.018). North-Central Interior Floodplain (CES202.694). Laurentian-Acadian Wet Meadow-Shrub Swamp (CES201.582).

GLOBAL DESCRIPTION

Concept Summary: This association is found throughout the northeastern United States and Canada, but its distribution as a natural type is complicated elsewhere. *Phalaris arundinacea* is native to the United States and Canada but is now more widely distributed and abundant because of local introductions from both local and European populations. The introduced strains may be more aggressive ecotypes than native strains. Stands are found in both minerotrophic basin wetlands as well as rivershores. *Phalaris arundinacea* has been widely used as a forage and hay crop, especially in marshes and floodplains, and it is used for wildlife food and for shoreline and ditch stabilization. Stands are dominated by *Phalaris arundinacea* (reed canarygrass), a 0.5- to 2-m tall perennial grass, which tends to occur in monocultures or associated with *Calamagrostis canadensis* (bluejoint). Associates in the glaciated Northeast include *Viburnum nudum* (possumhaw), *Alnus incana* (gray alder) or *Alnus serrulata* (hazel alder), *Viburnum dentatum* (southern arrowwood), and *Agrostis gigantea* (redtop). In Central Appalachian bottomland old fields, characteristic associates include *Verbesina alternifolia* (wingstem, which may be codominant), *Solidago rugosa* (wrinkleleaf goldenrod), *Boehmeria cylindrica* (smallspike false nettle), and *Euthamia graminifolia* (flat-top goldentop), along with exotic species such as *Glechoma hederacea* (ground ivy), *Coronilla varia* (purple crownvetch), *Rosa multiflora* (multiflora rose), and *Elaeagnus umbellata* (autumn olive). Midwest associates include species characteristic of wet meadows. *Phalaris arundinacea* (reed canarygrass) can displace native species over time. Further work is required to resolve the natural versus introduced nature of this type in the Southeast before a description can be completed.

Environmental Description: Stands are found in both minerotrophic basin wetlands as well as rivershores. The dominant species has been widely used as a forage and hay crop, especially in marshes and floodplains, and it is used for wildlife food and for shoreline and ditch stabilization (Barnes 1999).

Vegetation Description: Stands are dominated by *Phalaris arundinacea* (reed canarygrass), a 0.5-m to 2-m tall perennial grass that is native to the United States and Canada, but which has also been introduced from European strains. The introduced strains may be more aggressive ecotypes than native strains (Barnes 1999). It tends to occur in monocultures or associated with *Calamagrostis canadensis* (bluejoint) or, less commonly, with a mixture of forbs equaling the graminoid cover. Associates in the glaciated Northeast include *Viburnum nudum* (possumhaw), *Salix* (willow) spp., *Alnus incana* (gray alder) or *Alnus serrulata* (hazel alder), *Viburnum*

dentatum (southern arrowwood), *Poa palustris* (fowl bluegrass), *Mentha arvensis* (wild mint), *Leersia virginica* (whitegrass), *Lythrum salicaria* (purple loosestrife), and *Agrostis gigantea* (redtop). In Central Appalachian bottomland old fields, characteristic associates include *Verbesina alternifolia* (wingstem, which may be codominant), *Solidago rugosa* (wrinkleleaf goldenrod), *Boehmeria cylindrica* (smallspike false nettle), and *Euthamia graminifolia* (flat-top goldentop), along with exotic species such as *Glechoma hederacea* (ground ivy), *Coronilla varia* (purple crownvetch), *Rosa multiflora* (multiflora rose), and *Elaeagnus umbellata* (autumn olive). Midwest associates include species characteristic of wet meadows. *Phalaris arundinacea* (reed canarygrass) can displace native species over time (Apfelbaum and Sams 1987, Barnes 1999, and references therein). Further work is required to resolve the natural versus introduced nature of this type in the Southeast.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Phalaris arundinacea</i> (reed canarygrass)

Characteristic Species: *Phalaris arundinacea* (reed canarygrass).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found throughout the northeastern United States and Canada, but its distribution as a natural type is complicated elsewhere. It currently ranges from Virginia north to Vermont, east to Minnesota and south to Tennessee.

States/Provinces: CT, DE, IA, IN, MA, MD, ME, MN, NH, NJ, NY, OH, ON, PA, RI, TN, VA, VT, WV.

Federal Lands: DOD (Camp Dawson); NPS (Allegheny Portage Railroad, Delaware Water Gap, Effigy Mounds, Eisenhower, Gettysburg, Indiana Dunes, Saratoga, Saugus Iron Works, Upper Delaware); USFWS (Assabet River?, Erie, Great Meadows?, Great Swamp, Oxbow, Parker River).

CONSERVATION STATUS

Rank: GNA (invasive) (1 Dec 1997).

Reasons: *Phalaris arundinacea* (reed canarygrass) is native to the United States and Canada but is now more widely distributed and abundant because of local introductions from both local and European populations (Apfelbaum and Sams 1987). It can invade a variety of habitats.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Type has a broad distribution; in fact, it is widespread throughout temperate areas of the Northern hemisphere. It is native to the United States and Canada, but is now more widely distributed and abundant because of local introductions from both local and European populations (Apfelbaum and Sams 1987). It can invade a variety of habitats, suggesting that little unites these stands apart from the dominance of *Phalaris arundinacea* (reed canarygrass).

Similar Associations:

- *Calamagrostis canadensis* - *Phalaris arundinacea* Herbaceous Vegetation (CEGL005174).
- *Phalaris arundinacea* Western Herbaceous Vegetation (CEGL001474).

Related Concepts: (see Appendix I for the definition of codes (=, ?) identifying the relationship between the USNVC concept and the concept listed).

- Bottomland old fields (Vanderhorst 2001a) =
- Palustrine Persistent Emergent Wetland (PEM1) (Cowardin et al. 1979) ?
- Reed canary grass riverine grassland (Perles et al. 2004) ?
- SNE low-energy riverbank community (Rawinski 1984) ?
- Shallow Emergent Marsh (Thompson 1996) ?
- Southern New England nutrient-poor streamside/lakeside marsh (Rawinski 1984) ?
- Southern New England nutrient-rich streamside/lakeside marsh (Rawinski 1984) ?

SOURCES

Description Authors: D. Faber-Langendoen, mod. S. C. Gawler.

References: Apfelbaum and Sams 1987, Barnes 1999, Cowardin et al. 1979, Edinger et al. 2002, Fike 1999, Metzler and Barrett 2001, Midwestern Ecology Working Group n.d., NRCS 2004, Perles et al. 2004, Perles et al. 2007, Rawinski 1984, Sperduto 2000a, Swain and Kearsley 2001, TDNH unpubl. data, TNC and WPC 2004, Thompson 1996, Thompson and Sorenson 2000, Vanderhorst 2001a.

COMMON NAME (PARK-SPECIFIC): REED-GRASS TIDAL MARSH

SYNONYMS

USNVC English Name: Common Reed Tidal Herbaceous Vegetation
USNVC Scientific Name: *Phragmites australis* Tidal Herbaceous Vegetation
USNVC Identifier: CEGLO04187

LOCAL INFORMATION

Environmental Description: This invasive herbaceous association is common along the southeastern and western banks of the Saugus River in the Saugus Iron Works National Historic Site. These marshes occur on low flats that are permanently saturated and also experience restricted tidal flooding as a result of road crossings and narrow culverts. These restrictions have prevented regular tidal flushing of the marshes, thereby reducing salinity over time and favoring *Phragmites australis* (common reed) expansion throughout the site. The soils consist of very poorly drained muck. The unvegetated surface is made up entirely of leaf litter (100% cover).

Vegetation Description: Stands of this vegetation are essentially monocultures of the invasive nonnative *Phragmites australis* (common reed, 95% cover) which is 2–5 m tall. Additional species may occur as scattered individuals beneath the “canopy” of reedgrass, including *Viburnum dentatum* (southern arrowwood), *Toxicodendron radicans* (eastern poison ivy), *Impatiens capensis* (jewelweed), *Pontederia cordata* (pickerelweed), *Rosa palustris* (swamp rose), *Onoclea sensibilis* (sensitive fern), and *Symplocarpus foetidus* (skunk cabbage).

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Phragmites australis</i> (common reed)

Characteristic Species: *Phragmites australis* (common reed).

Other Noteworthy Species:

<u>Species</u>	<u>GRank</u>	<u>Type</u>	<u>Note</u>
<i>Celastrus orbiculatus</i> (oriental bittersweet)	-	plant	exotic
<i>Rosa multiflora</i> (multiflora rose)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	S1*	B	.	Brackish Tidal Marsh	Swain and Kearsley 2001

Crosswalk Comments: The communities described in the MA vegetation classification and the USNVC are not equivalent in concept. The MA community type, Brackish Tidal Marsh, is broader in concept than the USNVC association Reed-grass Tidal Marsh. Under the MA classification, Brackish Tidal Marsh is ranked as a S1 type and it can include multiple USNVC associations that occur in the same environmental setting. Reed-grass Tidal Marsh, although invasive and not of conservation concern with a GRank of GNA (invasive), invades and persists what is called Brackish Tidal Marsh in the MA classification; therefore, it is crosswalked to the MA classification unit.

Local Range: Reed-grass Tidal Marsh is common in the park. The largest example occurs on the eastern side of the Saugus River in the central and southern portions of the site.

Classification Comments: Although the tide is restricted downstream, historically, Saugus Iron Works is located at the head of the tide. Storm and spring tides likely influence this community.

Other Comments: This invasive nonnative *Phragmites* (reed)-dominated community gradually replaced *Spartina* (cordgrass)-dominated salt marshes and brackish marshes as a result of restricted regular tidal flushing and increased sedimentation. Some native species such as

Onoclea sensibilis (sensitive fern) and *Impatiens capensis* (jewelweed) persist as an "understory" beneath *Phragmites australis* (common reed) in some portions of the marsh. In the unlikely event that full tidal flow is restored to the river, replacement of this vegetation by *Spartina* (cordgrass, presumably *Spartina alterniflora* [smooth cordgrass]) or *Typha angustifolia* (narrowleaf cattail) would be anticipated. If the target community is a more fresh-brackish marsh, a possible target community is Freshwater Tidal Mixed High Marsh (CEGL006325) characterized by a mixture of freshwater and brackish species including but not limited to: *Zizania aquatica* (annual wildrice), *Peltandra virginica* (green arrow arum), *Pontederia cordata* (pickerelweed), and *Sagittaria latifolia* (broadleaf arrowhead). Management of Reed-grass Tidal Marsh in portions of the park was observed in the summer of 2007 as part of the project "Restore Saugus River Turning Basin and Dock." The project includes the replacement of 1.5 ha (3.75 ac) of wetland vegetation, including most of the extent of this association within the park, with native brackish tidal marsh, open water, and intertidal mudflat.

Local Description Authors: M. Russo and E. Largay, Marc Albert.

Plots: SAIR.1.

Saugus Iron Works National Historic Site Inventory Notes: Figures 6 and 7 depict this vegetation association in the park.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Tidal temperate or subpolar grassland (V.A.5.N.n.)
Alliance	<i>Phragmites australis</i> Tidal Herbaceous Alliance (A.1477)
Alliance (English name)	Common Reed Tidal Herbaceous Alliance
Association	<i>Phragmites australis</i> Tidal Herbaceous Vegetation
Association (English name)	Common Reed Tidal Herbaceous Vegetation
Ecological System(s):	Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260). Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Northern Atlantic Coastal Plain Tidal Salt Marsh (CES203.519).

GLOBAL DESCRIPTION

Concept Summary: This community is dominated by dense tall grassland indicative of disturbance. It occurs in a range of tidal wetland habitats from fresh to brackish in salinity. It is characterized by dense stands of *Phragmites australis* (common reed), a species which tends to grow in colonies of tall, stout, leafy plants often to the exclusion of all other vascular plant species. Associated species are highly variable, depending on the community that has been invaded. Spreading in large colonies, *Phragmites* (reed) eventually dominates disturbed areas at coverage up to 100%. More typically, though, scattered individuals of other species may occur, such as sparse *Morella cerifera* (wax myrtle) shrubs, *Kosteletzkya virginica* (Virginia saltmarsh mallow), *Calystegia sepium* (hedge false bindweed), *Boehmeria cylindrica* (smallspike false nettle), *Typha angustifolia* (narrowleaf cattail), *Apocynum cannabinum* (Indianhemp), *Rosa palustris* (swamp rose), *Polygonum* (knotweed) spp., and *Mikania scandens* (climbing



Figure 6. Reed-grass Tidal Marsh in Saugus Iron Works National Historic Site (Plot SAIR.1). July 2007. NAD 1983 / UTM easting 334993, northing 4703655.



Figure 7. Reed-grass Tidal Marsh in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.

hempvine). Vines of *Toxicodendron radicans* (eastern poison ivy) are also frequent, but typically occur at low cover. This community has a broad geographic range, including coastal areas of the eastern and southeastern United States and Canada.

Environmental Description: This community is comprised of dense tall grassland indicative of disturbance. It occurs in a range of tidal wetland habitats from fresh to brackish in salinity.

Vegetation Description: This community is a broadly defined reed-grass marsh. It is characterized by dense stands of *Phragmites australis* (common reed), a species which tends to grow in colonies of tall, stout, leafy plants often to the exclusion of all other vascular plant species. Associated species are highly variable, depending on the community that has been invaded. Spreading in large colonies, *Phragmites* (reed) eventually dominates disturbed areas at coverage up to 100%. More typically, though, scattered individuals of other species may occur, such as sparse *Morella cerifera* (wax myrtle) shrubs, *Kosteletzkya virginica* (Virginia saltmarsh mallow), *Calystegia sepium* (hedge false bindweed), *Boehmeria cylindrica* (smallspike false nettle), *Typha angustifolia* (narrowleaf cattail), *Apocynum cannabinum* (Indianhemp), *Rosa palustris* (swamp rose), *Polygonum* (knotweed) spp., and *Mikania scandens* (climbing hempvine). Vines of *Toxicodendron radicans* (eastern poison ivy) are also frequent but typically occur at low cover.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Phragmites australis</i> (common reed)

Characteristic Species: *Phragmites australis* (common reed).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Estuarine.

DISTRIBUTION

Range: This community has a broad geographic range, including coastal areas of the eastern and southeastern United States and Canada.

States/Provinces: AL, CT, DE, FL, GA, LA, LB?, MA, MD, ME, MS, NC, NF?, NH, NJ, NS?, NY, PA, PE?, QC?, RI, SC, TX, VA.

Federal Lands: NPS (Assateague Island, Boston Harbor Islands, Cape Cod, Colonial, Fire Island, Gateway, George Washington Birthplace, Saugus Iron Works); USFWS (Back Bay, Bon Secour, Chesapeake Marshlands).

CONSERVATION STATUS

Rank: GNA (invasive) (22 Nov 1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 1 - Strong.

Comments: Although *Phragmites australis* (common reed) rhizomes have been noted in salt marsh sediments exceeding three thousand years in age (Niering and Warren 1977) and is thus a native component of salt marshes in some areas in North America, the growth of the species in its native condition was likely to have been significantly different than the dense monotypic stands that characterize this community in parts of its range today. The invasive, nonnative strain has been labeled haplotype M (Saltonstall 2002). The presence of the *Phragmites australis* (common reed) community in wetlands today generally indicates human-induced disturbance, either through direct habitat manipulation or through passive introduction of

reproductive material to naturally disturbed substrates. Historically, without alteration, these sites would generally be more saline. In New England, *Phragmites* (reed) tends to invade behind artificial/man-made levees where regular salt input is blocked, making the sites more brackish and less saline than prior to levee construction and anthropogenic modification. In cases where *Phragmites australis* (common reed) is a significant component of the vegetation, but the vegetation retains sufficient species composition to retain its identity, the site is considered an unhealthy or degraded example of that original community. Where *Phragmites australis* (common reed) cover is so high that native species have been excluded and the original community is no longer recognizable, the occurrence is then treated as an example of *Phragmites australis* (common reed) Tidal Herbaceous Vegetation (CEGL004187).

Similar Associations:

- *Phragmites australis* - (*Sagittaria platyphylla*, *Vigna luteola*) Tidal Herbaceous Vegetation (CEGL007891).
- *Phragmites australis* Eastern North America Temperate Semi-natural Herbaceous Vegetation (CEGL004141).

Related Concepts (see Appendix I for the explanation of codes defining the relationship between concepts):

- *Phragmites australis* Association (Fleming 1998) ?
- *Phragmites australis* community (Metzler and Barrett 1992) ?
- *Phragmites australis* tidal marsh association (Clancy 1993b) ?
- Brackish Tidal Marsh (Rawinski 1984) ?
- Salt Marsh Complex (Breden 1989) B

SOURCES

Description Authors: R. E. Zaremba.

References: Bell et al. 2002, Bowman 2000, Breden 1989, Clancy 1993b, Edinger et al. 2002, Fleming 1998, Harrison 2001, Metzler and Barrett 1992, Metzler and Barrett 1996, Metzler and Barrett 2001, NRCS 2001b, Nelson 1986, Niering and Warren 1977, Odum et al. 1984, Rawinski 1984, Saltonstall 2002, Schafale and Weakley 1990, Schotz pers. comm., Southeastern Ecology Working Group n.d., Swain and Kearsley 2001.

COMMON NAME (PARK-SPECIFIC): CATTAIL BRACKISH TIDAL MARSH

SYNONYMS

USNVC English Name: Narrowleaf Cattail - Eastern Rosemallow Herbaceous Vegetation
USNVC Scientific Name: *Typha angustifolia* - *Hibiscus moscheutos* Herbaceous Vegetation
USNVC Identifier: CEGLO04201

LOCAL INFORMATION

Environmental Description: Brackish narrowleaf cattail (*Typha angustifolia*) marshes occur south of the water wheel at the southern end of the pier and in linear patches along the eastern edge of the Saugus River within the park. The narrowleaf cattail (*Typha angustifolia*) marshes occur on wet flats with somewhat poorly drained 0.25-m thick muck soils. The unvegetated surface is made up entirely of leaf litter (100% cover). Restricted tidal flooding has reduced the salinity levels in this community. Evidence of disturbance includes the presence of exotic plant species.

Vegetation Description: The dense (90% cover) herbaceous layer, 2–5 m tall, is dominated by *Typha angustifolia* (narrowleaf cattail, 70% cover). Additional species in lesser amounts include *Agrostis stolonifera* (creeping bentgrass), *Eupatorium purpureum* (sweetscented joepyeweed), *Pontederia cordata* (pickerelweed), *Impatiens capensis* (jewelweed), *Apios americana* (groundnut), *Carex stricta* (upright sedge), *Echinocystis lobata* (wild cucumber), *Polygonum hydropiperoides* (swamp smartweed), *Schoenoplectus tabernaemontani* (softstem bulrush), *Symphotrichum novae-angliae* (New England aster), and *Rosa palustris* (swamp rose). Invasive exotics include *Lythrum salicaria* (purple loosestrife) and *Rosa multiflora* (multiflora rose).

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Eupatorium purpureum</i> (sweetscented joepyeweed), <i>Impatiens capensis</i> (jewelweed), <i>Lythrum salicaria</i> (purple loosestrife), <i>Pontederia cordata</i> (pickerelweed)
Herb (field)	Graminoid	<i>Typha angustifolia</i> (narrowleaf cattail)

Characteristic Species: *Typha angustifolia* (narrowleaf cattail).

Other Noteworthy Species:

<u>Species</u>	<u>GRank</u>	<u>Type</u>	<u>Note</u>
<i>Calystegia sepium</i> (hedge false bindweed)	-	plant	exotic
<i>Lythrum salicaria</i> (purple loosestrife)	-	plant	exotic
<i>Rosa multiflora</i> (multiflora rose)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	S1*	B	.	Brackish Tidal Marsh	Swain and Kearsley 2001

Crosswalk Comment: The communities described in the MA vegetation classification and the USNVC are not equivalent in concept. The MA community type, Brackish Tidal Marsh, is broader in concept than the USNVC association. Multiple USNVC associations can occur within one Brackish Tidal Marsh community as classified by MA. The concept of the Cattail Brackish Marsh in the USNVC is finer in scale than the unit classified in the MA vegetation classification and has a GRank of G4G5.

