

National Park Service
U.S. Department of the Interior

Saint-Gaudens National Historic Site
Cornish, New Hampshire



Saint-Gaudens National Historic Site

Exotic Plant Management Plan

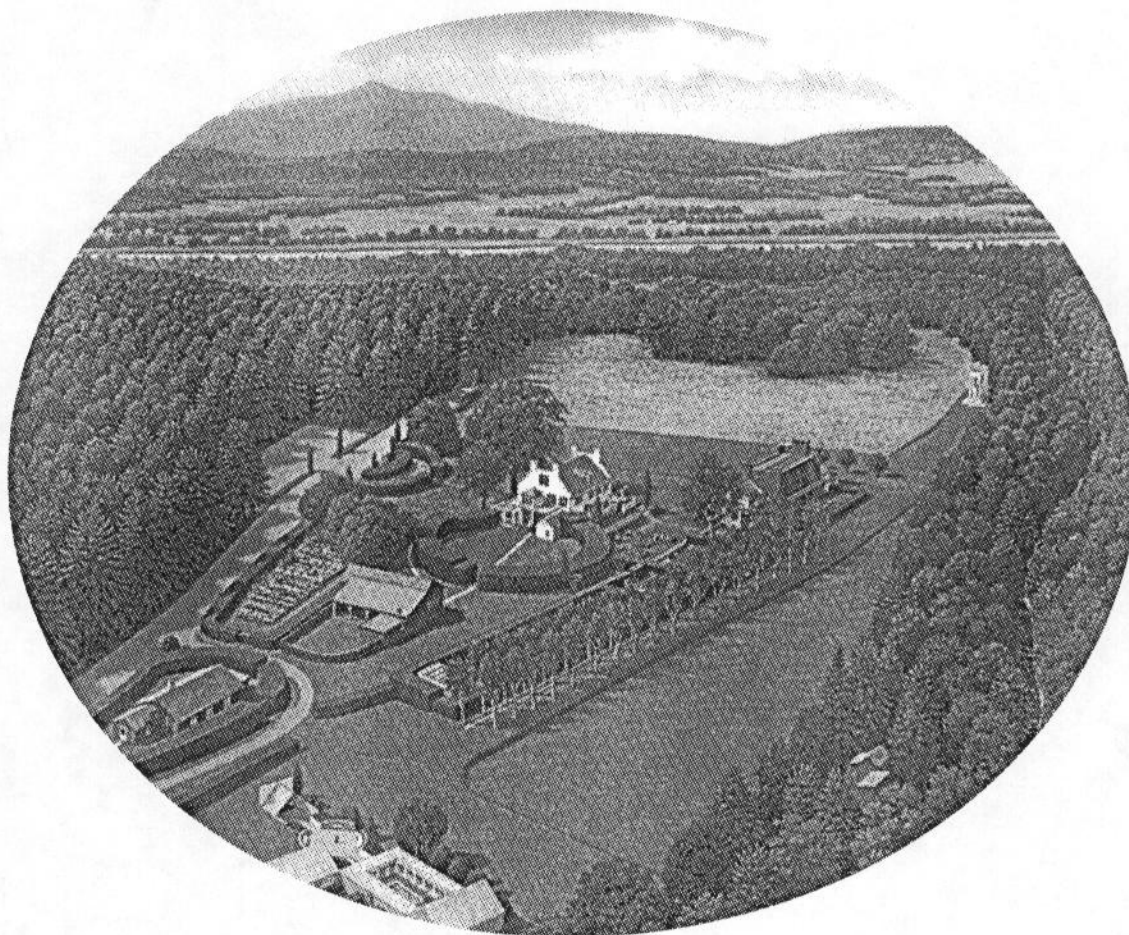


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EXECUTIVE SUMMARY

The populations of thirteen exotic plant species in a 133 acre region of Saint-Gaudens NHS were mapped in the summer and fall of 2001: autumn olive, black locust, black swallow-wort, common buckthorn, glossy buckthorn, Japanese barberry, Japanese tree lilac, morrow honeysuckle, multiflora rose, Norway maple, oriental bittersweet, winged burning bush, and yellow flag iris. Information on the position, size, density, and distribution of these populations was stored in a Geographic Information System.

Morrow honeysuckle was found to be the most prevalent exotic species. Japanese barberry was also a common and widely distributed invasive plant. Large populations of Japanese tree lilac and Norway maple were found in specific regions of the park. The other nine species were either uncommon or rare.

Using the results of inventory, the exotic species were prioritized for removal. Those species that were rare, highly invasive, easy to remove, and present in undisturbed natural areas were the highest priority for control. The sequence of plant species is as follows from highest to lowest priority for removal: glossy buckthorn, autumn olive, burning bush, oriental bittersweet, black locust, black swallow-wort, common buckthorn, multiflora rose, yellow flag iris, Japanese barberry, Norway maple, morrow honeysuckle, and Japanese tree lilac.

The appendices include information about the distinguishing characteristics, documented environmental impacts, management goals, and control options for each of the thirteen species. Suggested timetables for invasive plant control are also provided. These timetables are dependent on If funding and staffing permit implementing the recommended control options

INTRODUCTION

The threats that invasions of non-indigenous plants pose to native flora and fauna has been gathering increased attention by the scientific community. Exotic plants can be detrimental to ecological systems in many ways, including displacing or decreasing native plant populations (Webb and Kaunzinger 1993), negatively impacting wildlife (Schmidt and Whelan 1999), altering community structure (Robertson et al. 1994; Martin 1999), influencing succession (Fike and Niering 1999), and changing soil properties (Ehrenfeld et al. 2001). In the United States, the cumulative effects of non-indigenous species are believed to have contributed to the decline of 49% of threatened or endangered species, making the spread of alien species one of the greatest threats to biodiversity second only to habitat destruction (Wilcove et al. 1998).

In recognition of this problem, Executive Order 13112 (1999) requires the National Park Service (NPS) to prevent the introduction of invasive species and to respond to and control such species in an environmentally sound and cost-effective manner. Under the Government Performance and Results Act (GPRA) the NPS adopted a plan in 2001 to reduce exotic vegetation on 6.5% of targeted acres of parkland by September 30, 2005. Accordingly, Saint-Gaudens National Historic Site (SAGA) implemented a similar GPRA goal in 2001: to reduce exotic vegetation on 8.125 acres of 125 targeted acres of NPS land by September 30, 2005. Since evaluating percent cover of vegetation on parkland is difficult, SAGA has adopted additional goals regarding control of invasive species:

- 1) To remove new populations of invasive plant species before they become established;
- 2) To reduce the size of well-established infestations so that negative effects on ecosystems and biological diversity are minimized.

“Exotic vegetation” as defined by GPRA comprises invasive non-native plant species that pose a threat to native species and natural processes and for which effective and feasible treatments are available. In this document, “invasive plants” are defined as alien plant species that can alter ecosystem processes, dominate undisturbed native communities, eliminate resources needed by native species, or severely depress regeneration of native species.

The purpose of this study was to locate and describe invasive plant populations within the boundaries of SAGA. Previous plant inventories of the park in 1981 and 1996 recorded the presence of exotic species within the park, but did not specify the location or extent of the infestations. This information is required before control methods can be effectively planned, evaluated, and implemented. Removal of exotic species can be both cost-prohibitive and time-intensive and parks should not sustain an ineffective exotic control program. Monitoring of plant communities is needed before, during, and after invasive species management (Blossey 1999). Locating and mapping alien plant populations and storing this information in an ArcView Geographic Information System (GIS) is an important first step towards determining the extent of the problem and establishing a database necessary for future evaluation of control efforts.

STUDY LOCATION

Saint-Gaudens National Historic Site, located in Cornish, New Hampshire, was established by Congress in 1964 (Public Law 88-543) to preserve the home, studios, and artwork of the renowned American sculptor Augustus Saint-Gaudens (1848-1907). SAGA is further mandated by the National Park Service (1991), as a site containing “significant natural resources,” to manage and protect these resources and control those invasive species that may adversely affect

the natural environment. The authorized boundary includes 365 acres; at this time, the in-fee park acreage is 148 acres. Only the in-fee property was considered for this study, although the entire authorized boundary should be inventoried at an appropriate time in the future. The historic grounds comprise approximately 22 acres of the property and include buildings and cultivated lawns, gardens, and hedges. Another 9 acres of developed area includes maintenance facilities and park housing. The remainder of the park predominately consists of mixed pine and hemlock forests disturbed from logging activities in the previous centuries and in varying stages of succession. The topography is diverse, and much of the forested landscape is characterized by steep ravines leading into two drainages: the Blow-Me-Up (BMU) and Blow-Me-Down (BMD) Brooks. These flow into a dammed pond, the BMD Pond, which is surrounded by cattail marshlands and is adjacent to NH State Route 12A. The surrounding community of Cornish is rural in character and consists of forested areas, private residences, and farmland.