Local Range: Brackish cattail marshes occur south of the water wheel at the southern end of the pier and in linear patches along the eastern edge of the Saugus River within the park.

Classification Comments: The examples of this community at Saugus Iron Works National Historic Site do not include *Hibiscus moscheutos* (crimson-eyed rosemallow). These marshes have been altered by restricted tidal flow that has reduced the salinity of this portion of the Saugus River. However, storm events and spring high tides do influence this community.

Other Comments: This vegetation, although modified from its original state as a result of tidal restriction, is comprised largely of native species. In 2007–2008 the park will implement the project “Restore Saugus River Turning Basin and Dock.” The project includes the replacement of 1.5 ha (3.75 ac) of wetland vegetation, including much of the extent of this association within the park, with native brackish tidal marsh, open water and intertidal mudflat.

Local Description Authors: M. Russo and E. Largay, M. Albert.

Plots: SAIR.4.

Saugus Iron Works National Historic Site Inventory Notes: Figures 8 and Figure 9 depict this vegetation association at the park.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Tidal temperate or subpolar grassland (V.A.5.N.n.)
Alliance	<i>Typha (angustifolia, domingensis)</i> Tidal Herbaceous Alliance (A.1472)
Alliance (English name)	(Narrowleaf Cattail, Southern Cattail) Tidal Herbaceous Alliance
Association	<i>Typha angustifolia</i> - <i>Hibiscus moscheutos</i> Herbaceous Vegetation
Association (English name)	Narrowleaf Cattail - Eastern Rosemallow Herbaceous Vegetation
Ecological System(s):	Northern Atlantic Coastal Plain Brackish Tidal Marsh (CES203.894). Atlantic Coastal Plain Northern Salt Pond Marsh (CES203.892). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Acadian Estuary Marsh (CES201.579). Northern Atlantic Coastal Plain Tidal Salt Marsh (CES203.519).

GLOBAL DESCRIPTION

Concept Summary: This community is a brackish tidal marsh of the northern to central Atlantic coast, occurring along the margin of tidal rivers and at the upper margins of some high salt marshes and coastal salt ponds where water salinity ranges from 0.5–18.0 ppt. Brackish marshes are most extensive on large tidal rivers, but smaller marshes of this alliance also occur at the upper limits of larger tidal creeks. The vegetation of this tall grassland is a mixture of freshwater and saltmarsh species dominated by *Typha angustifolia* (narrowleaf cattail). *Phragmites australis* (common reed), and/or *Typha latifolia* (broadleaf cattail) can be codominant. The *Phragmites australis* (common reed) component is the native strain. Common associates include *Hibiscus moscheutos* (crimson-eyed rosemallow), *Schoenoplectus pungens* (common threesquare), *Impatiens capensis* (jewelweed), *Amaranthus cannabinus* (tidalmarsh amaranth), *Peltandra virginica* (green arrow arum), *Pontederia cordata* (pickerelweed), and *Bidens* (beggarticks) spp., plus *Spartina cynosuroides* (big cordgrass) in the south. Other infrequent associates include *Mikania scandens* (climbing hempvine), *Polygonum punctatum* (dotted smartweed), *Pluchea odorata* (sweetscent), *Eleocharis* (spikerush) spp., and *Schoenoplectus robustus* (sturdy bulrush), plus *Schoenoplectus americanus* (chairmaker's



Figure 8. Cattail Brackish Tidal Marsh in Saugus Iron Works National Historic Site (Plot SAIR.4). July 2007. NAD 1983 / UTM easting 334954, northing 4703784.



Figure 9. Cattail Brackish Tidal Marsh in Saugus Iron Works National Historic Site (No Plot recorded at this location). July 2007. No UTM coordinates taken.

bulrush) farther south. Species from adjacent high salt marsh may also be present. Substrate is muck or peat, and there is often an accumulation of *Typha* (cattail) litter.

Environmental Description: This association occurs in oligohaline to mesohaline areas of tidal marshes (0.5–18 ppt). In estuarine systems, it can occur in the uppermost zone of brackish marshes where there is freshwater influence; it receives diurnal tidal flooding of brackish water. In salt marshes behind barrier beaches it can occur in the upper reaches of larger tidal creeks within brackish areas and also at the upland border where there is significant freshwater input from the adjacent upland; here it receives irregular tidal flooding only during high spring tides. Substrate is muck or peat, and there is often an accumulation of *Typha* (cattail) litter.

Vegetation Description: The vegetation of this tall grassland is a mixture of freshwater and saltmarsh species dominated by *Typha angustifolia* (narrowleaf cattail). *Phragmites australis* (common reed), *Typha latifolia* (broadleaf cattail), *Spartina cynosuroides* (big cordgrass), or *Schoenoplectus pungens* (common threesquare) can codominate. The *Phragmites australis* (common reed) component is the native strain (Saltonstall 2002). Common associates include *Hibiscus moscheutos* (crimson-eyed rosemallow), *Schoenoplectus pungens* (common threesquare), *Impatiens capensis* (jewelweed), *Amaranthus cannabinus* (tidalmarsh amaranth), *Peltandra virginica* (green arrow arum), *Pontederia cordata* (pickerelweed), and *Bidens* (beggarticks) spp., plus *Spartina cynosuroides* (big cordgrass) in the south. Other infrequent associates include *Mikania scandens* (climbing hempvine), *Pluchea odorata* (sweetscent), *Polygonum punctatum* (dotted smartweed), *Eleocharis* (spikerush) spp., and *Schoenoplectus robustus* (sturdy bulrush), plus *Schoenoplectus americanus* (chairmaker's bulrush) farther south. Species from adjacent high salt marsh may also be present.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Semi-shrub	<i>Hibiscus moscheutos</i> (crimson-eyed rosemallow)
Herb (field)	Graminoid	<i>Schoenoplectus pungens</i> (common threesquare), <i>Typha angustifolia</i> (narrowleaf cattail)
Floating aquatic	Aquatic herb (floating & submergent)	<i>Pontederia cordata</i> (pickerelweed)

Characteristic Species: *Hibiscus moscheutos* (crimson-eyed rosemallow), *Typha angustifolia* (narrowleaf cattail).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Estuarine.

DISTRIBUTION

Range: This association occurs along the Atlantic coast from Maine to Virginia and possibly to South Carolina.

States/Provinces: CT, DE:S4, MA, MD:S4, ME, NC?, NH, NJ:S4, NY, RI, SC?, VA.

Federal Lands: NPS (Acadia, Assateague Island, Boston Harbor Islands, Cape Cod, Fire Island, Saugus Iron Works); USFWS (Back Bay?, Chesapeake Marshlands, Chincoteague, Monomoy?, Parker River?, Prime Hook).

CONSERVATION STATUS

Rank: G4G5 (19 Jan 2006).

Reasons: This common small-patch community occurs in the estuarine areas of up to 13 northeastern states, several of which rank this vegetation as S4. It is threatened by pollution and by encroachment of *Phragmites australis* (common reed).

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: A non-tidal barrier wetland documented at the Cove Point Wetland, Calvert County, Maryland (Steury 1999), appears to fit this concept.

Similar Associations:

- *Typha domingensis* Tidal Herbaceous Vegetation (CEGL008456).

Related Concepts: (see Appendix I for the explanation of codes defining the relationship between concepts).

- *Hibiscus* marsh (Cahoon and Stevenson 1986) ?
- *Typha (angustifolia, latifolia) - Hibiscus moscheutos* Herbaceous Vegetation (Harrison 2001) =
- *Typha angustifolia - Hibiscus palustris* community (Metzler and Barrett 1992) ?
- *Typha angustifolia* community (Good and Good 1975b) ?
- *Typha angustifolia* type (Ferren et al. 1981) ?
- *Typha* association (Shreve et al. 1910) =
- Brackish Tidal Marsh (Rawinski 1984) ?
- Brackish marsh (Sperduto 1994) ?
- Brackish tidal marsh (Reschke 1990) ?
- Brackish tidal marsh community (MENHP 1991) ?
- Brackish tidal marsh complex (Breden 1989) ?
- Cattail Community Type (Odum et al. 1984) ?
- Fresh-brackish marsh (Klotz 1986) ?
- Narrowleaf cattail type (McCormick and Ashbaugh 1972) ?
- Tidal Freshwater Marsh (Narrowleaf Cattail Subtype) (Schafale 2000) ?
- Transitional fresh marsh (Hill 1986) B

SOURCES

Description Authors: S. L. Neid.

References: Bowman 2000, Breden 1989, Breden et al. 2001, Cahoon and Stevenson 1986, Coulling 2002, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ferren et al. 1981, Fleming 2001, Fleming and Moorhead 1998, Fleming et al. 2001, Gawler 2002, Good and Good 1975b, Harrison 2001, Harrison 2004, Hill 1986, Klotz 1986, MENHP 1991, McCormick and Ashbaugh 1972, Metzler and Barrett 1992, Metzler and Barrett 2001, Odum et al. 1984, Rawinski 1984, Reschke 1990, Saltonstall 2002, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Shreve et al. 1910, Sperduto 1994, Sperduto 1997a, Sperduto 2000b, Steury 1999, Swain and Kearsley 2001.

**COMMON NAME (PARK-SPECIFIC): SKUNK-CABBAGE - ORANGE JEWELWEED
 SEEP**

SYNONYMS

USNVC English Name: Skunk-cabbage - Orange Jewelweed Herbaceous Vegetation
USNVC Scientific Name: *Symplocarpus foetidus* - *Impatiens capensis* Herbaceous Vegetation
USNVC Identifier: CEGL006567

LOCAL INFORMATION

Environmental Description: This wet herbaceous seep community occurs on the eastern and western sides of the Saugus River between the linear stands of Northeastern Modified Successional Forest upland and the marshes that are adjacent to the river. The seep on the western side of the river occurs at the toe of a relatively steep slope. Water was observed draining from this seep in the summer of 2007. The seep on the eastern side of the river is narrow and linear and occupies a flat, shallow depression at the base of a gentle slope. The soils in these seeps are saturated and consist of very poorly drained muck. The unvegetated surface is dominated by leaf litter (70% cover) with some large rocks (20%) and wood (10%). Evidence of disturbance includes the presence of trash and exotic plant species.

Vegetation Description: The overall appearance of this community is of a near monoculture of *Impatiens capensis* (jewelweed, 80% cover) in the herbaceous layer (90%) with scattered individuals of *Symplocarpus foetidus* (skunk cabbage) underneath. A sparse (5%) emergent (2–5 m tall) shrub layer of *Aesculus hippocastanum* (horse chestnut), *Toxicodendron radicans* (eastern poison ivy), and *Rosa multiflora* (multiflora rose) were also observed. Herbs including *Alliaria petiolata* (garlic mustard), *Geum canadense* (white avens), *Osmunda cinnamomea* (cinnamon fern), *Thalictrum pubescens* (king of the meadow), *Glechoma hederacea* (ground ivy), *Juncus tenuis* (poverty rush), *Brassica juncea* (India mustard), *Symphytichum novi-belgii* (New York aster), and *Ranunculus repens* (creeping buttercup) were noted. Overhanging trees provide 80% cover and include *Acer platanoides* (Norway maple), *Quercus rubra* (northern red oak), and *Ulmus rubra* (slippery elm).

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Impatiens capensis</i> (jewelweed), <i>Symplocarpus foetidus</i> (skunk cabbage)

Characteristic Species: *Symplocarpus foetidus* (skunk cabbage), *Impatiens capensis* (jewelweed).

Other Noteworthy Species:

<u>Species</u>	<u>GRank</u>	<u>Type</u>	<u>Note</u>
<i>Acer platanoides</i> (Norway maple)	-	plant	exotic
<i>Aesculus hippocastanum</i> (horse chestnut)	-	plant	exotic
<i>Alliaria petiolata</i> (garlic mustard)	-	plant	exotic
<i>Rosa multiflora</i> (multiflora rose)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	SNR	.	.	[not crosswalked]	.

Crosswalk Comments: There is no clear crosswalk in the MA classification to this USNVC association.

Local Range: This wet herbaceous seep community occurs on the eastern side of the Saugus River at the base of the hill where the maintenance office is located. The seep on the western side of the Saugus River runs parallel to the river and lies between Northeastern Modified Successional Forest and Reed-grass Tidal Marsh.

Classification Comments: This small woodland seep community is classified as an herbaceous association despite its occurrence under a tree canopy. The overhanging canopy is contributed by the adjacent forest and is largely unrelated to the vegetation occurring in the seep. At Saugus Iron Works National Historic Site, these seeps are mapped as inclusions within Northeastern Modified Successional Forest polygons. SAIR.3 for example, marks the location of a Skunk-cabbage - Orange Jewelweed Seep under a Northeastern Modified Successional Forest canopy.

Other Comments: The examples at Saugus Iron Works National Historic Site have a relatively high proportion of native species.

Local Description Authors: M. Russo and E. Largay.

Plots: SAIR.3.

Saugus Iron Works National Historic Site Inventory Notes: The extent of this small patch community is very limited at the park (0.2 ha [0.6 ac]). Because it is below the minimum map unit size (0.5 ha [1.24 ac]) and it is difficult to see the signature of this association under the canopy of the adjacent upland forest in the orthophoto, the polygons representing this association were not initially mapped. At the request of the Saugus Ironworks National Historic Site Natural Resource Management Specialist to illustrate the vegetation diversity of this small urban refuge, NatureServe adopted (and slightly modified) the polygon line work for this association as it is depicted in the Agius (2003b) vegetation map. Polygon locations and extent should be considered approximate based on this adaptation to the vegetation map. Figure 10 and Figure 11 depict this vegetation association in the park.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Saturated temperate perennial forb vegetation (V.B.2.N.f.)
Alliance	<i>Symplocarpus foetidus</i> - <i>Caltha palustris</i> Saturated Herbaceous Alliance (A.1694)
Alliance (English name)	Skunk-cabbage - Yellow Marsh-marigold Saturated Herbaceous Alliance
Association	<i>Symplocarpus foetidus</i> - <i>Impatiens capensis</i> Herbaceous Vegetation
Association (English name)	Skunk-cabbage - Orange Jewelweed Herbaceous Vegetation
Ecological System(s):	Information not available.

Global Description

Concept Summary: This small seepage wetland vegetation occurs in low-lying areas such as streamheads, lower slope drainages, and the borders of small streams where groundwater emerges. The substrate is mucky, with rocks and boulders often visibly protruding above the surface. Little quantitative data exist for this vegetation, although it appears to be quite common in the northeastern United States. Typically, this vegetation is shaded by tree species of higher ground and surrounding edges of the community, but these species are not characteristic of the vegetation and vary widely among occurrences. *Lindera benzoin* (northern spicebush) may



Figure 10. Skunk-cabbage - Orange Jewelweed Seep in Saugus Iron Works National Historic Site (Plot SAIR.3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.



Figure 11. Skunk-cabbage - Orange Jewelweed Seep in Saugus Iron Works National Historic Site (Plot SAIR. 3). July 2007. NAD 1983 / UTM easting 334936, northing 4703666.

occur, particularly at the edges. Characteristic herbaceous species are *Symplocarpus foetidus* (skunk cabbage), *Impatiens capensis* (jewelweed), and *Arisaema triphyllum* (Jack in the pulpit). Other common associates are variable but may include *Veratrum viride* (green false hellebore), *Pilea pumila* (Canadian clearweed), *Cardamine pensylvanica* (Pennsylvania bittercress), *Saxifraga pensylvanica* (eastern swamp saxifrage), *Carex canescens* (silvery sedge), *Caltha palustris* (yellow marsh marigold), and *Viola sororia* (common blue violet).

Environmental Description: This small seepage wetland vegetation occurs in low-lying areas such as streamheads, lower slope drainages, and the borders of small streams where groundwater emerges. The substrate is mucky, with rocks and boulders often visibly protruding above the surface. Little quantitative data exist for this vegetation, although it appears to be quite common in the Northeastern United States. Typically, this vegetation is shaded by tree species of higher ground and surrounding edges of the community, but these species are not characteristic of the vegetation and vary widely among occurrences.

Vegetation Description: Characteristic herbaceous species are *Symplocarpus foetidus* (skunk cabbage), *Impatiens capensis* (jewelweed), and *Arisaema triphyllum* (Jack in the pulpit). Other common associates are variable but may include *Veratrum viride* (green false hellebore), *Pilea pumila* (Canadian clearweed), *Cardamine pensylvanica* (Pennsylvania bittercress), *Saxifraga pensylvanica* (eastern swamp saxifrage), *Carex canescens* (silvery sedge), *Caltha palustris* (yellow marsh marigold), and *Viola sororia* (common blue violet). *Lindera benzoin* (northern spicebush) may occur, particularly at the edges.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Symplocarpus foetidus</i> (skunk cabbage)

Characteristic Species: *Arisaema triphyllum* (Jack in the pulpit), *Impatiens capensis* (jewelweed), *Symplocarpus foetidus* (skunk cabbage).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This vegetation occurs in the Northeastern United States.

States/Provinces: CT, DC, MA, MD?, ME, NH, NJ, NY, PA, RI, VT.

Federal Lands: DOD (Camp Dawson); NPS (Morristown, Saratoga, Saugus Iron Works).

CONSERVATION STATUS

Rank: GNR (8-Jul-1999).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Information not available.

Similar Associations:

- *Chrysosplenium americanum* Herbaceous Vegetation (CEGL006193).
- *Onoclea sensibilis* - (*Adiantum pedatum*) - *Impatiens capensis* - *Carex plantaginea* Herbaceous Vegetation [Provisional] (CEGL006409).
- *Vernonia noveboracensis* - *Thelypteris palustris* - *Symplocarpus foetidus* Herbaceous Vegetation (CEGL006448).

Related Concepts: (see Appendix I for the explanation of codes defining the relationship between concepts).

- Stream thicket community (Ehrenfeld 1977) B

SOURCES

Description Authors: L. A. Sneddon.

References: Eastern Ecology Working Group n.d., Ehrenfeld 1977, MNNHP 1993, NRCS 2004, White and Madany 1978.

COMMON NAME (PARK-SPECIFIC): **CENTRAL ATLANTIC FRESHWATER
SUBTIDAL RIVER BED**

SYNONYMS

USNVC English Name: **Sago Pondweed - Claspingleaf Pondweed - (Horned
Pondweed) Tidal Herbaceous Vegetation**

USNVC Scientific Name: ***Stuckenia pectinatus* - *Potamogeton perfoliatus* - (*Zannichellia
palustris*) Tidal Herbaceous Vegetation**

USNVC Identifier: **CEGL006027**

LOCAL INFORMATION

Environmental Description: This community consists of submerged aquatic vegetation growing on the exposed sandy mineral soil at the bottom of the Saugus River. The water, although seemingly fresh, does experience irregular tidal influence.

Vegetation Description: *Zannichellia palustris* (horned pondweed) and *Potamogeton crispus* (curly pondweed) were the only two submerged aquatic plants found in this occurrence during a brief inspection. According to the Saugus Iron Works National Historic Site Natural Resource Manger, there are more species that occur on the sandy and gravel/cobble bars that are exposed at lower tides including *Callitriche palustris* (vernal water-starwort) and *Lythrum salicaria* (purple loosestrife) on higher elevations.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Potamogeton crispus</i> (curly pondweed) <i>Zannichellia palustris</i> (horned pondweed)

Characteristic Species: *Potamogeton crispus* (curly pondweed), *Zannichellia palustris* (horned pondweed).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>SRank</u>	<u>Rel</u>	<u>Conf</u>	<u>SName</u>	<u>Reference</u>
MA	S2	=	1	Estuarine Subtidal: Fresh / Estuarine Brackish Flats	Swain and Kearsley 2001

Local Range: Small patches of this community occur submerged in the Saugus River.

Classification Comments: None.

Other Comments: According to Marc Albert, Saugus Iron Works National Historic Site Natural Resource Management Specialist, it is believed that this association is more abundant than was recognized during this work. He comments: "during every low tide there are large areas (perhaps 20-30% of the total 'river' area) that are exposed and that I would assume would map to this association (or another sparsely vegetated mixed-substrate river bed type). Ideally follow-up work would better classify, describe, and map this association, as it may ultimately meet the minimum map unit size if taken together."

Local Description Authors: E. Largay and L. A. Sneddon.

Plots: None.

Saugus Iron Works National Historic Site Inventory Notes: This community is below the minimum map unit size (0.5 ha, 1.24 ac) and was mapped within the Saugus River map class on the vegetation map. The approximate location of the one example of this community observed in the park is noted on the vegetation map. A photosignature could not be identified for this

community on the orthophoto. Figures 12 and Figure 13 depict this association in Saugus Iron Works National Historic Site.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Hydromorphic-rooted vegetation (V.C.)
Physiognomic Group	Temperate or subpolar hydromorphic-rooted vegetation (V.C.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar hydromorphic-rooted vegetation (V.C.2.N.)
Formation	Permanently flooded - tidal temperate or subpolar hydromorphic-rooted vegetation (V.C.2.N.b.)
Alliance	<i>Stuckenia pectinatus</i> - <i>Zannichellia palustris</i> Permanently Flooded - Tidal Herbaceous Alliance (A.1768)
Alliance (English name)	Sago Pondweed - Horned Pondweed Permanently Flooded - Tidal Herbaceous Alliance
Association	<i>Stuckenia pectinatus</i> - <i>Potamogeton perfoliatus</i> - (<i>Zannichellia palustris</i>) Tidal Herbaceous Vegetation
Association (English name)	Sago Pondweed - Claspingleaf Pondweed - (Horned Pondweed) Tidal Herbaceous Vegetation
Ecological System(s):	Northern Atlantic Coastal Plain Subtidal Aquatic Bed (CES203.521). Acadian Estuary Marsh (CES201.579).

GLOBAL DESCRIPTION

Concept Summary: This type includes vegetation of shallow subtidal fresh to slightly brackish water and mud or sand sediments exposed at extreme low tide occurring along the mid- and north Atlantic coast. Common and dominant species include *Stuckenia pectinatus* (sago pondweed), *Zannichellia palustris* (horned pondweed), *Vallisneria americana* (American eelgrass), *Najas guadalupensis* (southern waternymph), *Elodea nuttallii* (western waterweed), and *Ceratophyllum demersum* (coon's tail). *Ruppia maritima* (widgeongrass) may occur sporadically, but it is more prevalent in brackish and saline habitats. Invasive exotics often occur in this habitat, including *Myriophyllum spicatum* (spike watermilfoil) and *Trapa natans* (water chestnut). This association grades almost imperceptibly into brackish/saline aquatic bed vegetation.

Environmental Description: This association occurs on fresh to slightly brackish flats that are continuously flooded, although certain areas can be exposed briefly during very low tides.

Vegetation Description: This association includes beds of aquatic vegetation in fresh to slightly brackish waters. Common and dominant species include *Stuckenia pectinatus* (sago pondweed), *Zannichellia palustris* (horned pondweed), *Vallisneria americana* (American eelgrass), *Najas guadalupensis* (southern waternymph), *Elodea nuttallii* (western waterweed), and *Ceratophyllum demersum* (coon's tail). *Ruppia maritima* (widgeongrass) may occur sporadically, but it is more prevalent in brackish and saline habitats. Invasive exotics often occur in this habitat, including *Myriophyllum spicatum* (spike watermilfoil) and *Trapa natans* (water chestnut). This association grades almost imperceptibly into brackish/saline aquatic bed vegetation.

Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Potamogeton perfoliatus</i> (claspingleaf) <i>Stuckenia pectinatus</i> (sago pondweed) <i>Zannichellia palustris</i> (horned pondweed)



Figure 12. Central Atlantic Freshwater Subtidal River Bed and snapping turtle (*Chelydra serpentina*) in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.



Figure 13. Central Atlantic Freshwater Subtidal River Bed in Saugus Iron Works National Historic Site. (No Plot recorded at this location). July 2007. No UTM coordinates taken.

Characteristic Species: *Potamogeton perfoliatus* (claspingleaf pondweed), *Stuckenia pectinatus* (sago pondweed), *Zannichellia palustris* (horned pondweed).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Estuarine.

DISTRIBUTION

Range: This association occurs along the mid- and north Atlantic coast from Massachusetts to Virginia.

States/Provinces: CT, DE:S1, MA:S2, MD, NJ:S2S3, NY, VA.

Federal Lands: NPS (Saugus Iron Works); USFWS (Back Bay?).

CONSERVATION STATUS

Rank: G3G5 (1 Dec 1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: The vegetation composition of this association intergrades with that of saline/brackish subtidal aquatic beds. This association can be distinguished from *Ruppia maritima* (widgeongrass) Acadian/Virginian Zone Temperate Herbaceous Vegetation (CEGL006167) in that *Stuckenia pectinatus* (sago pondweed) and *Zannichellia palustris* (horned pondweed) rather than *Ruppia maritima* (widgeongrass) are strongly dominant. Southern analogs of fresh to oligohaline subtidal aquatic bed vegetation include *Ceratophyllum demersum* (coon's tail) - *Utricularia macrorhiza* (common bladderwort) - *Nymphaea odorata* (fragrant water lily) Herbaceous Vegetation (CEGL004661), which occurs in wind-tidal situations in the Chesapeake Bay area, and *Vallisneria americana* (American eelgrass) Estuarine Bayou Herbaceous Vegetation (CEGL004634) in the Gulf Coast. The vegetation composition of this association is very similar to, if not indistinguishable from, that of non-tidal submerged aquatic beds.

Similar Associations:

- *Ceratophyllum demersum* - *Utricularia macrorhiza* - *Nymphaea odorata* Herbaceous Vegetation (CEGL004661).
- *Ceratophyllum demersum* - *Vallisneria americana* - *Najas* spp. Tidal Herbaceous Vegetation (CEGL006048).
- *Ruppia maritima* - *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL006370).
- *Ruppia maritima* Acadian/Virginian Zone Temperate Herbaceous Vegetation (CEGL006167).
- *Vallisneria americana* Estuarine Bayou Herbaceous Vegetation (CEGL004634).

Related Concepts: (see Appendix I for the explanation of codes defining the relationship between concepts).

- *Potamogeton pectinatus* - *Zannichellia palustris* Herbaceous Vegetation [Provisional] (Bartgis 1986) =
- *Potamogeton* Community (Moore et al. 2000) ?
- Polyhaline subtidal aquatic bed (Breden 1989) ?
- Southern New England & Gulf of Maine Fresh /Brackish Subtidal Estuarine Communities (Rawinski 1984) ?

SOURCES

Description Authors: S. L. Neid.

References: Bartgis 1986, Berdine 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Moore et al. 2000, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001.

Vegetation Map Production

The final vegetation map is shown in Figure 14. A table of vegetation associations and their areas in the park is included in Table 3. Metadata for the vegetation map shapefile, the plot location shapefile, the sampling point location shapefile, and the digital photomosaic were prepared according to Federal Geographic Data Committee (1998a) standards and have been provided as a deliverable along with this report.

Vegetation associations are crosswalked to the US National Vegetation Classification. Land use/land cover map units are crosswalked to Anderson Level II categories (Anderson et al. 1976). The vegetation map uses local (park-specific) names for the associations found in the Park. The vegetation map is composed of six associations and three Anderson Level II (modified) map units.

Three small patch associations: Skunk-cabbage - Orange Jewelweed Seep, Reed Canarygrass Eastern Marsh and Central Atlantic Freshwater Subtidal River Bed were below the minimum map unit size of 0.5 ha (1.24 ac) and their exact locations and extent should be considered approximate as the line work was adopted from Agius (2003b). These associations were depicted in the vegetation map, despite being below the standard mapping unit, to illustrate the diversity of vegetation associations at this small urban park and to help inform interpretation, restoration, and resource management at the park.

The Saugus River map class includes the open water of the river as well as inclusions of Central Atlantic Freshwater Subtidal River Bed, the precise boundaries of which are not known. Two Anderson Level II (modified) land use/land cover map classes were identified: Mixed Urban or Built Up Land that includes lawn and landscaped areas, managed fields, buildings and structures, roads, trails, and parking lots. Other Urban or Built Up Land designates the abandoned slag pile, which is now overgrown. All of the vegetation, environmental and cultural units are mapped as polygons.

Accuracy Assessment

Positional Accuracy

Horizontal accuracy of the orthophoto mosaic is +/- 3 meters at the 95% confidence level at the nominal scale of 1:5,000, which meets Class 1 National Map Accuracy Standards (FGDC 1998b). (See Appendix A for more detailed information regarding acquisition and processing of the aerial photography.)

Thematic Accuracy

A thematic accuracy assessment was not completed for this park because every minimum mapping unit was visited.

Project Deliverables

Final products of the vegetation mapping project are listed in Table 4. All products have been delivered to the National Park Service by NatureServe with this report.

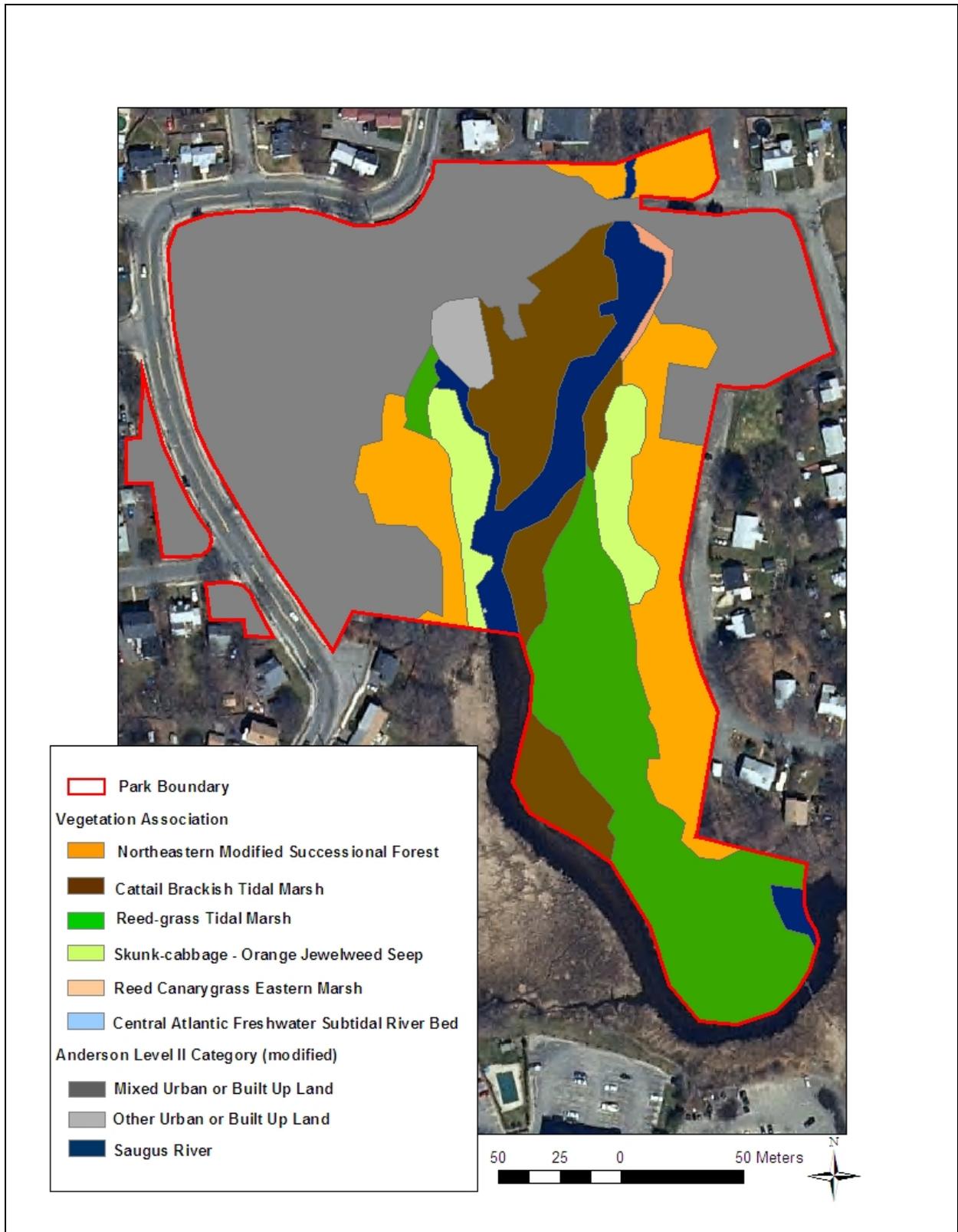


Figure 14. USNVC Vegetation Associations and Anderson Level II categories (modified) for Saugus Iron Works National Historic Site.

Table 3. Number of polygons and total mapped hectares within the park boundary for vegetation associations and Anderson Level II categories (modified) at Saugus Iron Works National Historic Site.

USNVC Association Local Name	Number of Polygons	Total Mapped Hectares
Northeastern Modified Successional Forest	4	0.74
Skunk-cabbage - Orange Jewelweed Seep	2	0.2 ¹
Cattail Brackish Tidal Marsh	4	0.52
Reed Canarygrass Eastern Marsh	1	0.02 ¹
Reed-grass Tidal Marsh	2	0.9
Central Atlantic Freshwater Subtidal River Bed	1	0.0003 ¹
Anderson Level II (modified) category		
Saugus River (including tributaries)	3	0.32
Mixed Urban or Built Up Land	3	2.3
Other Urban Land	1	0.1
Total	21	5.1

¹ Associations that fell under the minimum map unit size (0.5 acre) were included in the final vegetation map per request of Saugus Iron Works National Historic Site Natural Resource Manager. Linework for the Skunk-cabbage - Orange Jewelweed Seep and Reed Canarygrass Eastern Marsh polygons was adopted from Agius 2003b; these final areas should therefore be considered approximate. Central Atlantic Freshwater Subtidal River Bed was added to the final vegetation map per the request of the park. Location and size of polygon are approximate and based on one very small observation of the association; the full extent of this association in the park is not known.

Table 4. Summary of products resulting from the Saugus Iron Works National Historic Site vegetation classification and mapping project.

Product	FGDC-complaint spatial metadata
Aerial photos, including flight line map and photoindex held by MASS GIS*	Yes
Photomosaic as paper copy and in digital format	Yes
Annotated field forms with vegetation plot sampling data	Not Applicable
Vegetation plot sampling data in the PLOTS 2.0 database	Not Applicable
Differentially corrected GPS locations of vegetation plots	Yes
Digital photos representative of all sampled vegetation types	Not applicable
Final map of associations as paper copy and in digital format	Yes
Final report as paper copy and in digital format	Not applicable

*(See Appendix A for specific details. Note: These products will not be delivered to NPS)

Discussion

Vegetation Classification and Characterization

Six associations were identified at Saugus Iron Works National Historic Site: Northeastern Modified Successional Forest, Reed Canarygrass Eastern Marsh, Reed-grass Tidal Marsh, Cattail Brackish Tidal Marsh, Skunk-cabbage - Orange Jewelweed Seep, and Central Atlantic Freshwater Subtidal River Bed. These vegetation types reflect the varied land use history, ongoing management, and varied environmental settings of the park.

Saugus Iron Works National Historic Site presented several minor mapping issues. The small size of the Park (5.1 ha) fostered the inclination to map even the smallest patches of vegetation, even those too small to fit a sampling plot (Agius 2000b). While this fine scale mapping may be quite useful for the park and has been requested by park resource managers, it does not comply with the USGS/NPS Vegetation Mapping Program Standards which set a minimum mapping unit size of 0.5 ha (1.24 ac).

Also adding to the challenge of mapping these small patch vegetation associations was the fact that they were not visible on the aerial photography. For example, the Skunk-cabbage - Orange Jewelweed Seep was at the base of a steep slope on the western side of the Saugus River and was shaded by the overhanging trees of a separate Northeastern Modified Successional Forest association. Likewise, the seep examples on the eastern side of the river occurred under a Northeastern Modified Successional Forest canopy. A distinct signature for this community was not discernable on the orthophoto.

These issues were best resolved by adopting and slightly adjusting the line work depicted in the Agius (2003b) USNVC Alliance vegetation map for the small patch associations, Reed Canarygrass Eastern Marsh and Skunk-cabbage - Orange Jewelweed Seep that were not visible in the photography. The exact location and extent of the polygons depicting these two associations should be considered approximate. The inclusion of these associations on the final vegetation map, despite their small size, illustrates the diversity of vegetation communities at this small park more accurately than lumping the associations into broader map classes would.

The Central Atlantic Freshwater Subtidal River Bed was discovered during a 2007 survey of the vegetation bordering the river, but we were not equipped to conduct a detailed survey of the precise boundaries of this association that was also not visible on aerial photography. According to Marc Albert, Saugus Iron Works National Historic Site Natural Resource Management Specialist, it is believed that this association is more abundant than was recognized during this work. He comments: “during every low tide there are large areas (perhaps 20-30% of the total ‘river’ area) that are exposed and that I would assume would map to this association (or another sparsely vegetated mixed-substrate river bed type). Ideally follow-up work would better classify, describe, and map this association, as it may ultimately meet the minimum map unit size if taken together” (Albert, pers. comm., 2008).

Contributing also to the mapping challenges at the site was an abundance of invasive and exotic plant species, which alter the habitat and natural function of the vegetation. The invasive plant survey conducted concurrently with the preliminary USNVC Alliance mapping at the site found

that 72% of available natural habitat was inhabited by 11 invasive species (Agius 2003a, b). Historic land uses have created unique features at the site including a slag pile, developed areas, and landscaping, plus they have influenced the tidal flow of the Saugus River. The effects of these land uses were visible and are reflected in the vegetation classification and the vegetation map.

The Northeastern Modified Successional Forest was relatively limited in extent within Saugus Iron Works National Historic Site (0.7 ha [1.8 ac]). These forest stands occurred only on the slopes adjacent to the Saugus River. Prior to disturbance, this association was likely an example of the Upland / Wetland Transitional Forest, a forest association characterized by northern red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), and red maple (*Acer rubrum*), with ferns and leafy forbs in the understory. The Upland / Wetland Transitional Forest would likely be the desired condition should an attempt be made to restore these forests at Saugus Iron Works National Historic Site. This association contained Skunk-cabbage - Orange Jewelweed Seep inclusions.

The Skunk-cabbage - Orange Jewelweed Seep occurred as linear depressions adjacent to the Northeastern Modified Successional Forest polygons on the east and west sides of the Saugus River. This community was classified as herbaceous vegetation despite its occurring under a tree canopy. The overhanging canopy was contributed by the adjacent forest and was unrelated to the vegetation occurring in the seep, and was not used to classify this vegetation. The seep examples at Saugus Iron Works National Historic Site had a relatively high proportion of native species.

Cattail Brackish Tidal Marsh occurred adjacent to the slag pile and on the eastern shore of the Saugus River. This vegetation, although modified from its original state as a result of tidal restriction, was largely comprised of native species. At 0.6 ha (1.4 ac), this vegetation often occurred naturally in small patches and in linear stands adjacent to the river.

The Reed-grass Tidal Marsh map class occupied a relatively large area of 0.9 ha (2.2 ac) adjacent to the river. This was an invasive community that replaced cordgrass (*Spartina* spp) salt marshes and brackish marshes when natural tidal flow was restricted. Some native species such as sensitive fern (*Onoclea sensibilis*) and jewelweed (*Impatiens capensis*) persisted as an “understory” beneath the common reed (*Phragmites australis*) canopy. In the admittedly unlikely event that full tidal flow is restored to the river, replacement of this vegetation by salt marsh cordgrasses (*Spartina* spp.), presumably smooth cordgrass (*Spartina alterniflora*) or saltmeadow cordgrass (*Spartina patens*), would be anticipated.