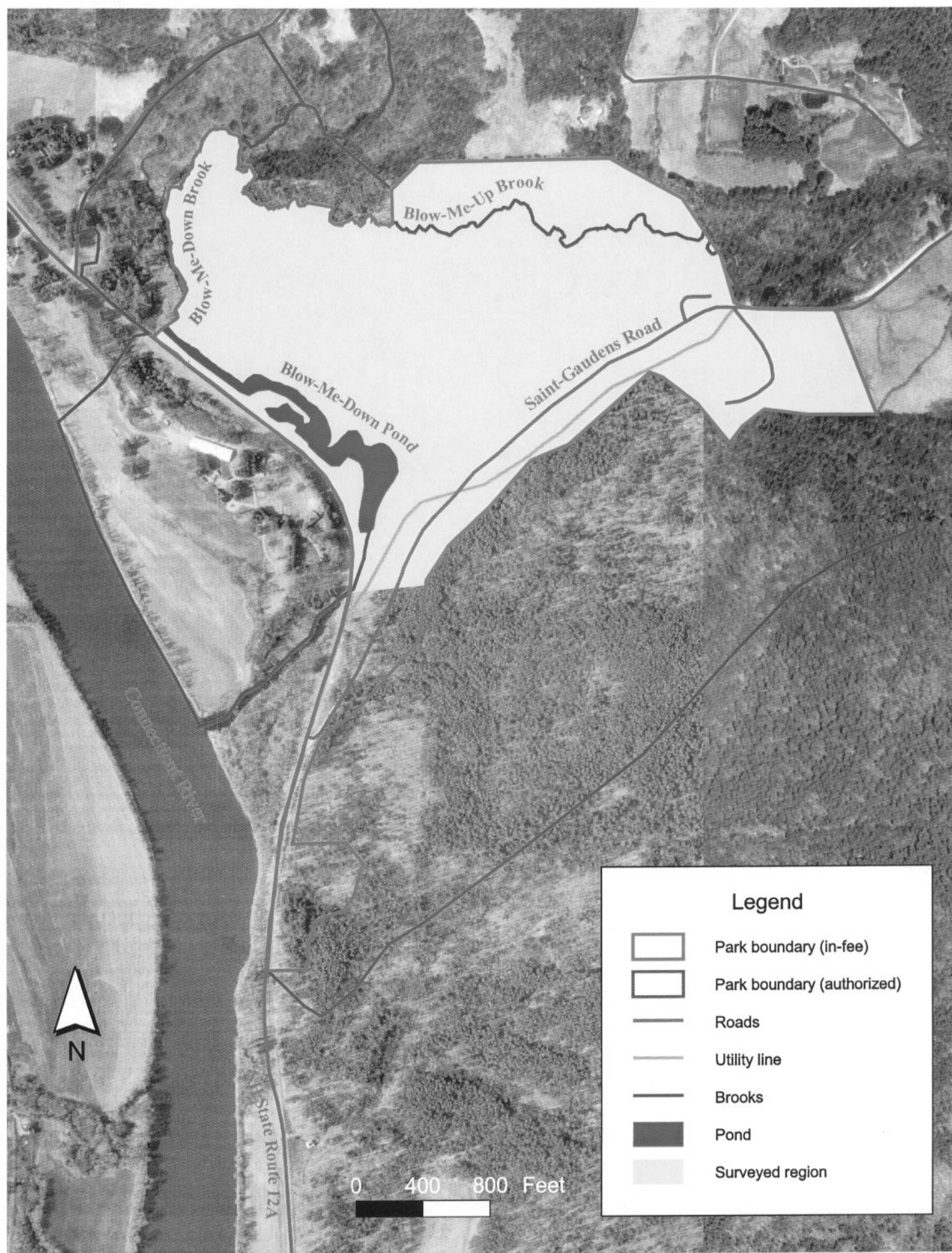
The entire in-fee park property was not inspected for invasive plants. The study site included a total of 133 acres; the extreme southwest corner of the in-fee property (15 acres) was not mapped due to time constraints (see Figure 1). This region, which consists of mixed coniferous/hardwood forest bordering NH State-Route 12A and Saint-Gaudens Road, should be mapped in 2002.

METHODS

The populations of thirteen exotic plant species were mapped and described: autumn olive (*Elaeagnus umbellata* Thunb.), black locust (*Robinia pseudoacacia* L.), black swallow-wort (*Vincetoxicum nigrum* (L.) Moench), common buckthorn (*Rhamnus cathartica* L.), glossy buckthorn (*Rhamnus frangula* L.), Japanese barberry (*Berberis thunbergii* DC), Japanese tree lilac (*Syringa reticulata* (Blume) Hara), morrow honeysuckle (*Lonicera morrowii* A. Gray), multiflora rose (*Rosa multiflora* Thunb.), Norway maple (*Acer platanoides* L.), oriental bittersweet (*Celastrus orbiculatus* Thunb.), winged burning bush (*Euonymus alatus* (Thunb.) Siebold), and yellow flag iris (*Iris pseudacorus* L.). Nomenclature follows Gleason and Cronquist (1991). These species were selected for monitoring either because land managers and scientists have nearly unanimously labeled them to be "invasive" or because they appeared to be displacing native species and disrupting natural processes at SAGA. Most alien species found in the park were not considered to be invasive because they were contained in disturbed areas such as roadsides or ornamental gardens and do not persist in natural areas. Although purple loosestrife (*Lythrum salicaria* L.) is well documented to be invasive throughout northeastern North America and is present within the park, its populations were not documented in this study. In 2000, purple loosestrife infestations were mapped and a separate monitoring and control program was initiated (Appendix G).

The study site was completely traversed and surveyed for the targeted exotic populations in 2001 from August through October. Whenever a population of the exotics was found, a survey form was completed (Appendix A). The location and surrounding native vegetation were described, and the UTM coordinates were recorded with a Trimble Pathfinder Pro XL Global Positioning System (GPS) unit. Next, the size of the infestation was roughly estimated to be greater or smaller than 1 m², 25 m², 100 m², or 144 m². The abundance of the exotic was then determined by estimating the number of plant stems within one of five categories: one stem, 2-19 stems, 20-99 stems, 100-999 stems, or 1000 or more stems. The local distribution of the population was placed in a category ranging from one to five. A higher number correlated with a greater density of the exotic species. On the data sheets, one corresponded to "single," two to "small patches," three to "large patches," four to "broken mat," and five to "extensive mat." If the populations

Figure 1: Surveyed Region of Saint-Gaudens National Historic Park



consisted of one stem or a small clump of stems (approx. 1 m² or less), then they were categorized as "single." Populations were classified as "small patches" if there were several single stems or 1 m² clusters distinct from each other yet not farther than 5 m apart. The category "large patches" was similarly defined, except the clusters were larger than 1 m². "Broken mat" meant the exotic plant was the dominant species within the infested area, but the population did not crowd out all other vegetation. The last level, "extensive mat," was an exotic population that had formed a virtual monospecific stand. Finally, the infested area was classified as one or a combination of the following fifteen habitat types: forest edge, upland hardwood, hemlock/hardwood, pine/hardwood, mixed conifer, herbaceous wetland, shrub wetland, forested wetland, streambank, aquatic, field/open area, steep slope, utility right-of-way, cultivated area, and roadside. These groupings were used in lieu of the classifications established in the vegetation map produced by Cronan et al (1981) shown in Figure 2, although the habitat type for a given exotic population nearly always corresponded with what would be predicted from this map.

Each data sheet was assigned a unique number for ease in record keeping. Each time a UTM coordinate reading was taken, the data sheet number, species name, distribution, habitat type, and date were recorded in the GPS datalogger.

If several of the targeted exotic species were found within a circular area with a radius of 5-10 m, then all the above information was recorded for each species on a single survey form. If an exotic population had a consistent distribution over a circular area with a radius of well over ten meters, more than one reading was taken with the GPS unit. However, if the exotic population also changed a level in its distribution pattern, a new survey form was filled out and new UTM coordinates were taken to record this change in population structure.

RESULTS

A total of 465 UTM coordinates, representing distinct exotic populations, were recorded within the study site (Figure 3). Morrow honeysuckle, Japanese barberry, and Norway maple were the most abundant invasive plant species at SAGA. Less widespread were black swallow-wort, common buckthorn, Japanese tree lilac, multiflora rose, and yellow flag iris. Populations of autumn olive, black locust, glossy buckthorn, winged burning bush, and oriental bittersweet were more rare. The greatest diversity of invasives was found around the BMD Pond.

The most prevalent invasive plant at SAGA was morrow honeysuckle (Figure 4). Populations were found predominately along roadsides, trails, forest edges, utility right-of-ways, in hedges, and along the BMD Pond, brooks, and ephemeral streams. Nearly all of the high-density, reproductive populations were concentrated around the BMD Brook and Pond. In upland forests and along ephemeral streams and the BMU Brook, most honeysuckle populations consisted of immature individuals and small patches. Japanese barberry (Figure 5) was the next most widely distributed invasive plant and was found throughout the park except in the central mowed fields and successional pine and hardwood forest. There were fewer high-density populations (broken or extensive mats) of this species throughout the study site than morrow honeysuckle. Most large patches of Japanese barberry were distributed along the BMD Trail and utility right-of ways. Norway maple (Figure 6) was a common species found in the southern half of the study site. More seedlings and saplings were found than mature trees, and nowhere did Norway maple dominate the canopy.