The vegetation dynamics and ecological processes of the natural and semi-natural vegetation at Saugus Iron Works National Historic Site were influenced by the Saugus River and surrounding suburban development. The river had small tidal amplitude with minor influxes of brackish water (Agius 2003b). Over the last four centuries, tidal restrictions such as bridge crossings were constructed along the Saugus River downstream of the historic site. Upstream of the site, a dam breached and was removed in 1957 allowing all the stored sediment behind the dam to enter the tidal portion of the river in the site. The vegetation that would occur in a normal tidal regime is quite different from what existed during this mapping effort. The high cover of impervious surfaces surrounding the site facilitated additional sedimentation and non-point-source pollution into the Saugus River.

Vegetation Map Production

The final vegetation map for Saugus Iron Works National Historic Site included six vegetation associations and three modified Anderson Level II (modified) land use / land cover categories. The vegetation map produced by this project provides crucial baseline data for park resource managers to use for ecological land management, conservation planning and research, biological inventory and monitoring, and environmental education.

Recommendations for Future Projects

As the park staff is well aware, invasive exotic plant species are the main threat to the native vegetation at Saugus Iron Works National Historic Site, particularly on forest edges and along trails and roads. The most common and problematic species include common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and Norway maple (*Acer platanoides*). Oriental bittersweet (*Celastrus orbiculatus*) is a problem in the Northeastern Modified Successional Forest where it has the potential to out-compete native understory trees. A few scattered patches of Japanese knotweed (*Polygonum cuspidatum*) also occur on site and have the potential to spread.

Additional inventory and mapping of the Central Atlantic Freshwater Subtidal River Bed association is recommended. Classification was limited to data collected from a very small patch of this submerged vegetation that was observed during a site reconnaissance visit and was less than four square meters in patch size. Follow-up work during low tide would better classify, describe, and map this association.

The park staff has begun active management of the Reed-grass Tidal Marshes and Cattail Brackish Tidal Marshes through the project “Restore Saugus River Turning Basin and Dock.” The project includes the removal of 1.5 ha (3.75 ac) of contaminated sediments and wetland vegetation that will be replaced by 0.6 ha (1.57 ac) of diverse native brackish tidal marsh and 0.88 ha (2.18 ac) of open water and intertidal mudflat. The project also includes the removal of the nearest downstream tidal restriction, an abandoned weir at the Hamilton Street crossing. It is unclear how much effect these actions will have on the restoration of natural tidal flow and the introduction of more saline water; therefore, it is difficult to predict the success of this activity. However, the advantage of a small park is the capability to undertake intensive management, provided funds and staff time are sufficient (Albert, pers. comm., 2008).

The restoration is predicted to foster conditions conducive to a fresh-brackish marsh community. A possible target USNVC association for this desired community is Freshwater Tidal Mixed High Marsh, which is dominated by a variable mixture of *Peltandra virginica* (green arrow arum), *Pontederia cordata* (pickerelweed), *Zizania aquatica* (annual wildrice), *Sagittaria* spp. (arrowhead), and a mixture of other freshwater and brackish species. This association occurs primarily in low portions of the intertidal zone, on mucky substrates. A possible target USNVC association for the desired intertidal mudflat community is North Atlantic Coastal Plain River Brackish Intertidal Mudflat. NatureServe has helped other parks develop target conditions for restoration projects using USNVC associations and can provide more guidance to Saugus Iron Works National Historic Site restoration efforts if desired (Largay and Sneddon 2007).

The Northeastern Modified Successional Forest, particularly that on the eastern shore of the Saugus River, retains a moderate cover of native species that may begin to expand if removal of exotic species is undertaken. The nature trail, however, runs through this association and provides an excellent conduit for exotic species. Active removal of exotic species and rerouting the nature trail may improve the condition of this association. Prior to disturbance and invasion by *Acer platanoides* (Norway maple), *Rosa multiflora* (multiflora rose), *Poa pratensis* (Kentucky bluegrass), and many other exotic invasive species, this forest community was likely an Upland / Wetland Transitional Forest, dominated by *Quercus rubra* (northern red oak), *Carya alba* (mockernut hickory), *Fagus grandifolia* (American beech), and *Prunus serotina* (black cherry), with *Osmunda cinnamomea* (cinnamon fern) dominant in the herb layer. The target community, should the park consider restoring this upland forest, is this original forest type: Upland / Wetland Transitional Forest (*Quercus rubra* - *Betula alleghaniensis* / *Osmunda cinnamomea* Forest).

Literature Cited

- Agius, B. 2003a. Forging changes in an American landscape: Invasive plant species at the Saugus Iron Works National Historic Site. Unpublished report to the National Park Service. 16 pp.
- Agius, B. 2003b. Vegetation classification of Saugus Iron Works National Historic Site Unpublished report to the National Park Service. 4 pp. plus appendixes.
- Anderson, J. R., E. E. Hardy, J. T. Roach, and R. W. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey professional paper 964. U.S. Government Printing Office. Washington, DC. 28 pp.
- Anderson, L. E. 1990. A checklist of *Sphagnum* in North America north of Mexico. *Bryologist*, **93**:500–501.
- Anderson, L. E., H. A. Crum, and W. R. Buck. 1990. List of mosses of North America north of Mexico. *Bryologist* **93**:448–499.
- Avery, T. E. 1978. Forester's Guide to Aerial Photo Interpretation. U.S. Department of Agriculture. U.S. Forest Service. Agriculture Handbook 308. 40 pp.
- Egan, R. S. 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. *The Bryologist* **90**:77–173.
- Egan, R. S. 1989. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition I. *The Bryologist* **92**(1):68–72.
- Egan, R. S. 1990. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition II. *The Bryologist* **93**(2):211–219.
- Egan, R. S. 1991. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition III. *The Bryologist* **94**(4):396–400.
- Environmental Systems Research Institute, Inc (ESRI). 1992–2007. ArcGIS9.1. Environmental Systems Research Institute, Inc. Redlands, CA.
- Esslinger, T. L., and R. S. Egan. 1995. A Sixth Checklist of the Lichen-forming, Lichenicolous, and Allied Fungi of the Continental United States and Canada. *The Bryologist* **98**(4):467–549.
- Federal Geographic Data Committee(FGDC). 1996. FGDC Vegetation classification and information standards. Federal Geographic Data Committee. Reston, VA. 31 pp.

- Federal Geographic Data Committee (FGDC). 1998a. Content standard for digital geospatial metadata (FGDC-STD-001-1998). Retrieved October 2001 from <http://www.fgdc.gov/metadata/contstan.html>.
- Federal Geographic Data Committee (FGDC). 1998b. Geospatial positioning accuracy standards, Part 3: National Standard for Spatial Data Accuracy. (FGDC-STD-007.3-1998). Retrieved October 2001 from http://www.fgdc.gov/standards/status/sub1_3.html.
- Fuller, D. C., and E. L. Francis. 1984. Soil Survey of Essex County, Southern Part, Massachusetts. United States Department of Agriculture. Natural Resources Conservation Service.
- Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I. The National Vegetation Classification System: development, status and applications. The Nature Conservancy. Arlington, VA. 126 pp.
- Kartesz, J. T. 1999. A Synonymized Checklist and Atlas with Biological Attributes for the Vascular flora of the United States, Canada, and Greenland. First Edition. *In* Kartesz, J. T., and C. A. Meacham. Synthesis of the North American Flora. Version 1.0. North Carolina Botanical Garden. Chapel Hill, NC.
- Keys, J. E., Jr., C. A. Carpenter, S. L. Hooks, F. G. Koenig, W. H. McNab, W. E. Russell, M. Smith. 1995. Ecological Units of the Eastern United States. USDA Forest Service.
- Largay, E. F., and L. A. Sneddon. 2007. An approach to quantifying desired forest conditions at Valley Forge National Park. Technical Report NPS/NER/NRTR—2007/082. National Park Service. Philadelphia, PA.
- MassGIS. 2007. Data layers/GIS Database. 1:5,000 Color Ortho Imagery - April 2005. Commonwealth of Massachusetts Office of Geographic and Environmental Information. Executive Office of Environmental Affairs. Boston, MA. <http://www.mass.gov/mgis/colororthos2001.htm>.
- Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. New York. Wiley.
- National Park Service (NPS). 2003. Resource Inventories. <http://www.nature.nps.gov/protectingrestoring/IM/resourceinventories.htm>.
- National Park Service (NPS). 2006. Saugus Iron Works National Historic Site. U.S. Department of the Interior. <http://www.nps.gov/sair/naturescience/index.htm>.
- NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of October 2007.

- Perles, S. J., G. S. Podniesinski, E. A. Zimmerman, W. A. Millinor, and L. A. Sneddon. 2006. Vegetation Classification and Mapping at Friendship Hill National Historic Site. Technical Report NPS/NER/NRTR—2006/041. National Park Service. Philadelphia, PA.
- Sneddon, L. A. (editor). 1993. Field form instructions for the description of sites and terrestrial, palustrine, and vegetated estuarine communities. Unpublished document. The Nature Conservancy. Boston, MA. 26 pages plus appendixes.
- Sneddon, L., M. Anderson, and K. Metzler. 1996. Community alliances and elements of the Eastern Region. Unpublished report. The Nature Conservancy. Eastern Heritage Task Force. Boston, MA. 235 pp.
- Stotler, R., and B. Crandall-Stotler. 1977. A checklist of the liverworts and hornworts of North America. *Bryologist*, 80:405–428.
- Strakosch-Walz, K. Editor. 2000. Instruction Manual on Heritage Field Methodology: Documenting Ecological Communities. New Jersey Natural Heritage Program. Trenton, NJ. 86 pp.
- Swain, P. C., and J. B. Kearsley. 2001. Classification of natural communities of Massachusetts. September 2001 draft. Natural Heritage and Endangered Species Program. Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994a. NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System. 188 pp. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA. <http://biology.usgs.gov/npsveg/standards.html>.
- The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994b. NBS/NPS Vegetation Mapping Program: Field Methods for Vegetation Mapping. 92 pp. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA. <http://biology.usgs.gov/npsveg/standards.html>.
- The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994c. NBS/NPS Vegetation Mapping Program: Accuracy Assessment Procedures. 71 pp. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA. <http://biology.usgs.gov/npsveg/standards.html>.
- United States Department of Agriculture, National Resources Conservation Service (USDA, NRCS). 2006. *The PLANTS Database*, Version 3.5 (<http://plants.usda.gov>). Data compiled from various sources by Mark W. Skinner. National Plant Data Center. Baton Rouge, LA.
- United States Geological Survey (USGS). 2004. Tools for creation of formal metadata, a compiler for formal metadata. Retrieved June 2004 from <http://geology.usgs.gov/tools/metadata/tools/doc/mp.html>.

Wall, S., G. N. Eby, and E. Winter. 2004. Geoarchaeological traverse: soapstone, clay and bog iron in Andover, Middleton, Danvers and Saugus, Massachusetts. In Hanson, L. (ed.) Guidebook to Field Trips from Boston, MA to Saco Bay, ME. New England Intercollegiate Geological Conference. Salem, MA. Pp. 257–276.

Appendix A. Detailed information about the aerial photography and orthophoto acquired from Mass GIS.

An orthophoto mosaic developed from a set of digital 1:5,000 scale medium resolution true color aerial images that are considered to be the new “base map” for the Commonwealth of Massachusetts was used as the base for the vegetation mapping project. Sanborn Colorado L.L.C. of Colorado Springs, CO, performed all work for the "base map" project. The source imagery was acquired with a Vexcel Ultracam digital camera at a flying height of 5,070 meters above mean terrain and an approximate pixel resolution of 45 cm. Forward overlap was approximately 60%, except 80% in areas with tall structures (downtown Boston, Worcester, and Springfield), in order to reduce building lean, with sidelap of 33%. The entire state was covered by about 5500 image frames, captured over seven days from April 9 through April 17, 2005.

The ground control used to support the mapping was collected by photographic identification of strategic points. The ground control coordinates were collected via GPS ground survey techniques. Aerial Triangulation was performed on softcopy workstations using Intergraph ISAT software for photo measurement and matching. The final bundle adjustment was performed using BINGO 5.2 software.

A new digital elevation model was stereo compiled for the entire state from the newly acquired 2005 imagery. The DTM includes mass points, soft breaklines, and hard breaklines. The images were ortho-rectified using METRO, Sanborn's proprietary software. Bridges were modeled in 3-D using standard photogrammetric stereo-compilation techniques on softcopy workstations. Sanborn's Metro process rectifies the bridges with a 3-Dimensional model using similar methodologies for correcting the positional accuracy of other ground features. The bridges were uniquely coded and later removed from the final deliverable DTM file.

Imagery was originally georeferenced to Massachusetts State Plane Mainland (Lambert Conformal Conic Projection) NAD83 coordinate system, denominated in meters. NatureServe GIS specialist, Jon Hak, converted the image projection to UTM Zone 19 NAD 83 coordinate system.

Color balancing was performed using METRO_NICE software. The resulting images were mosaicked into one seamless database of imagery and extracted to match the existing MassGIS Orthophoto Index Grid tile layout (each image tile covers 4,000×4,000 m on the ground.). Images were quality-controlled by Sanborn using Adobe PhotoShop software. Final deliverables included 1/2-meter pixel resolution GeoTiff images with supplementary tfw files and metadata.

MassGIS quality assurance included rigorous independent checks of the spatial accuracy using other datasets of significantly higher accuracy, and field work that included the capture of highly accurate GPS points that were compared to the same locations appearing on the deliverables. MassGIS also assessed the visual quality and appearance of the images.

A metadata record for the mosaic was prepared according to current Federal Geographic Data Committee standards (FGDC 1998a). Metadata were produced in ARCGIS 9.1 using the USGS metadata compiler program (MP) to locate errors and omissions (USGS 2004). After all errors

and omissions were corrected, MP was used to generate final TXT, HTML, and XML versions of each metadata record. These are stored in the air photo archive.

Appendix B. Vegetation Classification of Saugus Iron Works National Historic Site prepared by Brad Agius (2003b).

Objective

To classify and map the alliance level vegetation types present at the Saugus Iron Works National Historic Site using the National Vegetation Classification System.

Materials and Methods

This was a preliminary mapping vegetation survey. The vegetation types were classified to the alliance level at the site on July 17, 2003, by Lesley Sneddon at Nature Serve, prior to mapping. The actual mapping for the vegetation was conducted from July 17 through August 14, 2003. Data collection for mapping was designed specifically for this project and followed no existing protocol. The survey was conducted in a systematic fashion, using grids created in GIS software (ESRI ArcView 3.2) and were overlaid on the site. Grids were saved in 'shapefile' format. The 50×50 m (i.e., 0.25 ha or 0.62 ac) grid was used to survey the entire site. Each of the 28, 50×50 m grid cells was assigned a unique ID number that was used for referencing grid cell locations.

During the survey, there were instances when a portion of the site was not covered by the grid, but those sections were systematically surveyed as well, to cover the site in its entirety. Prior to field surveys, black and white maps were printed that included the grid layer with individual grid attribute ID numbers, 1 m black and white digital orthophotos, site boundary, scale bar, and north arrow. Maps typically included a block of four grids per 8.5×11 inch pages, although other grid dimensions were used when necessary.

The grid shapefile was also uploaded into the GPS unit to aid in navigation. In the field, a piece of tracing paper was placed over the 2×2 grid map, and the corners of the grids marked for aligning the tracing paper with the grid map. The surveyor's name, date, site, and grid numbers were recorded on the tracing paper.

Each grid was surveyed by bushwhacking the perimeter and then making transects (e.g., numerous transverse passes) within the grid until completely covered, with all targeted vegetation types and features (landscaping and slag pile) being mapped. Pinpointing locations in the field was done by referencing features on the ground (e.g., trails, roads, water bodies, trees, structures, fields, etc.) that were visible on the 1 m black and white orthophotos; grid lines on the paper map; and the GPS tracks line, current position of GPS cursor, and grid lines on the GPS display screen. Using these references enabled the survey to be conducted with an accuracy of 1 m or the margin of error produced by the GPS unit. In the field, the vegetation types and features were sketched onto the tracing paper in the exact location that they occurred in the field.

Hand-drawn polygons created on tracing paper in the field were transferred into digital format using 'heads-up' digitizing capabilities of ArcView 3.2 (ESRI 1999). One shapefile was created for each of the eight alliance level vegetation types (Table 1), landscaping, and slag pile with an attribute table containing unique ID #, USNVC code, alliance name, and area m² (fields 1–4, respectively) for each polygon. In addition, structures, open water, and development (e.g.,

pavement, asphalt, stone walkways) were added to the USNVC shapefile and created by 'heads-up' digitizing using photo-interpretation. The structures, open water, and development at the site were digitized around the objects using 0.5 m color orthophotos as a base map. One shapefile was used for the entire site so that polygons could be snapped together, without overlap. The entire USNVC shapefile was clipped to the Saugus Iron Works National Historic Site boundary.

The map (Figure B1) for this report was exported from ArcView as .JPG files to present the relevant invasive species data. The resolution of the final map (in JPEG format) does not reflect all of the data viewable in the ArcView layout. In addition, more data is contained in the attribute table of the ArcView files that is not shown in the JPG files. If finer resolution maps or additional data is needed, copies are available through the Natural Resource Manager at Saugus Iron Works Historic Site or the database manager at the Northeast Temperate Network.

Results and Discussion

The initial classification survey yielded eight distinct vegetation types (Table B1, Appendix B¹). The largest vegetation type at the site was *Dactylis glomerata - Rumex acetosella* herbaceous alliance (V.A.5.N.c.103.). At 1.4 ha, the *Dactylis glomerata - Rumex acetosella* herbaceous alliance covers 27.4 % of the entire site. The developed areas equal 16.8 % of the total site (i.e., the combined area of pavement and structures, Figure B2). The 682 m² area of the “landscaping” is misleading. The majority of the landscaping at the site was encompassed by the *Dactylis glomerata - Rumex acetosella* herbaceous alliance, and designated as such. “Landscaping” was the garden areas of the park: thin strips along the fences, isolated hedges and shrubs, and small beds around buildings.

Much of the natural vegetation of the site is heavily influenced by the Saugus River that bisects the site. The river has a small tidal amplitude with minor influxes of brackish water. The vegetation classifications influenced by the Saugus River include: V.A.5.N.n.7, V.B.2.N.f.13, N.A.5.N.k.33, V.A.5.N.n.2, V.A.5.N.k.20, V.B.2.N.g.3, and I.B.2.N.a.39. The site is also influenced by the encircling suburban development and impervious surfaces. The area site has been altered by humans for hundreds of years.

¹ NatureServe comment: Appendix B as referred to here is a preliminary vegetation classification reported from the Biological Conservation Datasystem in 2003. The most up-to-date data and vegetation classification is presented in the Results Section in this report under Vegetation Association Descriptions. Appendix B from Agius (2003b) was not included here to avoid confusion and redundancy. A crosswalk of the (Agius 2003b) vegetation map classes to final vegetation map for this project is provided in Table 2.