Figure 2: Vegetation Map for Saint-Gaudens National Historic Site (Adapted from Cronan et al, 1981)

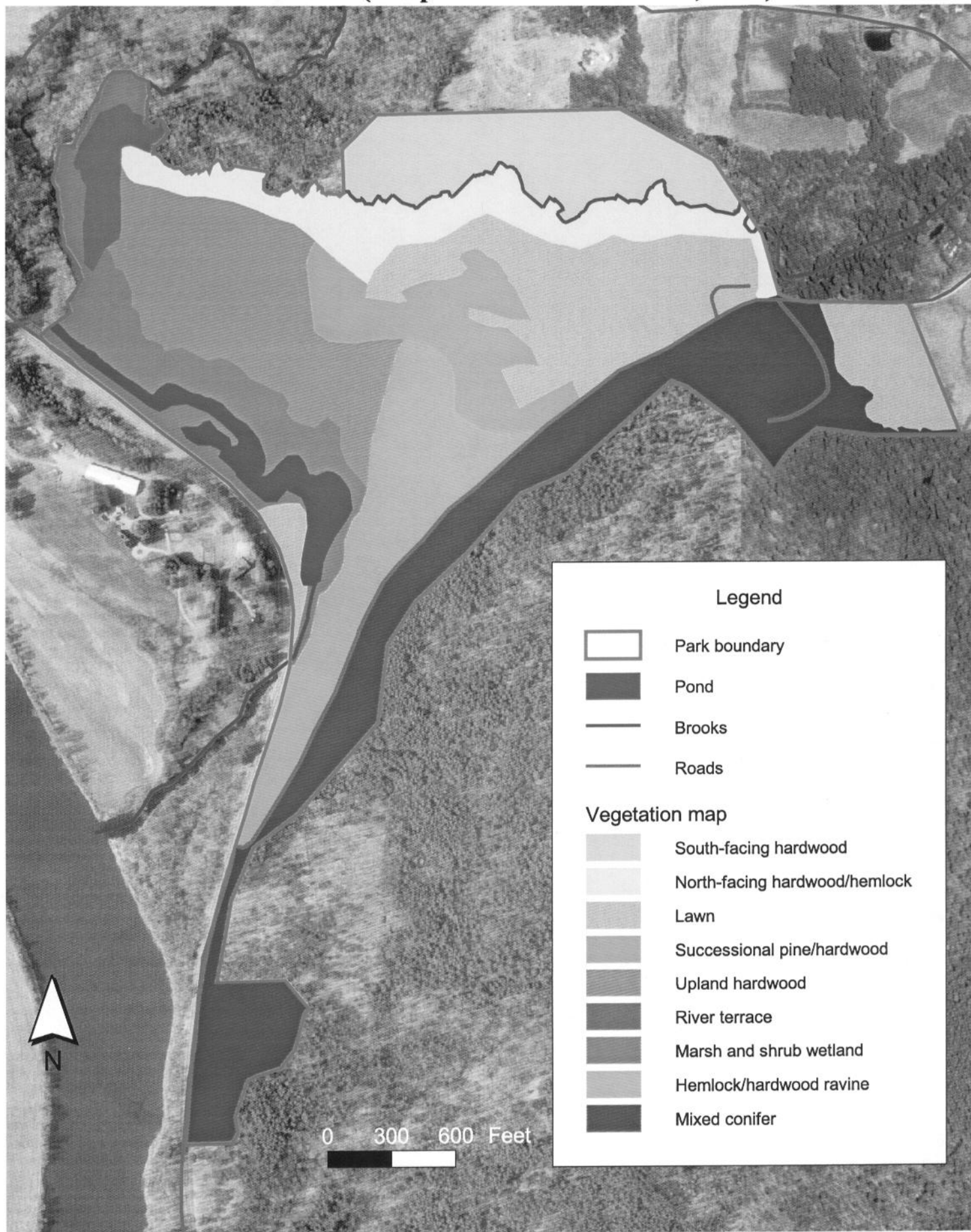


Figure 4: Morrow Honeysuckle Populations at Saint-Gaudens National Historic Site

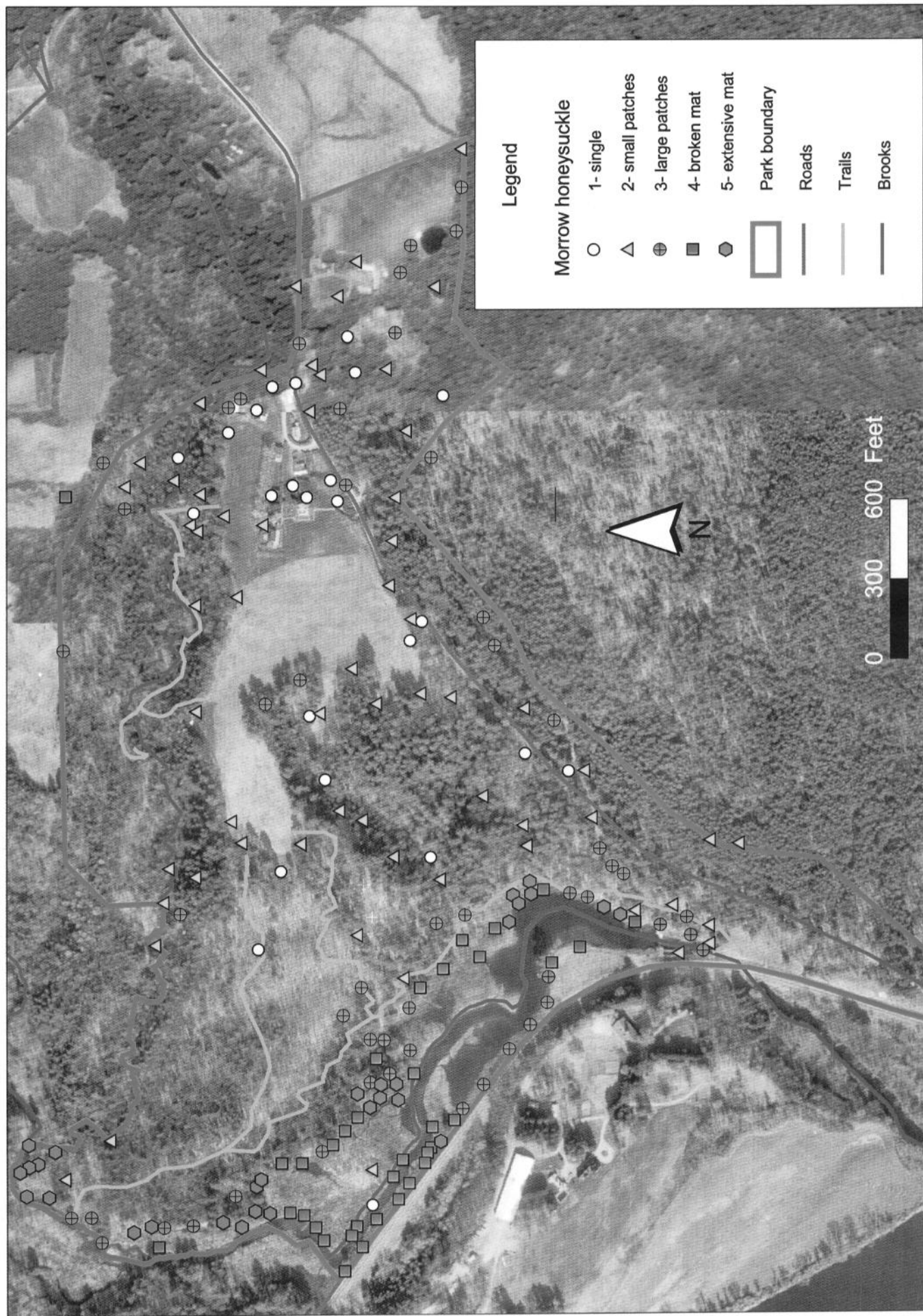
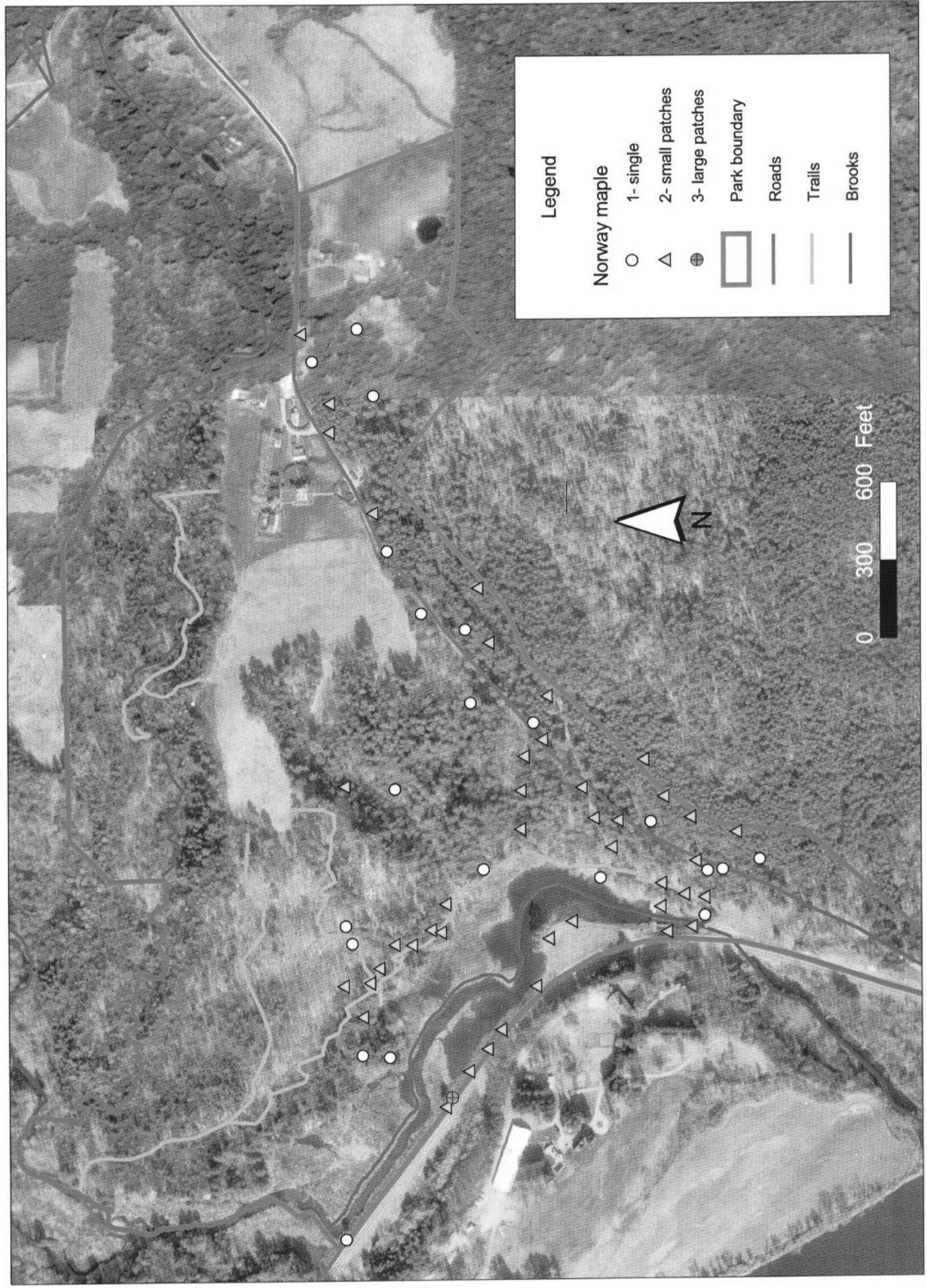


Figure 5: Japanese Barberry Populations at Saint-Gaudens National Historic Site



Figure 6: Norway Maple Populations at Saint-Gaudens National Historic Site



Three of the less abundant invasive species were predominately found in specific regions. The Japanese tree lilac populations (Figure 7) were concentrated around the historic gardens where it was planted during Augustus Saint-Gaudens' time. It has since spread to form dense populations in adjacent wooded areas, and smaller populations have dispersed along the BMU and BMD Brooks. Most of the black swallow-wort (Figure 8) was found around the BMD Pond and along Saint-Gaudens Road. Nearly all of the yellow flag iris (Figure 9) was clustered in the BMD Pond.

The other two less prevalent invasive plants were distributed more widely throughout the park. Patches of multiflora rose (Figure 10) were scattered along the BMU and BMD Brooks and along forest edges. Most fruit-bearing populations of common buckthorn trees (Figure 11) were found by the BMD Brook and Pond, although small seedlings of this species were widespread.

The final five plant species mapped in this study were uncommon within the park. The populations of autumn olive (Figure 12) consisted of two isolated shrubs by a small farm pond at the east end of the property. A few black locust trees and saplings (Figure 13) were found in two locations: by the BMD Pond and by the confluence of the BMD and BMU Brooks. Some seedlings were also found by the BMU Brook. One winged burning bush (Figure 14) was situated by the BMD Trail. Three glossy buckthorn seedlings (Figure 15) were found by the BMD Pond and an ephemeral stream. Small patches of oriental bittersweet (Figure 16) were located by the BMD Pond and along the forest edge adjoining the historic meadow.

Positive identification of a few of the less abundant species was difficult. All of the individuals of oriental bittersweet and glossy buckthorn were immature and did not bear any flowers or fruits, and so it is possible that some of these recorded populations were misidentified. One population classified as yellow flag iris may have actually been a native iris; the population was discovered past its flowering stage. These populations should be positively identified by their vegetative characteristics by an expert or monitored until they produce flowers and can be easily identified by an amateur botanist. The locations of these populations are listed in Appendix B.

Figure 17 shows which habitat types supported the most invasive populations. To create this chart, the 15 habitat types used in the field were condensed to 7 types. The habitat types of hemlock/hardwood and pine/hardwood were combined to form "mixed conifer and hardwood," herbaceous wetland, shrub wetland, forest wetland, and streambank formed "mesic forest and wetland," and field, roadside, utility right-of-way, and cultivated areas created "disturbed." Most populations were found in "mesic forest/ wetland" and "disturbed habitats;" very few were found in "upland forest" or in "coniferous," although most of the property with mixed conifer forests was not surveyed.

Figure 7: Japanese Tree Lilac Populations at Saint-Gaudens National Historic Site