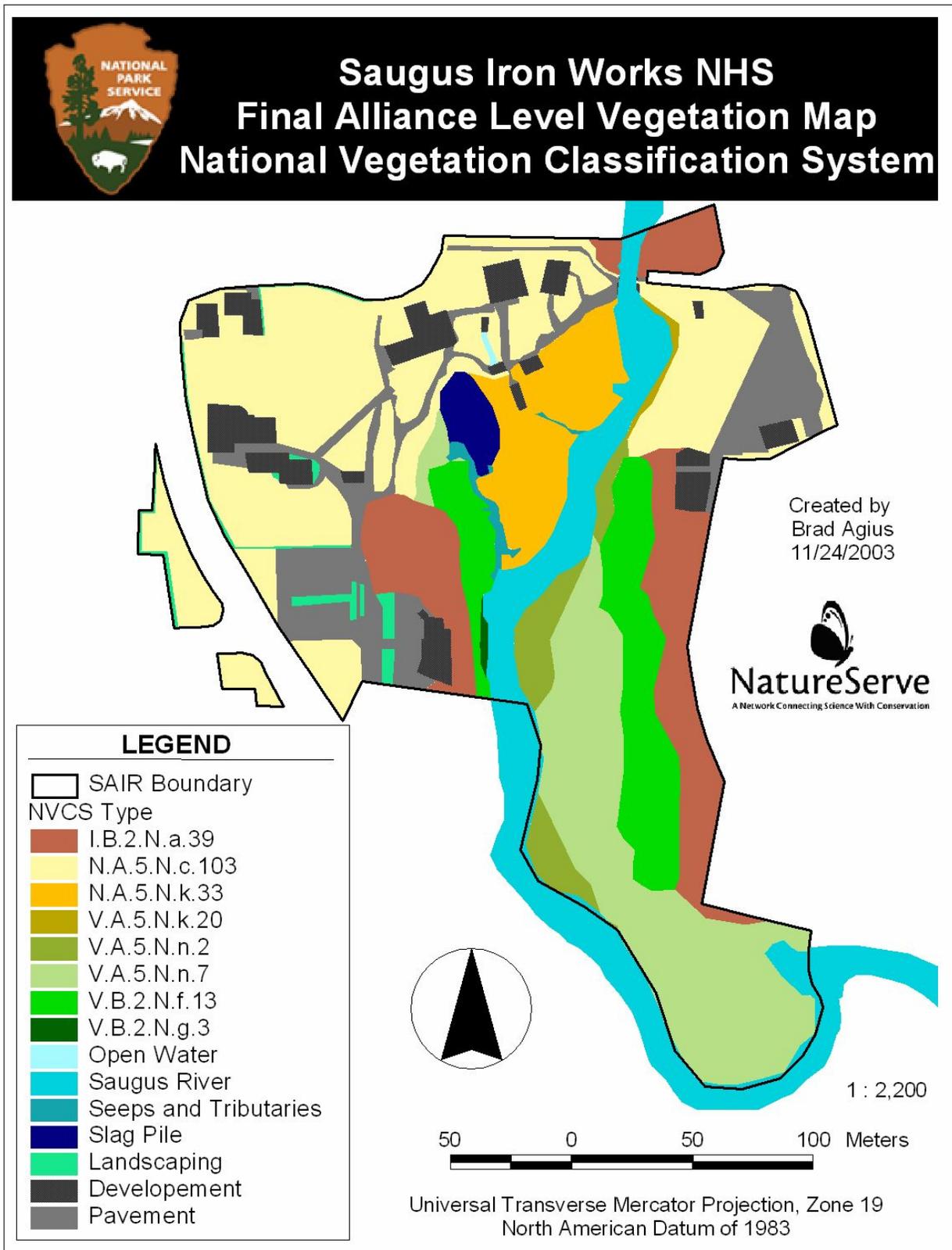


Figure B1. Agius (2003b) Saugus Iron Works National Historic Site Final Alliance Level Vegetation Map based on the National Vegetation Classification System.

Table B1. Eight alliance level vegetation types present at Saugus Iron Works NHS.

USNVC Code	Alliance Level Vegetation Type
I.B.2.N.a39.	<i>Quercus rubra</i> – (<i>Acer saccharum</i>) Forest Alliance
V.A.5.N.c103.	<i>Dactylis glomerata</i> – <i>Rumex acetosella</i> Herbaceous Alliance
V.A.5.N.k.20.	<i>Phalaris arundinacea</i> Seasonally Flooded Herbaceous Alliance
V.A.5.N.k.33.	<i>Typha spp.</i> – (<i>Schoenoplectus spp.</i> , <i>Juncus spp.</i>) Seasonally Flooded Herbaceous Alliance
V.A.5.N.n.7.	<i>Phragmites australis</i> Tidal Herbaceous Alliance
V.A.5.N.n.2.	<i>Typha (Angustifolia domingensis)</i> Tidal Herbaceous Alliance
V.B.2.N.f.13.	<i>Symplocarpusfoetidus</i> – <i>Caltha palustris</i> Saturated Herbaceous Alliance
V.B.2.N.g.3.	<i>Peltandra virginica</i> – <i>Pontederia cordata</i> Tidal Herbaceous Alliance

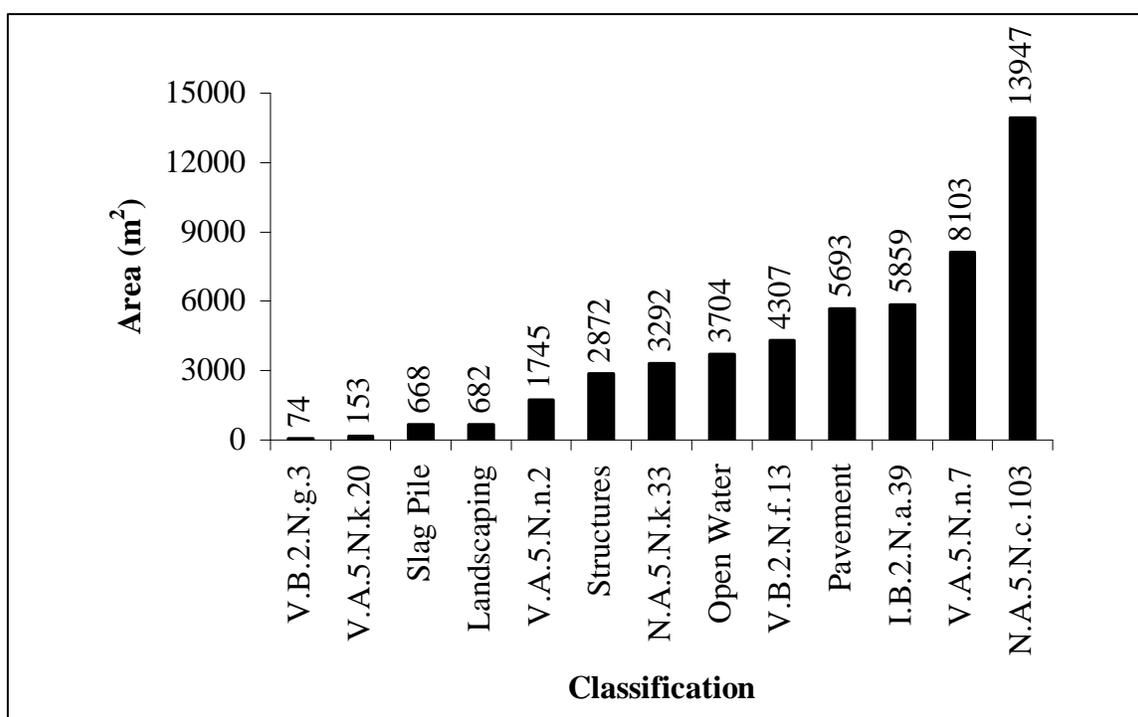


Figure B2. The area (m²) for each classification type at Saugus Iron Works NHS.

The Saugus Iron Works National Historic Site posed challenges for mapping the USNVC types. First, the small size of the site (5.1 ha) and fragmented habitats made some of the vegetation polygons fall well below the minimum mapping unit (Figure 1). The typical minimum USNVC mapping unit is 0.5 ha (1.24 ac) (L. Sneddon, pers. comm.). Secondly, the site is extremely infested with invasive and exotic plant species which alter the habitat types and natural function of the ecological communities. The invasive plant survey conducted concurrently with the USNVC mapping at the site found that 72.3% of available natural habitat is inhabited by the 11 invasive species (Agius 2003). Third, historic land use has created unique features such as the slag pile, developed structures, and landscaping. While the slag pile and vegetation types are mapped, there is room for a finer description of the vegetation types to the association level. Additional systematic surveys of the vegetation types should incorporate the National Park Vegetation Mapping Program Plot Surveys.

Literature Cited

Agius, B. 2003. Forging Changes to an American Landscape: Invasive Plant Species at the Saugus Iron Works National Historic Site. National Park Service.

Appendix C. Photomosaic interpretation descriptions for vegetation map classes and Anderson Level II (modified) categories at Saugus Iron Works National Historic Site for April 2005 Photomosaic.

Forest Community

Signature is predominantly blue with some gray; vertical boles of trees may be present with tan patches beneath; Canopy structure can be variable. **Northeastern Modified Successional Forest**

Herbaceous Communities

Signature is predominantly gray or green, ranging from uniform to mottled. Shrubs, appearing as round gray circles, may be present or absent, scattered or in clumps within the gray matrix of herbaceous vegetation. Buildings, structures, parking lots, roads, and open water are absent.

Signature has dense bumpy gray-brown signature, with occasional small, interspersed patches of tan to light gray and a few scattered dark gray clumps indicating more open herbaceous vegetation. **Cattail Brackish Tidal Marsh**

Signature lacks bumpy texture and is gray interspersed with bright tan patches along both sides of Saugus River; Gray to black linear drainage features are common. **Reed-grass Tidal Marsh**

Signature is linear and darker-blue gray than the forest signature; occurs adjacent to and interspersed with forest signature. **Skunk-Cabbage - Orange Jewelweed Seep**

Signature is typically bright green. Dark green or gray bumpy clumps representative of shrubs and trees may be present along the edges of the brighter green fields; tan features may also be present. **Lawn and Landscaped Areas mapped as Urban or Built up Land**

Signature cannot be determined from photo as these communities are less than 0.02 ha (0.05 acres) in size; examples were observed in field. **Reed Canarygrass Eastern Marsh and Central Atlantic Freshwater Subtidal River Bed**

Land Use and Water Feature Photo Signatures

Buildings, structures, planting areas, parking lots or roads are present, often surrounded by frequently mowed turf grass that has a green signature. Or, signature is uniform dark gray to black, indicating open water. Or, signature is mottled gray-purple with distinctive irregularly shaped tan clump indicating slag pile.

Dark blue, light blue or white reflective rectangular signatures indicative of buildings, structures, and parking lots with cars, often surrounded by frequently mowed turf grass that has a light, bright green signature. **Buildings and Structures mapped as Urban or Built up Land**

Medium gray to light blue linear to rectangular signature indicative of roads, asphalt walkways and parking lots often with visible lane lines or cars. **Roads, Parking Lots and Pathways mapped as Urban or Built up Land**

Rectangular features surrounded by roads or buildings with a purple-red-gray signature. **Landscaping mapped as Urban or Built up Land**

Purple grading into dark gray to black linear to rectangular signature south of a small building. **Open Water, mapped as Saugus River**

Signature is typically bright green. Dark green or gray bumpy clumps representative of shrubs and trees may be present along the edges of the brighter green fields; tan features may also be present. **Lawn and Landscaped Areas mapped as Urban or Built up Land**

Large, wide, linear, sinuous dark gray to black feature that runs through the middle of the site; occasional linear tan-to-brown wisps (sand bars) prominent alongside the edges; runs through the middle of the park. **Saugus River**

Signature is mottled gray-purple with distinctive irregularly shaped tan feature and some black patches. **Slag Pile mapped as Other Urban Land**

Appendix D. Vegetation plot sampling form.

Form 3: NPS Quantitative Community Characterization

SAUGUS IRON WORKS NHS

A. Identifiers (general EOR information)

2. USNVC Code / Name _____	
4. Survey site name: _____	
5. Quad name(s): _____	7. County name: _____
9. Town (LOCAL JURIS): _____	
10. Lat: _____ N	11. Long: <u>0</u> _____ W
12. Directions: _____ _____ _____	
13. Source code: _____	
14. Survey Date: _____	
17. State: <u>MA</u>	
18. Surveyors: _____	

B. Environmental Description

19. Transect / Observation point #	20. Image annotation #	21. Elevation:
22. Topographic position: <input type="checkbox"/> Interfluvial <input type="checkbox"/> Backslope <input type="checkbox"/> High slope <input type="checkbox"/> Step in slope <input type="checkbox"/> High level <input type="checkbox"/> Lowslope <input type="checkbox"/> Midslope <input type="checkbox"/> Toeslope <input type="checkbox"/> Low Level <input type="checkbox"/> Channel wall <input type="checkbox"/> Channel bed <input type="checkbox"/> Basin floor <input type="checkbox"/> Other	23. Topographic sketch:	24. Slope degrees: _____ 25. Slope aspect: _____ ----- 26. Parent material:
27. Soil profile description: note depth, texture, and color of each horizon. Note significant changes such as depth to mottling, depth to water table, root penetration depth (SOILCOM)	31. Soil moisture regime: <input type="checkbox"/> Extremely dry <input type="checkbox"/> Somewhat wet <input type="checkbox"/> Very dry <input type="checkbox"/> Wet <input type="checkbox"/> Dry <input type="checkbox"/> Very wet <input type="checkbox"/> Somewhat moist <input type="checkbox"/> Permanently inundated <input type="checkbox"/> Moist <input type="checkbox"/> Periodically inundated	32. <input type="checkbox"/> Stone free <0.1% <input type="checkbox"/> Moderately stony 0.1-1% <input type="checkbox"/> Stony 3-15% <input type="checkbox"/> Very stony 15-50% <input type="checkbox"/> Exceedingly stony 50-90% <input type="checkbox"/> Stone piles >90%
28. Organic horizon depth: _____	33. Soil drainage: <input type="checkbox"/> Rapidly drained <input type="checkbox"/> Somewhat poorly drained <input type="checkbox"/> Well drained <input type="checkbox"/> drained <input type="checkbox"/> Moderately well drained <input type="checkbox"/> Very poorly drained	34. Average texture: <input type="checkbox"/> sand <input type="checkbox"/> clay loam <input type="checkbox"/> sandy loam <input type="checkbox"/> clay <input type="checkbox"/> loam <input type="checkbox"/> other:
29. Organic horizon type: _____	35. Unvegetated surface: <input type="checkbox"/> % Bedrock <input type="checkbox"/> % Large rocks (cobble, boulders >10cm) <input type="checkbox"/> % Small rocks (gravel, 0.2-10 cm) <input type="checkbox"/> % Bare soil	
30. Average pH of mineral soil: _____	_____ % Litter, duff _____ % Wood (> 1cm) _____ % Water _____ % Other: _____	
36. Environmental Comments: Note homogeneity of vegetation, erosion / sedimentation, inundation, etc.		
37. Plot representativeness:		

Appendix E. Metadata for PLOTS 2.0 Database.

Table	Field	Meaning	Comment re SAIR
Plots	Plot Code	Unique identifier assigned by PLOTS using 4-letter park code and sequential numbers	
Plots	Field Plot Name	Plot as identified on field form	
Plots	County		
Plots	SubPlot	Was plot a sub-unit of a larger plot?	
Plots	SubPlot Parent Code	Identifier of larger plot if this is a subplot	n/a for SAIR
Plots	Air Photo Number	Reference number for aerial photo that covers the plot area	
Plots	Polygon Code	Identifier of polygon on vegetation map in which plot falls	
Plots	Map Unit	Name of map class for polygon in which plot falls	
Plots	Classified Community Name	Standard association name from the National Vegetation Classification	
Plots	USNVC ELCODE	Standard element code from the National Vegetation Classification	
Plots	Sublocation	Narrative for location of plot within the park	
Plots	Quad Name	Name of USGS 7.5' quadrangle in which plot falls	
Plots	Quad Code	Standardized code for USGS quadrangle	
Plots	Coord System	Coordinate system used for geographic location of plots: "1" if UTM, "2" if latitude/longitude	
Plots	GPS File	Name of file in which coordinates are stored	
Plots	GPS Techniques	Type of GPS unit used to secure location plus any applicable comments	
Plots	Field UTM X	X UTM coordinate as recorded in field	
Plots	Field UTM Y	Y UTM coordinate as recorded in field	
Plots	Corrected UTM X	Corrected X UTM coordinate if post-processing is used	n/a for SAIR as no post-processing was used
Plots	Corrected UTM Y	Corrected Y UTM coordinate if post-processing is used	n/a for SAIR as no post-processing was used
Plots	UTM Zone	UTM zone	
Plots	Survey Date	Date field data were taken	
Plots	Surveyors	Field personnel	
Plots	Plot Directions	Detailed directions to plot using ground landmarks	
Plots	X Dimension	Length of side of plot in m	
Plots	Y Dimension	Width of plot in m	
Plots	Plot Shape	Square, rectangular, round, etc.	Combination for SAIR

USGS-NPS Vegetation Mapping Program
 Saugus Iron Works National Historic Site

Table	Field	Meaning	Comment re SAIR
Plots	Photos	Yes/No	
Plots	Roll Number	Roll number for film photos	
Plots	Frame Number	Frame number for film photos; file name for digital photos	
Plots	Permanent	Is plot permanent? Yes/no	
Plots	Representativeness	Narrative for how representative of community plot seems to be	
Plots	Elevation	Plot average elevation above mean sea level	in meters
Plots	Elevation Units	"1" = meters, "2" = feet	
Plots	GPS Datum	Datum used by GPS	NAD83 for SAIR
Plots	GPS Accuracy	As recorded in field	
Plots	Slope	Slope category (pick-list)	Flat = 0°; Gentle = 0-5°; Moderate = 6-14°; Somewhat steep = 15-25°; Steep = 27-45°; Very steep = 45-69°; Abrupt = 70-100°; Overhanging/sheltered = 100°
Plots	Precise Slope	Slope measurement	in degrees
Plots	Slope range	Range of slope, where uphill and downhill values are given	
Plots	Aspect	Aspect category (pick-list)	Flat; Variable; N 338-22°; NE 23-67°; E 68-112°; SE 113-157°; S 158-202°; SW 203-247°; W 248-292°; NW 293-337°
Plots	Precise Aspect	Measured aspect in True degrees	
Plots	Topo Position	Topographic position of plot (pick-list)	Crest/Summit/Ridge ; Upper/Shoulder Slope ; High Plateau ; Middle Slope ; Slope step (terracette) ; Lower Slope ; Toe slope ; Low level/terrace ; Channel wall ; Channel bed ; Depression
Plots	Landform	Landform on which plot occurs (pick-list)	Bar ; Basin ; Beach. ; Bluff/bank ; Channel ; Cliff ; Cove ; Delta ; Dome ; Drumlin ; Dune ; Escarpment ; Esker ; Estuary ; Flat ; Floodplain ; Gorge ; Hill ; Kame ; Kettle ; Lake /pond; Ledge ; Moraine ; Mountain ; Outwash plain ; Oxbow ; Plain ; Plateau ; Ravine ; Ridge ; Saddle ; Swale ; Talus ; Terrace ; Valley ; Other
Plots	Surficial Geology	Geologic setting (pick-list)	Bedrock ; Talus ; Glacial till; Moraine; Esker/outwash; Glacial delta; Lacustrine/; fluvial; Marine; Aeolian ; Other
Plots	Cowardin System	Broad wetland classification from Cowardin 1979	Upland, Palustrine, Estuarine, Riverine, Lacustrine
Plots	Hydro Regime	Hydrologic regime (wetlands only)	Permanently Flooded ; Semipermanently Flooded ; Seasonally Flooded ; Saturated ; Temporarily Flooded ; Intermittently Flooded ; Tidally Flooded
Plots	Salinity/Halinity		
Plots	Hydrology Evidence	Notes on evidence used to deduce hydrologic regime	
Plots	Environmental Comments	Narrative description of the habitat	
Plots	Landscape Comments	Narrative description of the surrounding area	