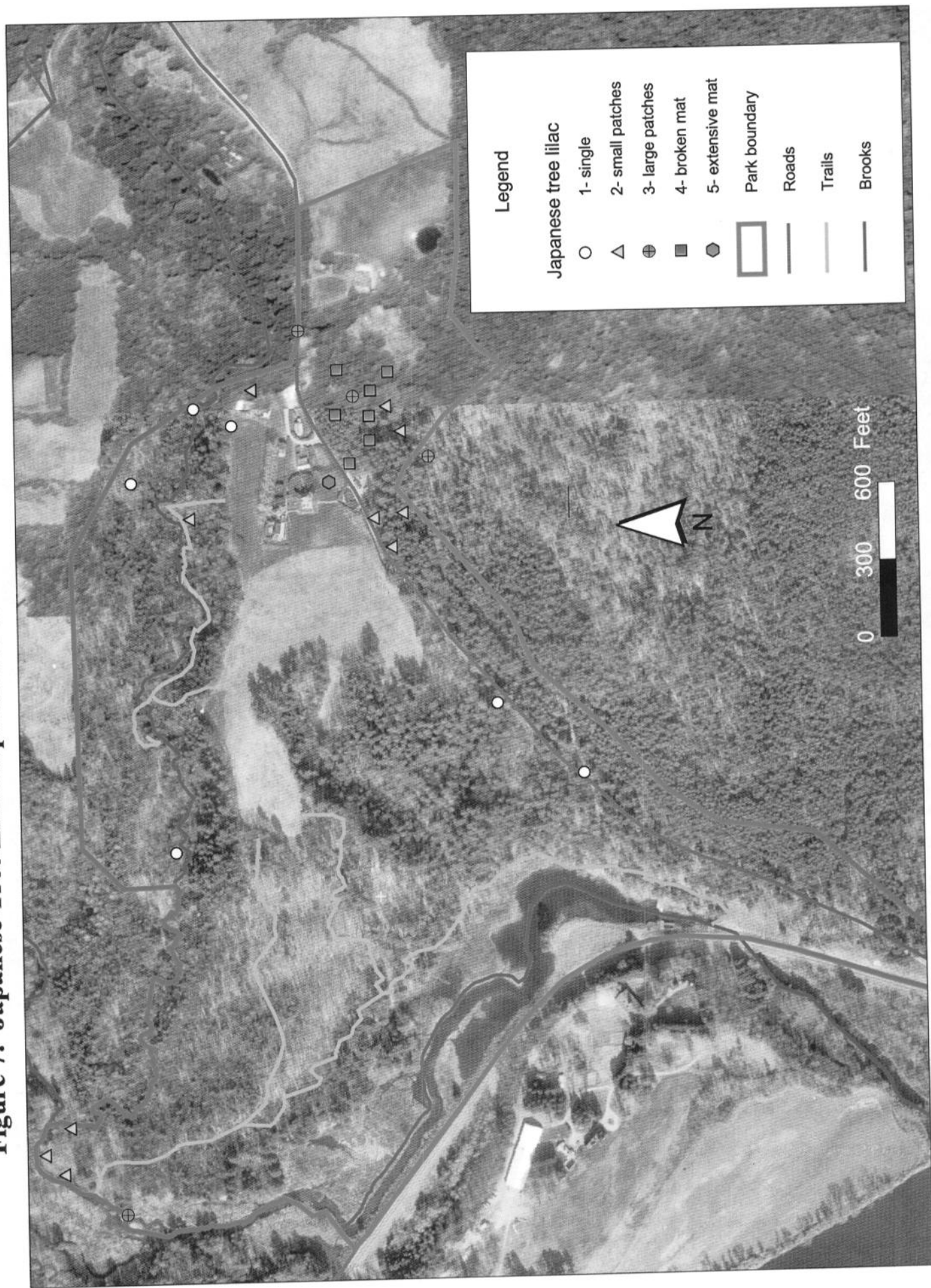


Figure 8: Black Swallow-wort Populations at Saint-Gaudens National Historic Site

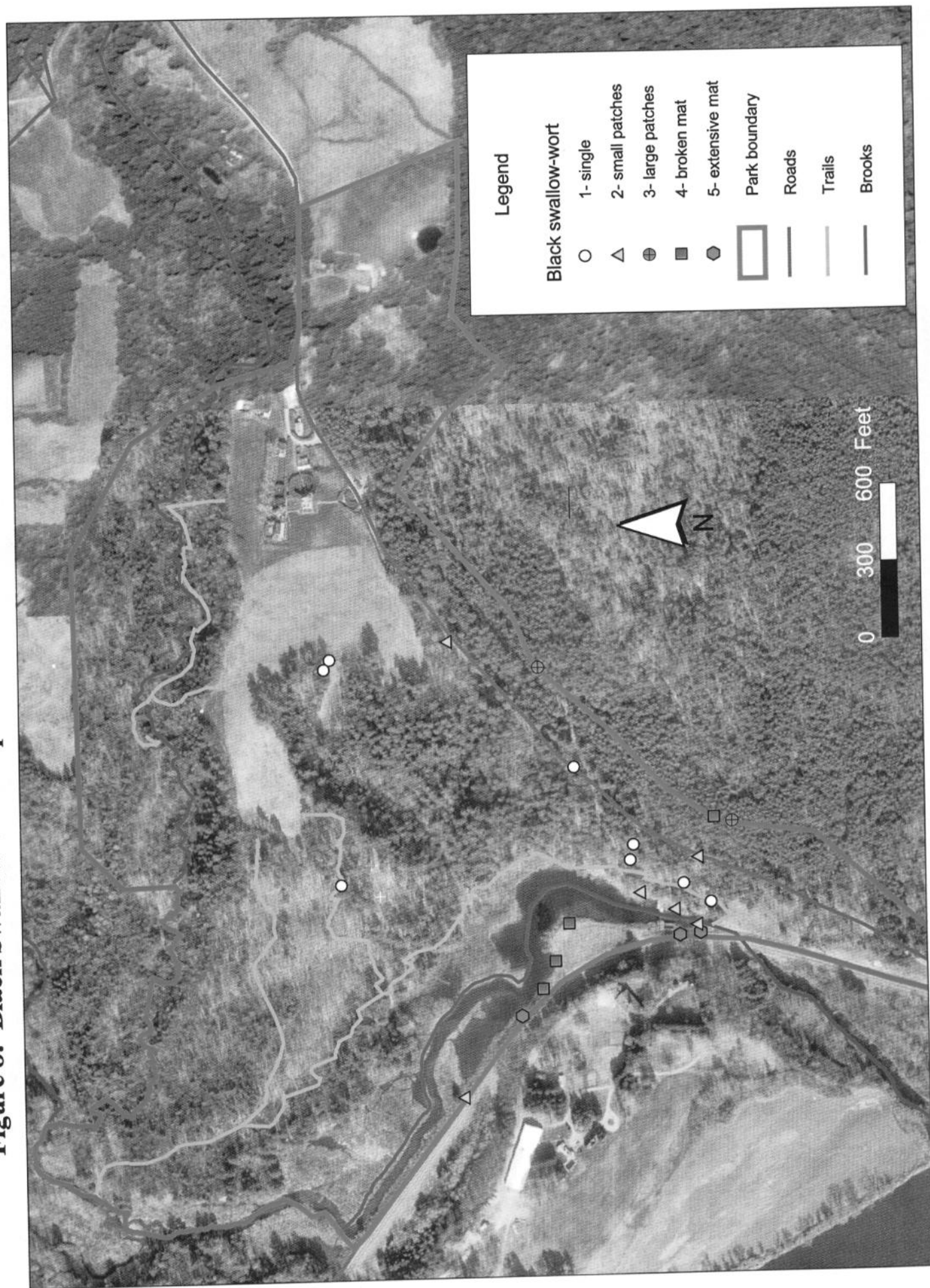


Figure 9: Yellow Iris Populations at Saint-Gaudens National Historic Site

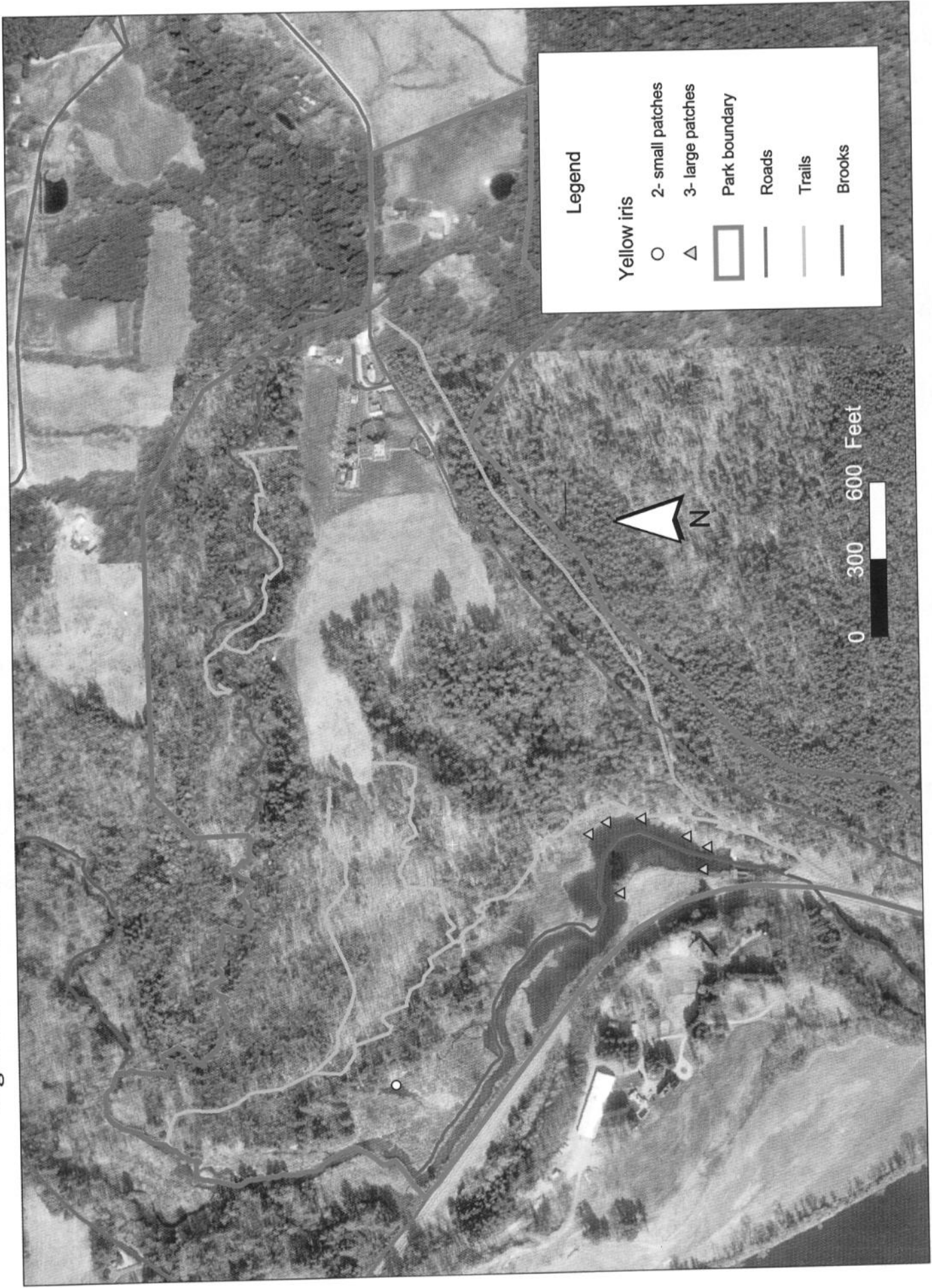


Figure 10: Multiflora Rose Populations at Saint-Gaudens National Historic Site

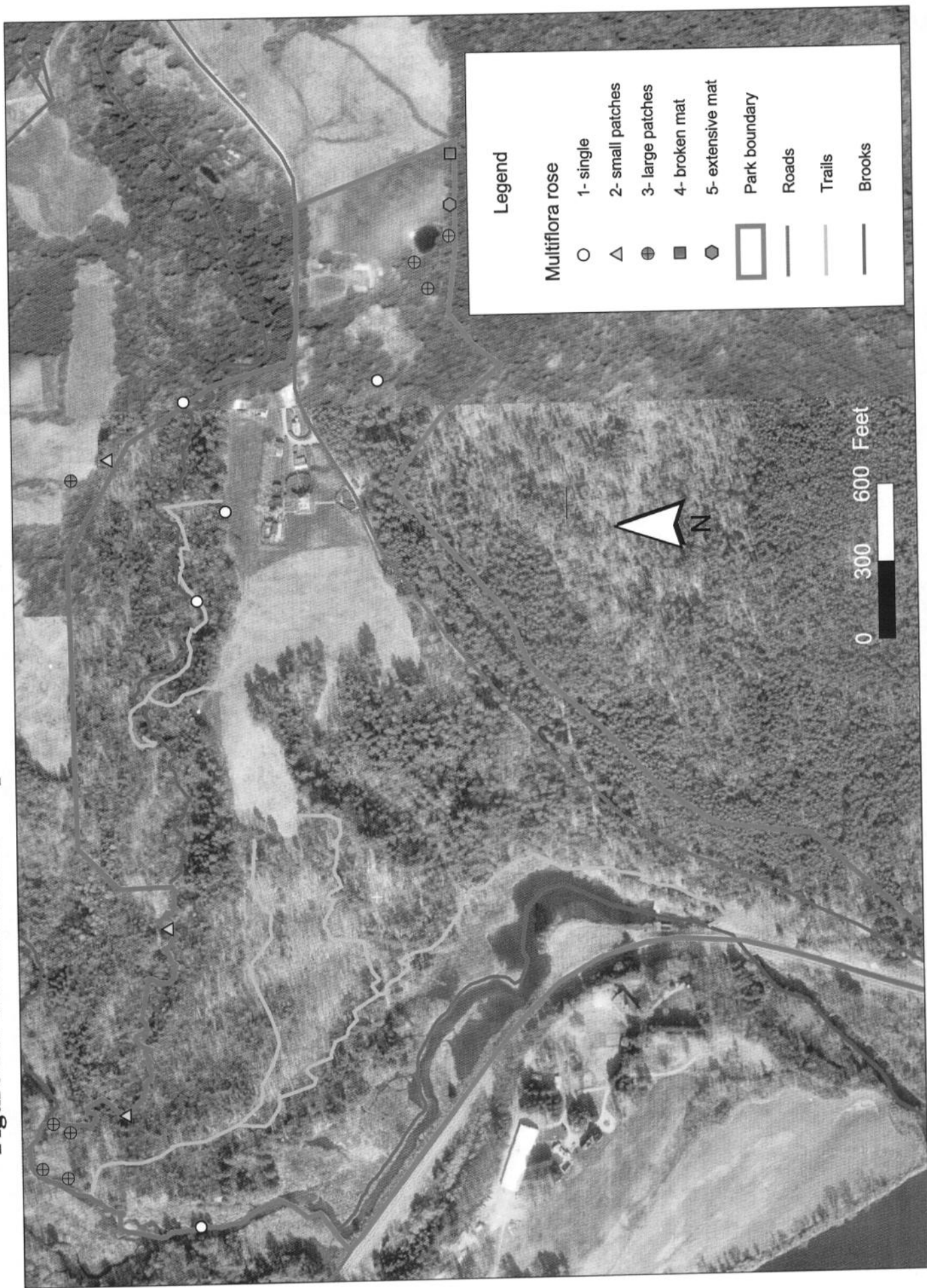


Figure 11: Common Buckthorn Populations at Saint-Gaudens National Historic Site

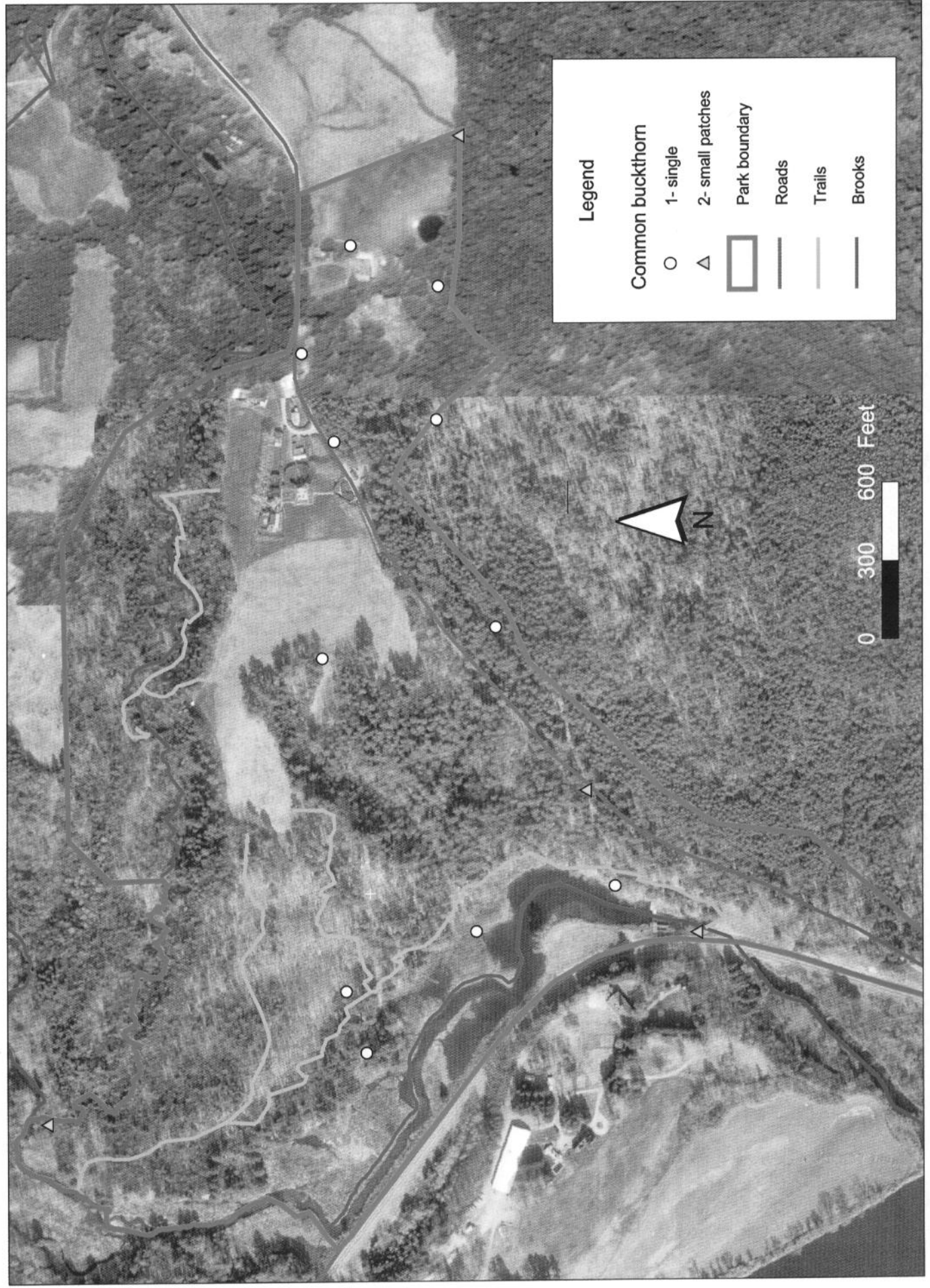