USGS-NPS Vegetation Mapping Program
Saugus Iron Works National Historic Site

Table	Field	Meaning	Comment re SAIR
Plots	Soil Taxon/Description	Narrative of soil profile	
Plots	Soil Texture	Soil texture class	sand ; sandy loam ; loam ; silt loam ; silt ; clay loam ; clay ; peat ; muck
Plots	Soil Depth	Depth to obstruction	
Plots	Soil Depth Units	1=meters, 2=cm, 3=feet, 4=inches	cm
Plots	Soil Drainage	Drainage category (pick-list)	rapidly drained ; well drained ; moderately well drained ; somewhat poorly drained ; poorly drained ; very poorly drained
Plots	% Bedrock	% unvegetated ground surface covered	
Plots	% Large Rocks	% unvegetated ground surface covered	
Plots	% Small Rocks	% unvegetated ground surface covered	
Plots	% Sand	% unvegetated ground surface covered	
Plots	% Litter, Duff	% unvegetated ground surface covered	
Plots	% Wood	% unvegetated ground surface covered	
Plots	% Water	% unvegetated ground surface covered	
Plots	% Bare Soil	% unvegetated ground surface covered	
Plots	% Other	If "other" is used as a ground surface cover category	
Plots	% Other Description	If "other" is used as a ground surface cover category	
Plots	Leaf Phenology	Of dominant stratum	Evergreen, Cold-deciduous, Mixed evergreen-cold-deciduous, Herb – annual, Herb – perennial
Plots	Leaf Type	Of dominant stratum	Broad-leaved, Needle-leaved, Microphyllous, Graminoid, Broad-leaved herbaceous, Pteridophyte, Nonvascular
Plots	Physio Class	Physiognomic Class according to USNVC hierarchy; applies to dominant stratum (highest stratum with at least 25% cover)	Forest (>60% tree canopy -crowns overlapping), Woodland (25%-60% open tree canopy), Shrubland (<25% trees, and shrubby cover >0.5 m tall greater than other strata), Dwarf Shrubland (<25% trees, and shrubby cover <0.5 m tall greater than other strata), Herbaceous (herb cover exceeds that of other strata), Nonvascular (nonvascular cover exceeds that of other strata), or Sparse vegetation (total vegetation <25%)
Plots	T1 Hgt	Height of emergent tree layer	in meters if applicable
Plots	T1 Cover	% cover of emergent tree layer	cover classes (for all strata): 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%
Plots	T2 Hgt	Height of tree canopy layer	
Plots	T2 Cover	% cover of tree canopy layer	
Plots	T3 Hgt	Height of tree subcanopy layer	

USGS-NPS Vegetation Mapping Program
 Saugus Iron Works National Historic Site

Table	Field	Meaning	Comment re SAIR
Plots	T3 Cover	% cover of tree subcanopy layer	
Plots	S1 Hgt	Height of tall shrub layer	
Plots	S1 Cover	% cover of tall shrub layer	
Plots	S2 Hgt	Height of short shrub layer	
Plots	S2 Cover	% cover of short shrub layer	
Plots	S3 Hgt	Height of dwarf shrub layer	
Plots	S3 Cover	% cover of dwarf shrub layer	
Plots	H Hgt	Height of herb layer	
Plots	H Cover	% cover of herb layer	
Plots	N Cover	% cover of non-vascular layer	
Plots	V Hgt	Height of vine layer, if present	
Plots	V Cover	% cover of vine layer	
Plots	Other Measure1 Defined	Explanation of other measure of species presence	
Plots	Other Measure2 Defined	Explanation of other measurement used for species presence	
Plots	Animal Use Evidence		
Plots	Disturbance Comments	Narrative on natural and anthropogenic disturbance	
Plots	Other Comments		
Plots	Update	When record was last updated (using Plots 2.0 interface)	does not apply to values directly manipulated in tables
Plots	User	Initials of person entering record	
Plots	Species Counter	Number of plant species recorded in plot	
Plots	Optional Fields Defined	Narrative defining any optional fields that are used	Opt1: Basal area in m2/ha, rounded
Plots	Opt1	For MABI, basal area (m2/ha, rounded)	
Plots	Provisional Community Name	Community name assigned in field or before final analyses	
Plots-Species	Plot Code	Unique identifier assigned by PLOTS using 4-letter park code and sequential numbers	provides link to Plots table
Plots-Species	Plot Species Counter	Unique integer sequence for species within this plot	
Plots-Species	Plant Symbol	From USDA Plants db table	
Plots-Species	Scientific Name	Accepted Latin name of the plant species	
Plots-Species	Common Name		
Plots-Species	Family		
Plots-Species	Specimen Number	If collected	
Plots-Species	Used PLANTS	Yes if name came from The PLANTS database	
Plots-Species	Source	From Plant List table: SS or NS	

USGS-NPS Vegetation Mapping Program
 Saugus Iron Works National Historic Site

Table	Field	Meaning	Comment re SAIR
Plots-Species	Within Plot	Yes/No: Species is present within the Plot boundaries	
Plots-Species	Stratum Sort	Major sort order of strata	to sort from highest to lowest or vice versa
Plots-Species	Stratum	Stratum this species being recorded in	T1 = Emergent; T2 = Tree Canopy; T3 = Tree Subcanopy; S1 = Tall Shrub; S2 = Short Shrub; H = Herbaceous; N = Nonvascular plant; V = Vine/liana
Plots-Species	Strat-Simple	Simplified stratum	Tree, Shrub, Herb, Non-vasc, Vine
Plots-Species	Diagnostic	Yes/No: Species is a known diagnostic for the community	
Plots-Species	Range Cover	Midpoint of cover class	cover classes (for all strata): < 1 / 1-5% / 6-10% / 11-25% / 26-50% / 51-75% / 76-100%
Plots-Species	Real Cover	If % cover measured directly	not used at SAIR
Plots-Species	Other Measure1	Other measure of species presence	CalculatedCover: from relativized basal area (Keeton data) * total canopy cover
Plots-Species	Other Measure2	Other measure of species presence	not used at SAIR
Plots-Species	DBH	Diameter at breast height for all trees above 10 cm diameter (comma delimited)	recorded on field forms
Plots-Species	Update	When record was last updated (using Plots 2.0 interface)	does not apply to values directly manipulated in tables
Plots-Species	User	Initials of person entering record	
Plots-Species	SciName-Field	Scientific name used on field form	names standardized to Kartesz 1999 (updated NPS names are in "Scientific Name" field)

Appendix F. Plants observed in Saugus Iron Works National Historic Site during vegetation plot sampling and reconnaissance, and species list acquired from the park.

Nomenclature follows the PLANTS 3.5 Database developed by the Natural Resources Conservation Service in cooperation with the Biota of North America Program (USDA, NRCS 2006). For this report, some common names listed in the PLANTS database were changed to reflect the common names typically used by ecologists and resource managers in this region. Species with an asterisk (*) notate species that were sampled within plots.

Family	Scientific Name	Common name
Aceraceae	<i>Acer negundo</i>	boxelder
	<i>Acer platanoides</i> *	Norway maple
	<i>Acer rubrum</i>	red maple
	<i>Acer saccharinum</i>	silver maple
	<i>Acer saccharum</i>	sugar maple
Alismataceae	<i>Alisma</i> sp.	water plantain
	<i>Sagittaria latifolia</i>	broadleaf arrowhead
Amaranthaceae	<i>Amaranthus hybridus</i>	slim amaranth
Anacardiaceae	<i>Rhus hirta</i>	staghorn sumac
	<i>Toxicodendron radicans</i> *	eastern poison ivy
Apiaceae	<i>Daucus carota</i>	Queen Anne's lace
	<i>Sium suave</i> *	hemlock waterparsnip
Araceae	<i>Arisaema triphyllum</i> *	Jack in the pulpit
	<i>Peltandra virginica</i>	green arrow arum
	<i>Symplocarpus foetidus</i> *	skunk cabbage
Asclepiadaceae	<i>Asclepias incarnata</i>	swamp milkweed
	<i>Asclepias syriaca</i>	common milkweed
Asteraceae	<i>Achillea millefolium</i>	common yarrow
	<i>Anaphalis margaritacea</i>	western pearly everlasting
	<i>Arctium minus</i>	lesser burdock
	<i>Artemisia vulgaris</i>	common wormwood
	<i>Bidens tripartita</i>	threelobe beggarticks
	<i>Bidens frondosa</i>	devil's beggartick
	<i>Cichorium intybus</i>	chicory
	<i>Erigeron annuus</i> *	eastern daisy fleabane
	<i>Eupatorium perfoliatum</i>	common boneset
	<i>Eupatorium purpureum</i> *	sweetscented joeypyeweed
	<i>Hieracium pilosella</i>	mouseear hawkweed
	<i>Leucanthemum vulgare</i>	oxeye daisy
	<i>Mikania scandens</i>	climbing hempvine
	<i>Solidago canadensis</i>	Canada goldenrod
	<i>Solidago rugosa</i> *	wrinkleleaf goldenrod
	<i>Symphyotrichum cordifolium</i>	common blue wood aster
<i>Symphyotrichum lanceolatum</i>	white panicle aster	
<i>Symphyotrichum novae-angliae</i> *	New England aster	
<i>Symphyotrichum patens</i>	late purple aster	

Family	Scientific Name	Common name
Asteraceae (cont.)	<i>Symphyotrichum novi-belgii</i>	New York aster
	<i>Symphyotrichum pilosum</i> var. <i>pilosum</i>	hairy white oldfield aster
	<i>Taraxacum officinale</i>	common dandelion
Balsaminaceae	<i>Impatiens capensis</i> *	jewelweed
Berberidaceae	<i>Berberis thunbergii</i>	Japanese barberry
Betulaceae	<i>Alnus incana</i> ssp. <i>rugosa</i>	speckled alder
Boraginaceae	<i>Borago officinalis</i>	common borage
	<i>Myosotis scorpioides</i>	true forget-me-not
	<i>Alliaria petiolata</i> *	garlic mustard
Brassicaceae	<i>Brassica juncea</i>	India mustard
	<i>Cardamine pensylvanica</i>	Pennsylvania bittercress
	<i>Hesperis matronalis</i>	dames rocket
	<i>Sisymbrium officinale</i>	hedgemustard
	<i>Callitriche palustris</i>	vernal water-starwort
Callitrichaceae	<i>Callitriche palustris</i>	vernal water-starwort
Campanulaceae	<i>Campanula rapunculoides</i>	rampion bellflower
Caprifoliaceae	<i>Viburnum dentatum</i>	southern arrowwood
	<i>Viburnum lentago</i>	nannyberry
Caryophyllaceae	<i>Dianthus armeria</i>	Deptford pink
	<i>Saponaria officinalis</i>	bouncingbet
	<i>Silene vulgaris</i>	maidenstears
	<i>Celastrus orbiculatus</i> *	oriental bittersweet
Celastraceae	<i>Celastrus orbiculatus</i> *	oriental bittersweet
Chenopodiaceae	<i>Chenopodium album</i>	lambsquarters
Clethraceae	<i>Clethra alnifolia</i>	coastal sweetpepperbush
Clusiaceae	<i>Hypericum boreale</i>	northern St. Johnswort
	<i>Hypericum perforatum</i>	Common St. Johnswort
	<i>Hypericum punctatum</i>	spotted St. Johnswort
	<i>Calystegia sepium</i> *	hedge false bindweed
Convolvulaceae	<i>Ipomoea cairica</i> .*	mile a minute vine
Cornaceae	<i>Cornus amomum</i>	silky dogwood
Cucurbitaceae	<i>Echinocystis lobata</i> *	wild cucumber
Cyperaceae	<i>Carex lupulina</i>	hop sedge
	<i>Carex stricta</i> *	upright sedge
	<i>Carex vulpinoidea</i>	fox sedge
	<i>Schoenoplectus acutus</i> *	hardstem bulrush
	<i>Dipsacus fullonum</i>	Fuller's teasel
Dipsacaceae	<i>Dipsacus fullonum</i>	Fuller's teasel
Dryopteridaceae	<i>Athyrium filix-femina</i> *	common ladyfern
	<i>Athyrium filix-femina</i> ssp. <i>angustum</i>	subarctic ladyfern
	<i>Onoclea sensibilis</i>	sensitive fern
Elatinaceae	<i>Elatine americana</i>	American waterwort
Equisetaceae	<i>Equisetum arvense</i>	field horsetail
Euphorbiaceae	<i>Euphorbia esula</i>	leafy spurge
Fabaceae	<i>Apios americana</i> *	groundnut
	<i>Lotus corniculatus</i>	birdfoot deervetch
	<i>Medicago lupulina</i>	black medick
	<i>Trifolium arvense</i>	rabbitfoot clover
	<i>Trifolium hybridum</i>	alsike clover
	<i>Trifolium pratense</i>	red clover
	<i>Trifolium repens</i>	white clover
	<i>Vicia cracca</i>	bird vetch
Fagaceae	<i>Fagus grandifolia</i> *	American beech

Family	Scientific Name	Common name
Fagaceae (cont.)	<i>Quercus alba</i>	white oak
	<i>Quercus coccinea</i>	scarlet oak
	<i>Quercus rubra</i> *	northern red oak
Hamamelidaceae	<i>Hamamelis virginiana</i>	American witchhazel
Hippocastanaceae	<i>Aesculus hippocastanum</i> *	horse chestnut
Juglandaceae	<i>Carya alba</i> *	mockernut hickory
	<i>Carya ovata</i>	shagbark hickory
	<i>Juglans nigra</i>	black walnut
Juncaceae	<i>Juncus acuminatus</i>	tapertip rush
	<i>Juncus effusus</i>	common rush
	<i>Juncus tenuis</i>	poverty rush
	<i>Schoenoplectus tabernaemontani</i>	softstem bulrush
Lamiaceae	<i>Ajuga reptans</i>	common bugle
	<i>Glechoma hederacea</i>	ground ivy
	<i>Lamiaeum galeobdolon</i>	yellow archangel
	<i>Lamium album</i>	white deadnettle
	<i>Leonurus cardiaca</i>	common motherwort
	<i>Lycopus virginicus</i>	Virginia water horehound
	<i>Melissa officinalis</i>	common balm
	<i>Mentha arvensis</i>	wild mint
	<i>Monarda didyma</i>	scarlet beebalm
	<i>Monarda fistulosa</i>	wild bergamot
	<i>Prunella vulgaris</i>	common selfheal
	<i>Stachys officinalis</i>	common hedgenettle
	Lythraceae	<i>Lythrum salicaria</i> *
Malvaceae	<i>Hibiscus moscheutos</i> *	crimson-eyed rosemallow
Molluginaceae	<i>Mollugo verticillata</i>	green carpetweed
Moraceae	<i>Morus alba</i>	white mulberry
Oleaceae	<i>Fraxinus pennsylvanica</i> *	green ash
	<i>Syringa vulgaris</i>	common lilac
Onagraceae	<i>Circaea lutetiana</i> ssp. <i>canadensis</i> *	broadleaf enchanter's nightshade
	<i>Oenothera biennis</i>	common evening-primrose
Osmundaceae	<i>Osmunda cinnamomea</i> *	cinnamon fern
Oxalidaceae	<i>Oxalis</i> sp.*	woodsorrel
Papaveraceae	<i>Chelidonium majus</i> *	celandine
Phytolaccaceae	<i>Phytolacca americana</i>	American pokeweed
Plantaginaceae	<i>Plantago lanceolata</i>	narrowleaf plantain
	<i>Plantago major</i>	common plantain
Poaceae	<i>Agrostis capillaris</i>	colonial bentgrass
	<i>Agrostis stolonifera</i> *	creeping bentgrass
	<i>Cinna arundinacea</i>	sweet woodreed
	<i>Glyceria maxima</i>	reed mannagrass
	<i>Holcus lanatus</i>	common velvetgrass
	<i>Lolium perenne</i>	perennial ryegrass
	<i>Phalaris arundinacea</i> *	reed canarygrass
	<i>Phragmites australis</i> *	common reed
	<i>Poa pratensis</i> *	Kentucky bluegrass
	<i>Spartina pectinata</i>	prairie cordgrass
Polygonaceae	<i>Zizania aquatica</i>	annual wildrice
	<i>Polygonum amphibium</i> var. <i>emersum</i>	longroot smartweed

Family	Scientific Name	Common name
Polygonaceae (cont.)	<i>Polygonum cuspidatum</i>	Japanese knotweed
	<i>Polygonum hydropiperoides</i> *	swamp smartweed
	<i>Polygonum sagittatum</i>	arrowleaf tearthumb
	<i>Rumex acetosella</i>	common sheep sorrel
	<i>Rumex crispus</i>	curly dock
Pontederiaceae	<i>Rumex obtusifolius</i>	bitter dock
Potamogetonaceae	<i>Pontederia cordata</i> *	pickerelweed
	<i>Potamogeton crispus</i> *	curly pondweed
Ranunculaceae	<i>Stuckenia pectinatus</i>	sago pondweed
	<i>Ranunculus repens</i>	creeping buttercup
Rhamnaceae	<i>Thalictrum pubescens</i> *	king of the meadow
	<i>Frangula alnus</i>	glossy buckthorn
Rosaceae	<i>Agrimonia eupatoria</i>	churchsteeples
	<i>Agrimonia gryposepala</i>	tall hairy agrimony
	<i>Fragaria vesca</i>	woodland strawberry
	<i>Geum canadense</i> *	white avens
	<i>Malus pumila</i>	paradise apple
	<i>Potentilla argentea</i>	silver cinquefoil
	<i>Potentilla recta</i>	sulphur cinquefoil
	<i>Prunus serotina</i> *	black cherry
	<i>Prunus virginiana</i> *	chokecherry
	<i>Rosa multiflora</i> *	multiflora rose
	<i>Rosa palustris</i> *	swamp rose
	<i>Rubus pensilvanicus</i>	Pennsylvania blackberry
	<i>Sanguisorba minor</i>	small burnet
	<i>Sorbus aucuparia</i> *	European mountain ash
	Rubiaceae	<i>Cephalanthus occidentalis</i>
<i>Galium palustre</i>		common marsh bedstraw
<i>Galium tinctorium</i>		stiff marsh bedstraw
<i>Galium verum</i>		Yellow Spring bedstraw
Salicaceae	<i>Salix nigra</i>	black willow
Scrophulariaceae	<i>Chelone glabra</i>	white turtlehead
	<i>Linaria vulgaris</i>	butter and eggs
	<i>Verbascum thapsus</i>	common mullein
Simaroubaceae	<i>Ailanthus altissima</i>	tree of heaven
Smilacaceae	<i>Smilax rotundifolia</i> *	roundleaf greenbrier
Solanaceae	<i>Solanum dulcamara</i> *	climbing nightshade
Sparganiaceae	<i>Sparganium eurycarpum</i>	broadfruit bur-reed
Typhaceae	<i>Typha angustifolia</i> *	narrowleaf cattail
Ulmaceae	<i>Ulmus rubra</i> *	slippery elm
Urticaceae	<i>Boehmeria cylindrica</i>	smallspike false nettle
Vitaceae	<i>Parthenocissus quinquefolia</i> *	Virginia creeper
	<i>Vitis labrusca</i> *	fox grape
Zannichelliaceae	<i>Zannichellia palustris</i>	horned pondweed

Appendix G. Dichotomous field key to the U.S. National Vegetation Classification (USNVC) associations of Saugus Iron Works National Historic Site.

1

Vegetation primarily woody; trees include early successional and weedy species such as Norway maple (*Acer platanoides*), black cherry (*Prunus serotina*), and green ash (*Fraxinus pennsylvanica*). American beech (*Fagus grandifolia*) and northern red oak (*Quercus rubra*) may also be present; multiflora rose (*Rosa multiflora*) and southern arrowwood (*Viburnum dentatum*) are common shrubs; diverse, weedy herb layer is present. **Northeastern Modified Successional Forest** (CEGL006599)

Vegetation primarily non-forested; herbaceous. 2

2

Upland old field including mowed old fields and maintained grasslands. **Mixed Urban or Built Up Land**

Wetland herbaceous community. 3

3

Brackish or freshwater marshes dominated by graminoids (slender-leaved plants, including grasses, sedges, rushes, cattails, etc.). 4

Freshwater wetland and aquatic communities dominated by broad leaved herbaceous plants. 6

4

Brackish marsh dominated by narrowleaf cattail (*Typha angustifolia*). **Cattail Brackish Tidal Marsh** (CEGL006153)

Marsh not dominated by narrowleaf cattail (*Typha angustifolia*). 5

5

Brackish marsh dominated by common reed (*Phragmites australis*). **Reed-grass Tidal Marsh** (CEGL004187)

Freshwater marsh dominated by reed canarygrass (*Phalaris arundinacea*); typically very small patch. **Reed Canarygrass Eastern Marsh** (CEGL006044)

6

Freshwater seepage wetland dominated by broad-leaved herbs with overstory Northeastern Modified Successional Forest; dominated by skunk cabbage (*Symplocarpus foetidus*) and jewelweed (*Impatiens capensis*). **Skunk-cabbage - Orange Jewelweed Seep** (CEGL006567)

Aquatic herbaceous community growing on the exposed sandy mineral soil at the bottom of the Saugus River dominated by curly pondweed (*Potamogeton crispus*) and horned pondweed (*Zannichellia palustris*) **Central Atlantic Freshwater Subtidal River Bed** (CEGL006027)

Appendix H. Index of representative photographs of vegetation associations and classification plots at Saugus Iron Works National Historic Site.