Figure 12: Autumn Olive Populations at Saint-Gaudens National Historic Site

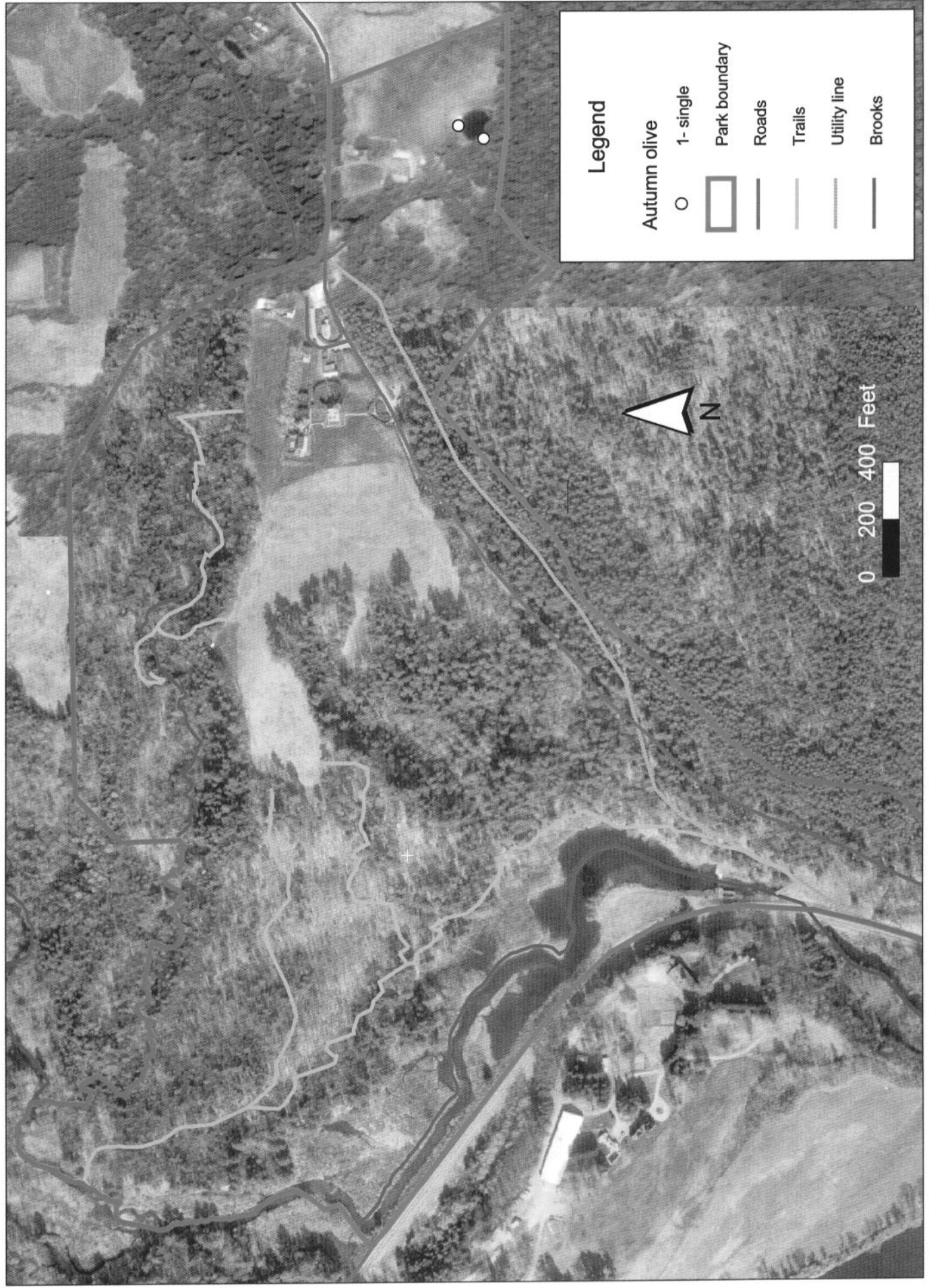


Figure 13: Black Locust Populations at Saint-Gaudens National Historic Site

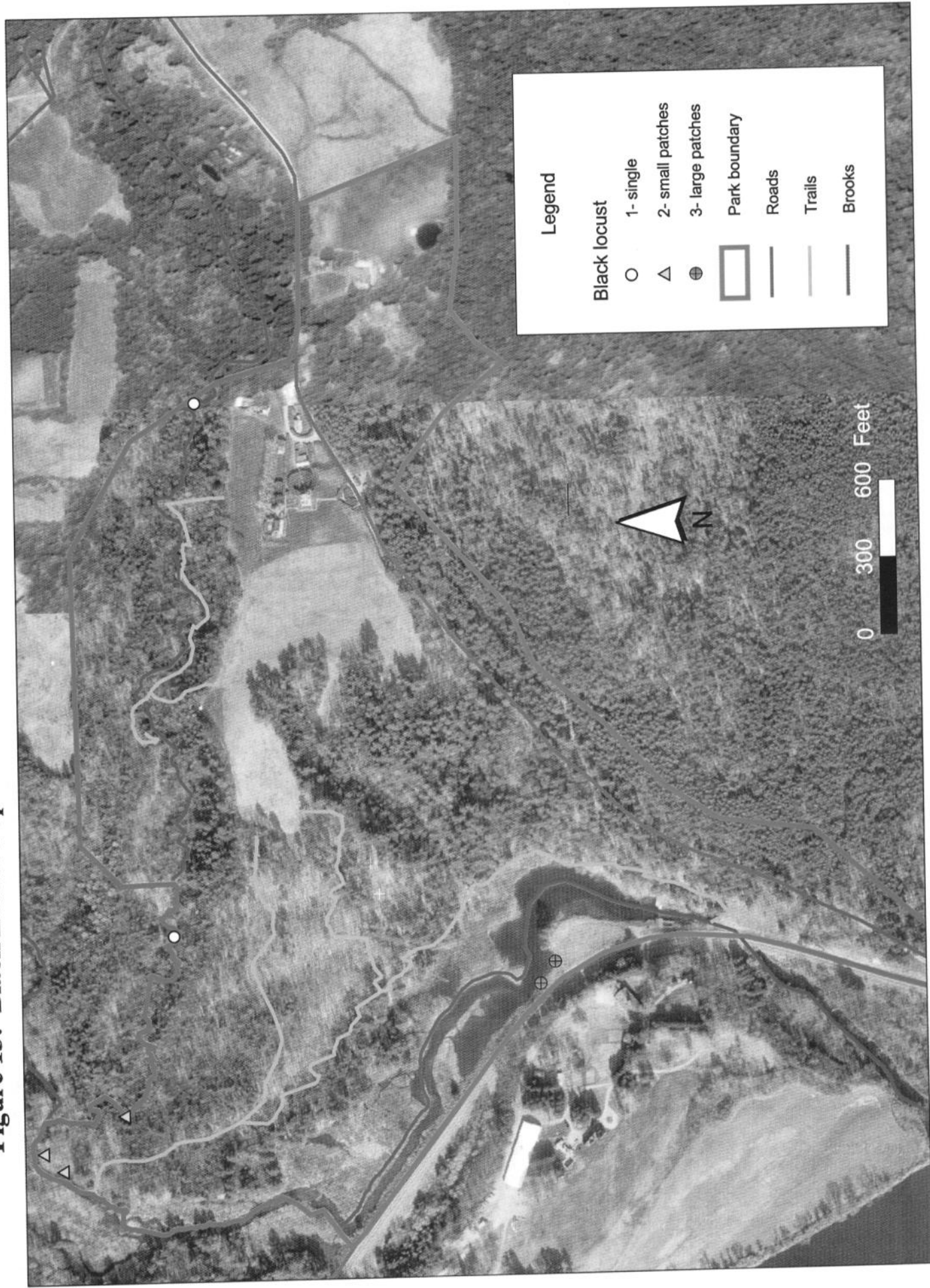


Figure 14: Winged Burning Bush Population at Saint-Gaudens National Historic Site