Index of Photographs

Photographs by Vegetation Association

Northeastern Modified Successional Forest

Figure 4	29
Figure 5	29

Reed-grass Tidal Marsh

Figure 6	40
Figure 7	40

Cattail Brackish Tidal Marsh

Figure 8	45
Figure 9	45

Skunk-cabbage – Orange Jewelweed Seep

Figure 10	50
Figure 11	50

Central Atlantic Freshwater Subtidal River Bed

Figure 12	55
Figure 13	55

Reed Canarygrass Eastern Marsh

No photograph was taken of this association within the park

Index of Photographs

Photographs by Plot Number

SAIR.1 Reed-grass Tidal Marsh (Figures 6 and 7)	40
SAIR.2 Northeastern Modified Successional Forest (Figure 4)	29
SAIR.3 Skunk-cabbage – Orange Jewelweed Seep (Figures 10 and 11)	50
SAIR.4 Cattail Brackish Tidal Marsh (Figure 8)	45

Appendix I. Field definitions for global and local vegetation association descriptions.

LOCAL DESCRIPTION

COMMON NAME (PARK-SPECIFIC):

A common or colloquial name used by the park for the Association.

Environmental Description: A summary of available information on the environmental conditions associated with the Association and any other important aspects of the environment which affect this particular type within the park, including elevation ranges and, where relevant, information on large landscape context, geology and soils.

Vegetation Description: A summary of available information on the vegetation, species composition (including dominant and diagnostic taxa, as well as problematic exotic species), structure (defining strata and their heights and percent cover), and variability of the vegetation of this Association as it occurs on the park.

Floristic Composition

Most Abundant Species: Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the community type as it occurs in the park.

Stratum: For each component plant species, the stratum (or strata) in which it occurs in the community within the park. Values for Stratum are:

Tree (canopy & subcanopy)	Short shrub/sapling
Tree canopy	Herb (field)
Tree subcanopy	Nonvascular
Shrub/sapling (tall & short)	Floating aquatic
Tall shrub/sapling	Submerged aquatic

Lifeform: The lifeform of each component plant species that is present within each designated stratum of the community as it occurs within the park. Values for Lifeforms are:

Needle-leaved tree	Tree fern
Broad-leaved deciduous tree	Bamboo
Broad-leaved evergreen tree	Needle-leaved shrub
Thorn tree	Broad-leaved deciduous shrub
Evergreen sclerophyllous tree	Broad-leaved evergreen shrub
Succulent tree	Thorn shrub
Palm tree	Evergreen sclerophyllous shrub
Palm shrub	Aquatic herb (floating & submergent)
Dwarf-shrub	Moss
Semi-shrub	Alga
Succulent shrub	Lichen
Ephiphyte	Fern or fern ally

Vine/Liana
Forb
Graminoid
Succulent forb

Other/unknown
Other shrub
Other herbaceous
Liverwort/hornwort

Species Name: Global scientific name (and common name) for each floristic component species of the community as it occurs within the park.

Characteristic Species: Component plant species that are characteristic for the community type as it occurs within the park.

Other Noteworthy Species: Other noteworthy species (i.e., species that are not necessarily diagnostic of the community, but that are worth noting for some other reasons, such as those that are rare species or exotic invasives) that are found within the community in the park.

DISTRIBUTION

State: The two-letter postal code of the for U.S. state(s) in which the park occurs.

State Rank: The Heritage Conservation Subnational Rank that best characterizes the relative rarity or endangerment of the Association within the specified state. See **Global Rank** for equivalent values. A star (*) indicates that the Subnational Rank is for the NHP/CDC Element (nonstandard) not the USNVC Association (standard, see below).

Relationship: The **State Name** (see below) is the name that the state Natural Heritage Program applies to their community Element. The **Relationship to Standard** is a value that indicates the relationship between the NHP (**Nonstandard**) Element and the related **Standard** Association (USNVC). Values for Relationship to Standard are:

- = - Equivalent = NHP community is equivalent to the standard Association
- B - Broader = the NHP community is more broadly classified than the standard Association
- F - Finer = the NHP community is more finely classified than the standard Association
- I - Intersecting = the NHP community is not clearly broader or finer than this standard Association; the standard and NHP communities are related in a way that is more complex than a simple broader/finer relationship
- ? - Undetermined = the relationship between the NHP community and this standard Association is unknown

State Name: If the USNVC Association has been crosswalked to a state classification type and it is equivalent to the USNVC type, the **State Name** is the name that the Natural Heritage Program applies to the same community. A value of [gname] indicates that the **State Name** is the same as the **Global Name**. A value of [not crosswalked] indicates that no state type representing the concept of the USNVC Association has been identified. If a state type has been identified that is NOT equivalent to the USNVC Association (**Standard**), then the subnational

type is considered a **Nonstandard** community. In this case, the **State Name** is the name of the nonstandard community.

Reference: This is the primary reference for the Natural Heritage Program classification that contains the **State Name** and confirms the presence of the Association in the state.

Local Range: A description of the total range (including present and historic, if known) of the Association within the park.

ADDITIONAL INFORMATION

Classification Comments: Comments about classification criteria used to define the community or description of any remaining issues associated with its classification on the park.

Other Comments: Additional comments about the community within the park.

Local Description Authors: Name(s) of the person(s) primarily responsible for authorship of the current description of this community on the park.

Plots: List of plot codes for plots used in the identification and classification of the community on the park.

Inventory Notes: Information regarding the sampling of the community in the park.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class: Class designates the growth form and structure of the vegetation of a community.

Physiognomic Subclass: Subclass designates growth form characteristics (e.g., leaf phenology) of a community.

Physiognomic Group: Group designates the leaf type of a community, corresponding to climate.

Physiognomic Subgroup: Subgroup designates the relative human impact (natural/semi-natural or cultural) on a community.

Formation: Formation designates additional physiognomic and environmental factors, including hydrology, of a community.

Classification Code: The US National Vegetation Classification (USNVC) Standard Classification code for the respective level of the hierarchy. Classification codes for the different levels are comprised of the following:

Class: Roman numerals (I-VII)

Subclass: Class code plus an uppercase letter (A-Z)

Group: Subclass code plus an Arabic number

Subgroup: Group code plus either the uppercase letter N (Natural/Semi-natural) or the uppercase letter C (Planted/Cultivated)

Formation: Subgroup code plus a lowercase letter (a-z)

Alliance: The names of dominant and diagnostic species are the foundation of the **Alliance Name**. At least one species from the dominant and/or uppermost stratum is included. In rare cases where the combination of species in the upper and lower strata is strongly diagnostic, species from other strata are included in the name. Species occurring in the same stratum are separated by a hyphen (-), and those occurring in a different strata are separated by a slash (/). Species occurring in the uppermost stratum are listed first, followed successively by those in lower strata. In physiognomic types where there is a dominant herbaceous layer with a scattered woody layer, alliance names can be based on species found in the herbaceous layer and/or the woody layer, whichever is more diagnostic of the type.

Species less consistently found in all associations of the alliance may be placed in parentheses, and these parenthetical names are generally listed alphabetically. In cases where a particular genus is dominant or diagnostic, but the presence of individual species of the genus may vary among associations, only the specific epithets are placed in parentheses.

Nomenclature for vascular plant species follows a nationally standardized list (Kartesz 1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990), Anderson et al. (1990), Egan (1987, 1989, 1990), Esslinger and Egan (1995), and Stotler and Crandall-Stotler (1977).

Alliance Key: A unique identifier for each Alliance that begins with the string "A." followed by a unique 3- or 4-digit number.

Alliance (English name): A repeat of the **Alliance Name** with a translation of the scientific names using standard Central Ecology-accepted common names for the plant taxa in the name.

Association: The **Association Name** includes the scientific names of dominant and diagnostic species. Species occurring in the same stratum are separated by a hyphen (-), and those occurring in different strata are separated by a slash (/). Species occurring in the uppermost strata are listed first, followed successively by those in lower strata. Within the same stratum, the order of species names generally reflects decreasing levels of dominance, constancy, or indicator value. In physiognomic types where there is a dominant herbaceous layer with a scattered woody layer, Association names can be based on species found in either the herbaceous layer or the woody layer, whichever is more diagnostic of the type. If both layers are used, then the uppermost layer is always listed first, regardless of which may be more diagnostic.

Species less consistently found in all occurrences of the Association are placed in parentheses (). In cases where a particular genus is dominant or diagnostic, but individual species of the genus may vary among occurrences, only the specific epithets are placed in parentheses. Association names conclude with the **Class Name** in which they are classified.

In cases where diagnostic species are unknown or in question, a more general term may be used as a species placeholder (e.g., *Sphagnum* spp., Mixed Herbs, Mesic Graminoids). An environmental or geographic term, or one that is descriptive of the height of the vegetation (e.g., Dwarf Forest, Northern Shrubland), can also be used as a modifier when such a term is necessary to adequately characterize the Association. For reasons of standardization and brevity, however, this is kept to a minimum. For **Provisional** Associations, [Provisional] is added at the end of the name (ex. *Salix wolfii* Shrubland [Provisional]).

Vascular plant species nomenclature for Association and Alliance names follows the nationally standardized list of Kartesz (1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990, 1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts.

Association (English name): A repeat of the **Association Name** but with a translation of the scientific names using standard Central Ecology-accepted common names for the plant taxa used in the name. Unlike **Global Name**, names in parentheses should be fully contained within the parentheses, and [Provisional] is not added at the end of name.

Ecological System(s): A list of the Ecological Systems (**Association Name** and **Elcode**) of which the Association is a member. Ecological Systems are groups of plant associations unified by similar ecological conditions and processes (e.g., fire, riverine flooding), underlying environmental features (e.g., shallow soils, serpentine geology), and/or environmental gradients (e.g., elevation, hydrology in coastal zones). They should form relatively robust, cohesive, and distinguishable units on the ground. In most landscapes, the Ecological System will manifest itself on the ground as a spatial aggregation at an intermediate scale (e.g., between the USNVC Alliance and Formation scales).

Global Description

Elcode (Identifier): For USNVC ecological units, a unique identifier code. Associations have a code that begins with the string "CEGL" (Community Element Global) followed by a unique 6-digit number; Ecological Systems have codes that begin "CES" (Community Ecological System) followed by the 3-digit primary division code, followed by a 3-digit number.

Concept Summary: A description of the range, structure, composition, environmental setting and dynamics associated with the community. Information includes a general understanding of the type, often with some concept of its distribution; environmental setting in which the type occurs and a summary of the important disturbance regimes, successional status, and temporal dynamics for this community rangewide; community structure/physiognomy; species by strata

(dominant and diagnostic taxa); and key diagnostic characteristics that distinguishes it from similar types.

Environmental Description: A summary of available information on the environmental conditions of the Association rangewide and any other important aspects of the environment which affect this particular type, including elevation ranges and, where relevant, information on large landscape context, geology and soils.

Vegetation Description: A summary of available information on the leaf type and phenology, species composition (including dominant and diagnostic taxa, as well as problematic exotic species), structure (defining strata and their heights and percent cover), and variability of the vegetation of this Association rangewide and any additional comments relating to the vegetation.

Floristic Composition

Most Abundant Species: Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the community type as it occurs rangewide.

Stratum: For each component plant species, the stratum (or strata) in which it occurs in the community rangewide. Values for Stratum are:

Tree (canopy & subcanopy)	Nonvascular
Tree canopy	Floating aquatic
Tree subcanopy	Submerged aquatic
Shrub/sapling (tall & short)	Other shrub
Tall shrub/sapling	Other herbaceous
Short shrub/sapling	Liverwort/hornwort
Herb (field)	

Lifeform: The lifeform of each component plant species that is present within each designated stratum of the community as it occurs rangewide. Values for Lifeforms are:

Needle-leaved tree	Broad-leaved evergreen shrub
Broad-leaved deciduous tree	Thorn shrub
Broad-leaved evergreen tree	Evergreen sclerophyllous shrub
Thorn tree	Palm shrub
Evergreen sclerophyllous tree	Dwarf-shrub
Succulent tree	Semi-shrub
Palm tree	Succulent shrub
Tree fern	Ephiphyte
Bamboo	Vine/Liana
Needle-leaved shrub	Forb
Broad-leaved deciduous shrub	Other/unknown
Graminoid	Lichen
Succulent forb	Fern or fern ally
Aquatic herb (floating & submergent)	Other shrub

Moss
Alga

Other herbaceous
Liverwort/hornwort

Species Name: Global scientific name (and common name) for each floristic component species of the community as it occurs rangewide.

Characteristic Species: Component plant species that are characteristic for the community type as it occurs rangewide.

Other Noteworthy Species: Other noteworthy species (i.e., species that are not necessarily diagnostic of the community, but that are worth noting for some other reasons, such as those that are rare species or exotic invasives) that are found within the community rangewide.

USFWS Wetland System: Systems developed for the classification of wetlands by the U.S. Fish and Wildlife Service. System refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphic, chemical, or biological factors. As defined in Cowardin et al. (1979), the values are:

Marine - consists of open ocean overlying the continental shelf and its associated high-energy coastline.

Estuarine - consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Riverine - includes all wetlands and deepwater habitats contained with a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5%.

Lacustrine - includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and (3) total area exceeds 8 ha (20 acres).

Palustrine - includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%.

DISTRIBUTION

Range: A description of the total range (present and historic, if known) of the Association rangewide, using names of nations, subnations or states, ecoregions, etc.

States/Provinces: The two-letter postal codes for U.S. states and Canadian provinces in which the Association occurs. Mexican two-letter state abbreviations are preceded by "MX". When the occurrence of the Association in a state/province is uncertain, a ? is appended. The state code may be followed by the **State Rank** when known.

Federal Lands: List of federal lands where the Association occurs or is believed to occur. Names used are shortened versions of the official name of the Federal land unit with "National Park, National Forest," etc. dropped from the name. A ? indicates that presence is uncertain.

Federal Agency Abbreviations are:

BIA = Bureau of Indian Affairs
BLM = Bureau of Land Management
COE = U.S. Army Corps of Engineers
DOD = Department of Defense
DOE = Department of Energy
NPS = National Park Service
PC = Parks Canada
TVA = Tennessee Valley Authority
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service

CONSERVATION STATUS

Global Rank: The Heritage Conservation Status **Global Rank** which best characterizes the relative rarity or endangerment of the Association worldwide. Values for Global Rank are:

- G1** = Critically imperiled globally = Generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range due to other factor(s)
- G2** = Imperiled globally = Generally 6-20 occurrences and/or few remaining acres or very vulnerable to elimination throughout its range due to other factor(s)
- G3** = Rare or uncommon = Generally 21-100 occurrences; either very rare and local throughout its range or found locally, even abundantly, within a restricted range or vulnerable to elimination throughout its range due to specific factor(s)
- G4** = Widespread, abundant, and apparently secure, but with cause for long-term concern = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery); apparently not vulnerable in most of its range
- G5** = Demonstrably widespread, abundant and secure = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery); not vulnerable in most of its range
- G#G#** = Numeric range rank (range no greater than 2) = Greater uncertainty about a rank is expressed by indicating the full range of ranks which may be appropriate; for example, a G1G3 rank indicates the rank could be G1, G2, or G3
- GNR** = Not yet ranked = Status has not yet been assessed
- GNA** = Rank not applicable
- GH** = Historical = Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with potential for restoration (e.g., *Castanea dentata* Forest)
- GX** = Extirpated = Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species
- GU** = Unrankable = Status cannot be determined at this time

Qualifiers:

- ? = Inexact numeric rank = A question mark added to a rank expresses an uncertainty about the rank in the range of 1 in either way on the 1-5 scale; for example, a G2? rank indicates that the rank is thought to be G2, but could be G1 or G3 (Note: G1? and G5? are both valid ranks)
- Q = Questionable taxonomy = A "Q" added to a rank denotes questionable taxonomy; it modifies the degree of imperilment and is only used in cases where the type would have a less imperiled rank if it were not recognized as a valid type (i.e., if it were combined with a more common type); a GUQ rank often indicates that the type is unrankable because of daunting taxonomic questions

For non-natural types, a **Global Rank** of **GNA = Rank not applicable** is assigned. They are further identified as one from the following:

Cultural - indicates that the Association is cultivated. Planted/cultivated areas are defined as being dominated by vegetation that has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. The majority of these areas are planted and/or maintained for the production of food, feed, fiber, or seed.

Ruderal - indicates that the Association is considered ruderal. Ruderal communities are vegetation resulting from succession following anthropogenic disturbance of an area. They are generally characterized by unnatural combinations of species (primarily native species, though they often contain slight to substantial numbers and amounts of species alien to the region as well). In many landscapes, ruderal communities occupy large areas - sometimes more than any other category of communities - and can provide important biodiversity functions.

Modified/Managed - indicates that the Association is modified or managed.

Modified/managed communities are vegetation resulting from the management or modification of natural/near-natural vegetation, but producing a structural and floristic combination not clearly known to have a natural analogue. Modified vegetation may be easily restorable by management, time, or restoration of ecological processes. It is not yet clear how to deal with these communities in the USNVC.

Invasive - indicates that the Association is weedy and invasive. Invasive communities are dominated by invasive alien species. Although these communities are often casually considered as "planted/cultivated," they are spontaneous, self-perpetuating, and not the (immediate) result of planting, cultivation, or human maintenance. Land occupied by invasive communities is generally permanently altered (converted) unless restoration efforts are undertaken. It is also important to recognize that these communities are novel; they are not merely a community "transplanted" from the native range of the dominant species. *Melaleuca* in south Florida, kudzu in the southeastern United States, tamarisk in the western United States, and red mangrove in Hawaii all form communities which have no equivalent in the native range of the dominant species (associated species, processes, landscape context, fauna, etc. are all significantly different).

Global Rank Date: The date the **Global Rank** was last *reviewed* (regardless of whether the rank was changed).

Global Rank Reasons: Reasons that the Heritage Conservation Status **Global Rank** for the Association was assigned, including key ranking variables and other considerations used.

Classification Information

Classification Status: The status of the Association in relation to the standard USNVC.

Values for Classification Status are:

- Standard – the Association has been formally recognized, described, and accepted by NatureServe Central Ecology as a standard Association in the USNVC.
- Nonstandard – the Association has not been accepted by NatureServe Central Ecology as a standard Association (i.e., it does not follow the standard classification).
- Provisional* – the Association is a candidate for acceptance into the standard classification but has not yet been comprehensively reviewed by Central Ecology.

Circumscription Confidence

The degree of confidence associated with the classification of the Association. This confidence is based on the quality and type of data used in the analysis, as well as the extent to which the entire (or potential) range of the Association was considered. Values for Circumscription

Confidence are:

- 1 – Strong: Classification is based on quantitative analysis of verifiable, high-quality field data (species lists and associated environmental information) from plots that are published in full or are archived in a publicly accessible database. A sufficient number of high-quality plots covering the expected geographic distribution and habitat variability of the vegetation type, as well as plots from related types across the region, have been used in the analysis.
- 2 – Moderate: Classification is based either on quantitative analysis of a limited data set of high-quality, published/accessible plots and/or plots from only part of the geographic range, or on a more qualitative assessment of published/accessible field data of sufficient quantity and quality.
- 3 – Weak: Classification is based on limited, or unpublished/inaccessible plot data or insufficient analysis, anecdotal information, or community descriptions that are not accompanied by plot data. These types have often been identified by local experts. Although there is a high level of confidence that these types represent recognized vegetation entities, it is not known whether they would meet national standards for floristic types in concept or in classification approach if sufficient data were available.

Classification Comments: Comments about classification criteria used to define the Association, or to describe any remaining issues associated with the classification. Any potentially confusing relationships with other existing Associations should be indicated if there is a potential that further scrutiny may result in a change in the classification of the Association. Discussion of any atypical occurrences and why they are included in this Association concept may also be addressed. In addition, rationale for choosing nominal species that are not dominant and other comments about nominal species pertaining to the classification of the community

should be included. Comments may explain confusion about the similarity between types that may not be distinguishable.

Similar Associations: The **Global Name** and **Elcode** of any closely related or apparently similar USNVC association(s) which may be mistaken for this Association. They may be in the same or different Formation or Alliance. This includes only types whose classification is not at issue (e.g., two types have similar sounding names but are differentiated by the degree of canopy closure and lower frequency of associated light-requiring species). **Notes** regarding the relationship and/or distinction of each particular Similar Association may follow.

Related Concepts: Name used by agencies or other published or unpublished classification systems to describe community types that may be related to this Association. These might include Society of American Foresters (SAF) cover types, Kuchler PNV types, U.S. Fish and Wildlife Service (USFWS) wetland types, or other local or regional vegetation classifications. The **Other Community Name** is followed by the associated **Reference** and **Relationship**. The **Related Concept Reference** is the source reference for the **Related Concept**. **Relationship** indicates whether the type designated in **Other Community Name** is more, less, or equally inclusive of the USNVC Association concept. Values for Relationship are:

- B – Broader: the concept of the Other Community is broader than the Association concept
- F – Finer: the concept of the Other Community is finer (more narrow) than the Association concept
- I – Intersects: the concepts of the Other Community and the Association overlap (i.e., neither fully includes the other) and are related in a way that is more complex than a simple "broader/finer" relationship
- = – Equivalent: concept designated in Other Community Name is equivalent to the Association concept
- ? – Unknown: the relationship of the Other Community to the Association has not been determined

Note: Names used by Heritage Programs/CDCs are listed in the section entitled **Subnational**

Distribution with Crosswalk data: Appendix I. Field definitions for global and local vegetation association descriptions (continued).

SOURCES

Description Authors: Name(s) of the person(s) primarily responsible for authorship of the current version of the Association's *description* and *characterization* including descriptions in **Environment, Vegetation, and Dynamics**. The abbreviation mod. before a name indicates that modifications were subsequently made to the original description by the person(s) listed.

References: Short citations of all references used in documenting the classification/concept and characterization of this Association.

Appendix J. Bibliography for USNVC global vegetation association descriptions.

- Apfelbaum, S. I., and C. E. Sams. 1987. Ecology and control of reed canary grass (*Phalaris arundinacea* L.). *Natural Areas Journal* 7(2):69–74.
- Barnes, W. J. 1999. The rapid growth of a population of reed canarygrass (*Phalaris arundinacea* L.) and its impact on some riverbottom herbs. *Journal of the Torrey Botanical Society* 126:133–138.
- Bartgis, R. 1986. Natural community descriptions. Unpublished draft. Maryland Natural Heritage Program. Maryland Department of Natural Resources. Annapolis.
- Bell, R., M. Chandler, R. Buchsbaum, and C. Roman. 2002. Inventory of intertidal habitats: Boston Harbor Islands, a National Park area. Technical Report NPS/NERBOST/NRTR-2004/1. USDI National Park Service. Northeast Region. Boston, MA. 13 pp.
- Bellis, V. J. 1992. Floristic continuity among the maritime forests of the Atlantic Coast of the United States. Pages 21–29 *in* C. A. Cole and F. K. Turner, editors. *Barrier island ecology of the mid-Atlantic Coast: A symposium*. Technical Report NPS/SERCAHA/NRTR-93/04.
- Berdine, M. A. 1998. Maryland vegetation classification. Maryland Department of Natural Resources. Annapolis, MD.
- Boggs, K., P. Hansen, R. Pfister, and J. Joy. 1990. Classification and management of riparian and wetland sites in northwestern Montana. Draft version I. Report prepared for the Montana Riparian Association and Montana Forest and Conservation Experiment Station. School of Forestry. University of Montana. Missoula. 216 pp.
- Boule, M. E. 1979. The vegetation of Fisherman Island, Virginia. *Castanea* 44:98–108.
- Bowman, P. 2000. Draft classification for Delaware. Unpublished draft. Delaware Natural Heritage Program.
- Breden, T. F. 1989. A preliminary natural community classification for New Jersey. Pages 157–191 *in* E. F. Karlin, editor. *New Jersey's rare and endangered plants and animals*. Institute for Environmental Studies. Ramapo College. Mahwah, NJ. 280 pp.
- Breden, T. F., Y. R. Alger, K. S. Walz, and A. G. Windisch. 2001. Classification of vegetation communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program. Office of Natural Lands Management. Division of Parks and Forestry. New Jersey Department of Environmental Protection. Trenton.
- Cahoon, D. R., and J. C. Stevenson. 1986. Production, predation, and decomposition in a low-salinity Hibiscus marsh. *Ecology* 67:1341–1350.

- Clancy, K. 1993b. A preliminary classification of the natural communities of Delaware. Unpublished draft. Delaware Natural Heritage Inventory. Division of Parks and Recreation. Dover. 30 pp.
- Clancy, K. 1996. Natural communities of Delaware. Unpublished review draft. Delaware Natural Heritage Program. Division of Fish and Wildlife. Delaware Division of Natural Resources and Environmental Control. Smyrna, DE. 52 pp.
- Coulling, P. P. 2002. A preliminary classification of tidal marsh, shrub swamp, and hardwood swamp vegetation and assorted non-tidal, chiefly non-maritime, herbaceous wetland communities of the Virginia Coastal Plain. October 2002. Virginia Department of Conservation and Recreation. Division of Natural Heritage. Natural Heritage Technical Report 02-18. 30 pp.
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service. Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.
- Crawford, R. C. 2001. Initial riparian and wetland classification and characterization of the Columbia Basin in Washington. Prepared for Environmental Protection Agency and Bureau of Land Management, Spokane District. Washington Natural Heritage Program. Washington Department of Natural Resources. Olympia. 83 pp.
- Dowhan, J. J., and R. Rozsa. 1989. Flora of Fire Island, Suffolk County, New York. Bulletin of the Torrey Botanical Club 116:265–282.
- Dunlop, D. A., and G. E. Crow. 1985. The vegetation and flora of the Seabrook Dunes with special reference to rare plants. *Rhodora* 87:471–486.
- Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe. Boston, MA.
- Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero, editors. 2002. Ecological communities of New York state. Second edition. A revised and expanded edition of Carol Reschke's ecological communities of New York state. (Draft for review). New York Natural Heritage Program. New York State Department of Environmental Conservation. Albany, NY.
- Ehrenfeld, J. G. 1977. Vegetation of Morristown National Historical Park: Ecological analysis and management alternatives. Final Report. USDI National Park Service. Contract No. 1600-7-0004. 166 pp.
- Enser, R. 1999. Natural communities of Rhode Island. Unpublished draft. December 1999. 22 pp.
- Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters. Washington, DC. 148 pp.

- Faber-Langendoen, D., and Midwest State Natural Heritage Program Ecologists. 1996. Terrestrial vegetation of the Midwest United States. International classification of ecological communities: Terrestrial vegetation of the United States. The Nature Conservancy. Arlington, VA.
- Ferren, W. R., Jr., R. E. Good, R. Walker, and J. Arsenault. 1981. Vegetation and flora of Hog Island, a brackish wetland in the Mullica River, New Jersey. *Bartonia* 48:1–10.
- Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Pennsylvania Department of Conservation and Recreation. Bureau of Forestry. Harrisburg, PA. 86 pp.
- Fleming, G. P. 1998. Virginia natural community framework, version January 30, 1998. Unpublished document. Virginia Department of Conservation and Recreation. Division of Natural Heritage. Richmond. 6 pp.
- Fleming, G. P. 2001. Community types of Coastal Plain calcareous ravines in Virginia. Preliminary analysis and classification. Virginia Department of Conservation and Recreation. Division of Natural Heritage. Richmond, VA. 4 pp.
- Fleming, G. P., P. P. Coulling, D. P. Walton, K. M. McCoy, and M. R. Parrish. 2001. The natural communities of Virginia: Classification of ecological community groups. First approximation. Natural Heritage Technical Report 01-1. Virginia Department of Conservation and Recreation. Division of Natural Heritage. Richmond, VA. Unpublished report. January 2001. 76 pp.
- Fleming, G. P., and W. H. Moorhead, III. 1998. Comparative wetlands ecology study of the Great Dismal Swamp, Northwest River, and North Landing River in Virginia. Natural Heritage Technical Report 98-9. Virginia Department of Conservation and Recreation. Division of Natural Heritage. Richmond. Unpublished report submitted to the U.S. Environmental Protection Agency. 181 pp. plus appendices.
- Gawler, S. C. 2002. Natural landscapes of Maine: A guide to vegetated natural communities and ecosystems. Maine Natural Areas Program. Department of Conservation. Augusta, ME. [in press.]
- Good, R. E., and N. F. Good. 1975b. Vegetation and production of the Woodbury Creek and Hessian Run freshwater tidal marshes. *Bartonia* 43:38–45.
- Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station. School of Forestry. University of Montana. Miscellaneous Publication No. 54. 646 pp. + posters.
- Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association. Montana Forest and Conservation Experiment Station. School of Forestry. University of Montana. Missoula. 478 pp.

- Harrison, J. W. 2001. Herbaceous tidal wetland communities of Maryland's eastern shore: Identification, assessment and monitoring. Report submitted to the U.S. EPA (Clean Water Act 1998 State Wetlands Protection Development Grant Program). Biodiversity Program. Maryland Department of Natural Resources. Wildlife and Heritage Division. 30 June 2001. [U.S. EPA Reference Wetland Natural communities of Maryland's Herbaceous Tidal Wetlands Grant #CD993724].
- Harrison, J. W., compiler. 2004. Classification of vegetation communities of Maryland: First iteration. A subset of the International Classification of Ecological Communities: Terrestrial Vegetation of the United States, NatureServe. Maryland Natural Heritage Program. Maryland Department of Natural Resources. Annapolis. 243 pp.
- Higgins, E. A. T., R. D. Rappleye, and R. G. Brown. 1971. The flora and ecology of Assateague Island. University of Maryland Experiment Station Bulletin A-172. 70 pp.
- Hill, S. R. 1986. An annotated checklist of the vascular flora of Assateague Island (Maryland and Virginia). *Castanea* 5:265–305.
- Klotz, L. H. 1986. The vascular flora of Wallops Island and Wallops Mainland, Virginia. *Castanea* 51:306–326.
- MENHP [Maine Natural Heritage Program]. 1991. Natural landscapes of Maine: A classification of ecosystems and natural communities. Unpublished document. Office of Comprehensive Planning, Maine Natural Heritage Program, Augusta. 77 pp.
- Minnesota Natural Heritage Program (MNNHP). 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources. Natural Heritage Program. St. Paul, MN. 110 pp.
- MacKenzie, W. H., and J. R. Moran. 2004. Wetlands of British Columbia: A guide to identification. Land Management Handbook #52. British Columbia Ministry of Forests. Victoria, BC. 287 pp.
- Marks, M., B. Lapin, and J. Randall. 1994. *Phragmites australis* (*P. communis*): Threats, management, and monitoring. *Natural Areas Journal* 14(4):285–294.
- Martin, W. E. 1959b. The vegetation of Island Beach State Park, New Jersey. *Ecological Monographs* 29:1–46.
- McCormick, J., and T. Ashbaugh. 1972. Vegetation of a section of Oldmans Creek Tidal Marsh and related areas in Salem and Gloucester counties, New Jersey. *Bulletin of the New Jersey Academy of Science* 17:31–37.
- Metzler, K. J., and J. Barrett. 1992. Connecticut community classification. Unpublished draft. Connecticut Department of Environmental Protection. Natural Resources Center. Natural Diversity Database. Hartford.

- Metzler, K. J., and J. P. Barrett. 2001. Vegetation classification for Connecticut. Draft 5/21/2001. Connecticut Department of Environmental Protection. Natural Resources Center. Natural Diversity Database. Hartford.
- Metzler, K., and J. Barrett. 1996. Vegetation classification for Connecticut organized into the modified UNESCO hierarchy. Unpublished review draft. Connecticut Natural Diversity Database. Hartford, CT. 48 pp.
- Metzler, K., and R. Rosza. 1982. Vegetation of fresh and brackish tidal marshes in Connecticut. *Newsletter of the Connecticut Botanical Society* 10(1):1–3.
- Midwestern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe. Minneapolis, MN.
- Moore, K. A., D. J. Wilcox, and R. J. Orth. 2000. Analysis of the abundance of submersed aquatic vegetation communities in the Chesapeake Bay. *Estuaries* 23:115–127.
- Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000a. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program. University of New Mexico. Albuquerque. NM.
- Nelson, J. B. 1986. The natural communities of South Carolina: Initial classification and description. South Carolina Wildlife and Marine Resources Department. Division of Wildlife and Freshwater Fisheries. Columbia, SC. 55 pp.
- Niering, W. A., and R. S. Warren. 1977. Our dynamic tidal marshes: Vegetation changes as revealed by peat analysis. *The Connecticut Arboretum Bulletin* 22.
- Odum, W. E., T. J. Smith, III, J. K. Hoover, and C. C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States east coast: A community profile. USDI Fish & Wildlife Service. FWS/OBS-83/17. 176 pp.
- Perles, S. J., G. S. Podniesinski, E. Eastman, L. A. Sneddon, and S. C. Gawler. 2007. Classification and mapping of vegetation and fire fuel models at Delaware Water Gap National Recreation Area: Volume 2 of 2 - Appendix G. Technical Report NPS/NER/NRTR—2007/076. National Park Service. Philadelphia, PA.
- Perles, S. J., G. S. Podniesinski, W. A. Millinor, and L. A. Sneddon. 2006c. Vegetation classification and mapping at Gettysburg National Military Park and Eisenhower National Historic Park. Technical Report NPS/NER/NRTR—2006/058. National Park Service. Philadelphia, PA.

- Perles, S., G. Podniesinski, and J. Wagner. 2004. Classification, assessment and protection of non-forested floodplain wetlands of the Susquehanna drainage. Report to the U.S. Environmental Protection Agency and Pennsylvania Department of Conservation and Natural Resources. Pennsylvania Natural Heritage Program. Harrisburg. 128 pp.
- Rawinski, T. 1984. Natural community description abstract - southern New England calcareous seepage swamp. Unpublished report. The Nature Conservancy. Boston, MA. 6 pp.
- Reschke, C. 1990. Ecological communities of New York State. New York Natural Heritage Program. New York State Department of Environmental Conservation. Latham, NY. 96 pp.
- Saltonstall, K. 2002. Cryptic invasion by a nonnative genotype of the common reed, *Phragmites australis*, into North America. Proceedings of the National Academy of Science 99:2445–2449.
- Schafale, M. 2000. Fourth approximation guide. Coastal Plain. January 2000 draft. North Carolina Natural Heritage Program. Raleigh.
- Schafale, M. 2003b. Fourth approximation guide. Coastal Plain communities. March 2003 draft. North Carolina Natural Heritage Program. Raleigh.
- Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina. Third approximation. North Carolina Department of Environment, Health, and Natural Resources. Division of Parks and Recreation. Natural Heritage Program. Raleigh. 325 pp.
- Schotz, Al. Personal communication. Community Ecologist. Alabama Natural Heritage Program. Huntingdon College. Montgomery, AL.
- Shreve, F., M. A. Chrysler, F. H. Blodgett, and F. W. Besley. 1910. The plant life of Maryland. Maryland Weather Service. Special Publication, Volume III. Johns Hopkins Press. Baltimore, MD.
- Smith, Latimore M. Personal communication. Natural Heritage Program Ecologist. Louisiana Department of Wildlife and Fisheries. Natural Heritage Program. Baton Rouge.
- Sneddon, L., M. Anderson, and K. Metzler. 1994. A classification and description of terrestrial community alliances in The Nature Conservancy's Eastern Region: First approximation. Unpublished report to USDI Fish & Wildlife Service. Gap Analysis Program. The Nature Conservancy. Eastern Heritage Task Force. Boston, MA. 116 pp.
- Sneddon, L., M. Anderson, and K. Metzler. 1996. Community alliances and elements of the Eastern Region. Unpublished report. The Nature Conservancy. Eastern Heritage Task Force. Boston, MA. 235 pp.
- Soil Conservation Service. 1987. Soil survey of Nassau County, New York. USDA Soil Conservation Service. 156 pp.

- Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe. Durham, NC.
- Sperduto, D. 1994. A classification of the natural communities of New Hampshire. April 1994 approximation. Unpublished document. New Hampshire Natural Heritage Inventory. Department of Resources and Economic Development. Concord, NH. 45 pp. plus appendixes.
- Sperduto, D. D. 1997a. The natural communities of New Hampshire: A guide and classification. The New Hampshire Natural Heritage Inventory. Concord, NH. 126 pp.
- Sperduto, D. D. 2000a. Natural communities of New Hampshire: A guide and classification. Near final unformatted draft without pictures and illustrations; includes upland classification. New Hampshire Natural Heritage Inventory. DRED Division of Forests and Lands. Concord, NH. 127 pp.
- Sperduto, D. D. 2000b. A classification of wetland natural communities in New Hampshire. New Hampshire Natural Heritage Inventory/ Department of Resources and Economic Development. Division of Forests and Lands. Concord, NH. 156 pp.
- Stalter, R. 1979. The major plant communities of the Fire Island National Seashore. Pages 177–181 in R. M. Linn, editor. Proceedings of the first conference on Scientific Research in the National Parks. USDI National Park Service. Washington, DC.
- Steury, B. W. 1999. Annotated list of vascular plants from a nontidal barrier wetland along the Chesapeake Bay in Calvert County, Maryland. *Castanea* 64(2):187–200.
- Swain, P. C., and J. B. Kearsley. 2001. Classification of natural communities of Massachusetts. September 2001 draft. Natural Heritage and Endangered Species Program. Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- Tennessee Division of Natural Heritage (TDNH). Unpublished data. Tennessee Division of Natural Heritage. Nashville, TN.
- The Nature Conservancy and Western Pennsylvania Conservancy (TNC and WPC). 2004. Classification, assessment, and protection of non-forested floodplain wetlands of the Susquehanna drainage. Pennsylvania Natural Heritage Program. Harrisburg, PA. 128 pp.
- Thompson, E. 1996. Natural communities of Vermont uplands and wetland. Nongame and Natural Heritage Program. Department of Fish and Wildlife in cooperation with The Nature Conservancy. Vermont chapter. 34 pp.
- Thompson, E. H., and E. R. Sorenson. 2000. Wetland, woodland, wildland: A guide to the natural communities of Vermont. The Nature Conservancy and the Vermont Department of Fish and Wildlife. University Press of New England. Hanover, NH. 456 pp.

- U.S. Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2001b. Soil survey of Gateway National Recreation Area, New York and New Jersey. USDA Natural Resources Conservation Service and USDI National Park Service, Gateway National Recreation Area in partnership with Cornell University Agricultural Experiment Station and New York City Soil and Water Conservation District.
- U.S. Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2004. Soil survey of Saratoga County, New York. USDA Natural Resources Conservation Service. 590 pp.
- Vanderhorst, J. 2001a. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Natural Heritage Program. West Virginia Division of Natural Resources. Elkins. 101 pp.
- White, J., and M. Madany. 1978. Classification of natural communities in Illinois. Pages 311–405 *in* Natural Areas Inventory technical report: Volume I, survey methods and results. Illinois Natural Areas Inventory. Urbana, IL.
- Willoughby, M. G., C. Stone, C. Hincz, D. Moisey, G. Ehlert, and D. Lawrence. 2004. Guide to range plant community types and carrying capacity for the dry and central mixedwood subregions in Alberta. Fourth Approximation. Alberta Sustainable Resource Development. Public Lands and Forests Division. Edmonton, AB. 245 pp.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-74 September 2008

National Park Service
U.S. Department of the Interior



Northeast Region

Natural Resource Stewardship and Science
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2878

<http://www.nps.gov/nero/science/>