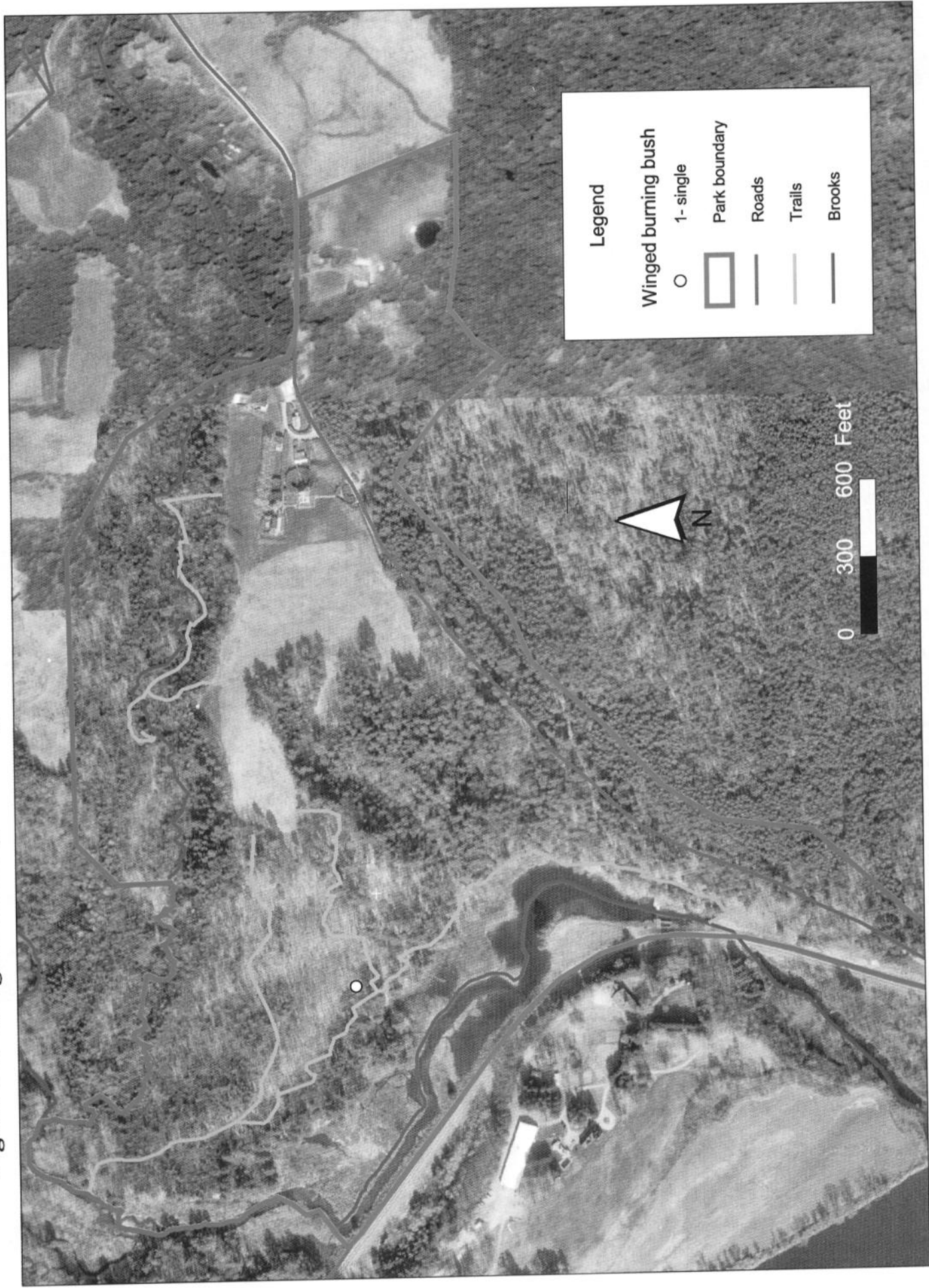


Figure 15: Glossy Buckthorn Populations at Saint-Gaudens National Historic Site

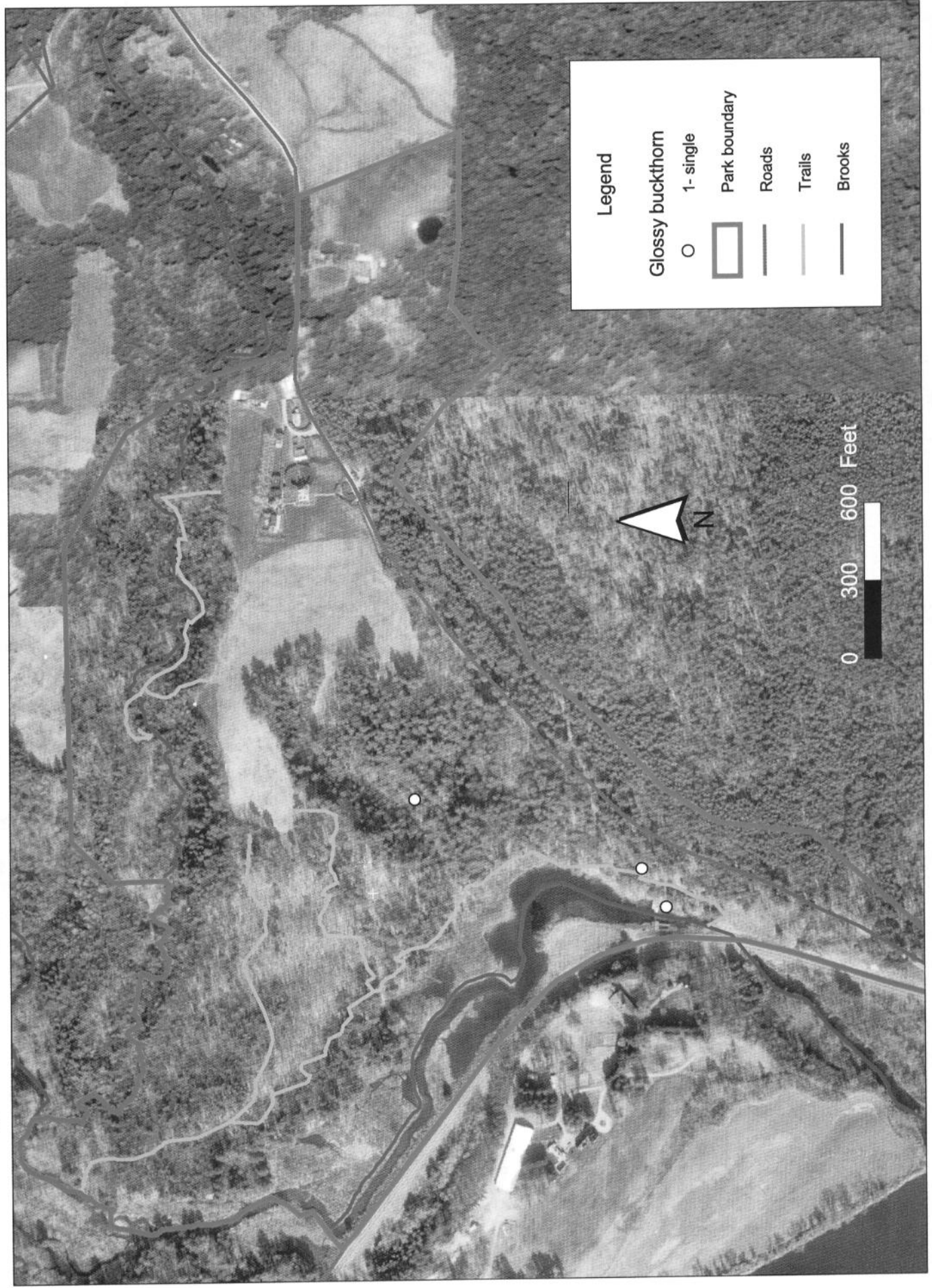


Figure 16: Oriental Bittersweet Populations at Saint-Gaudens National Historic Site

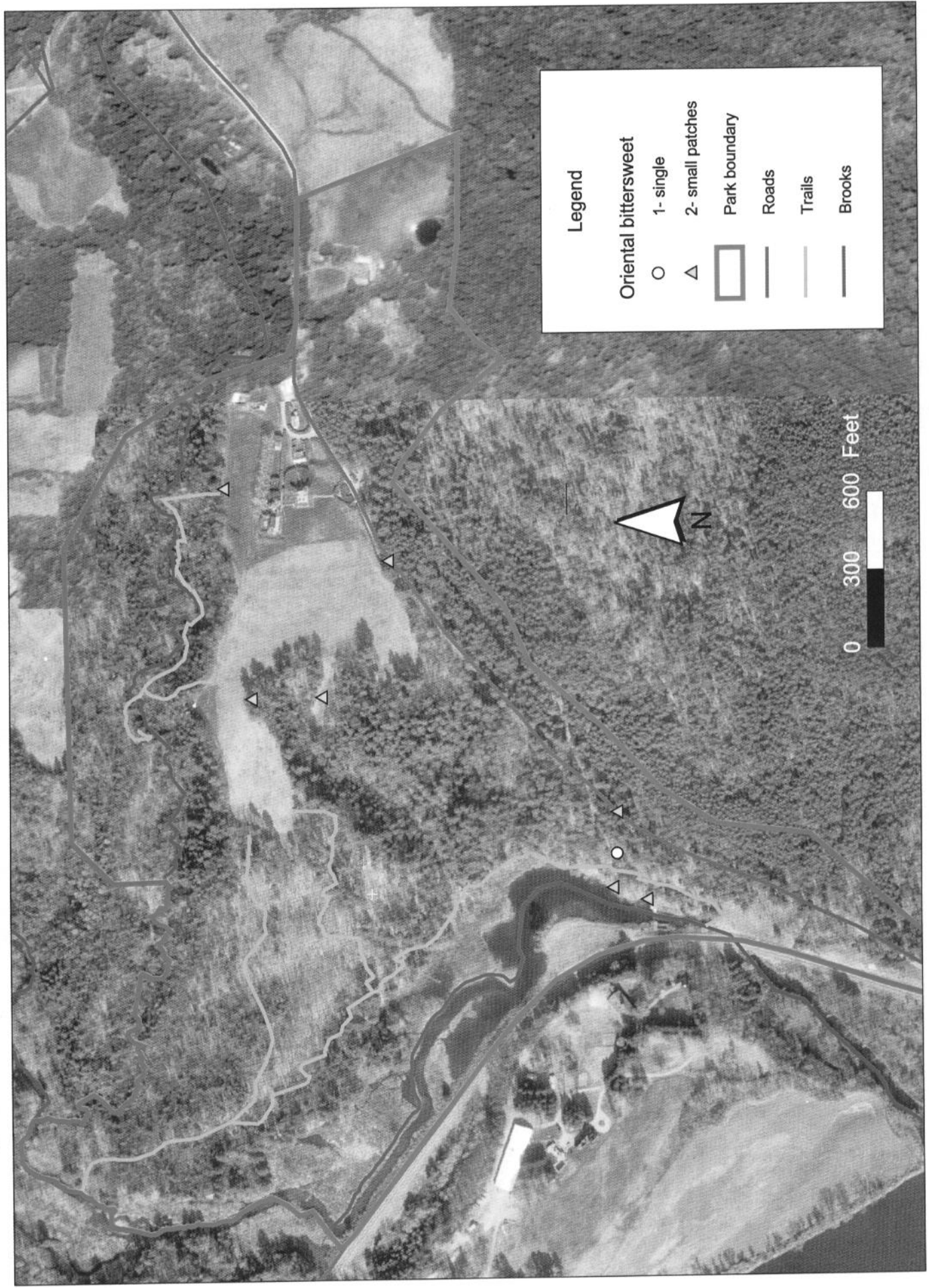
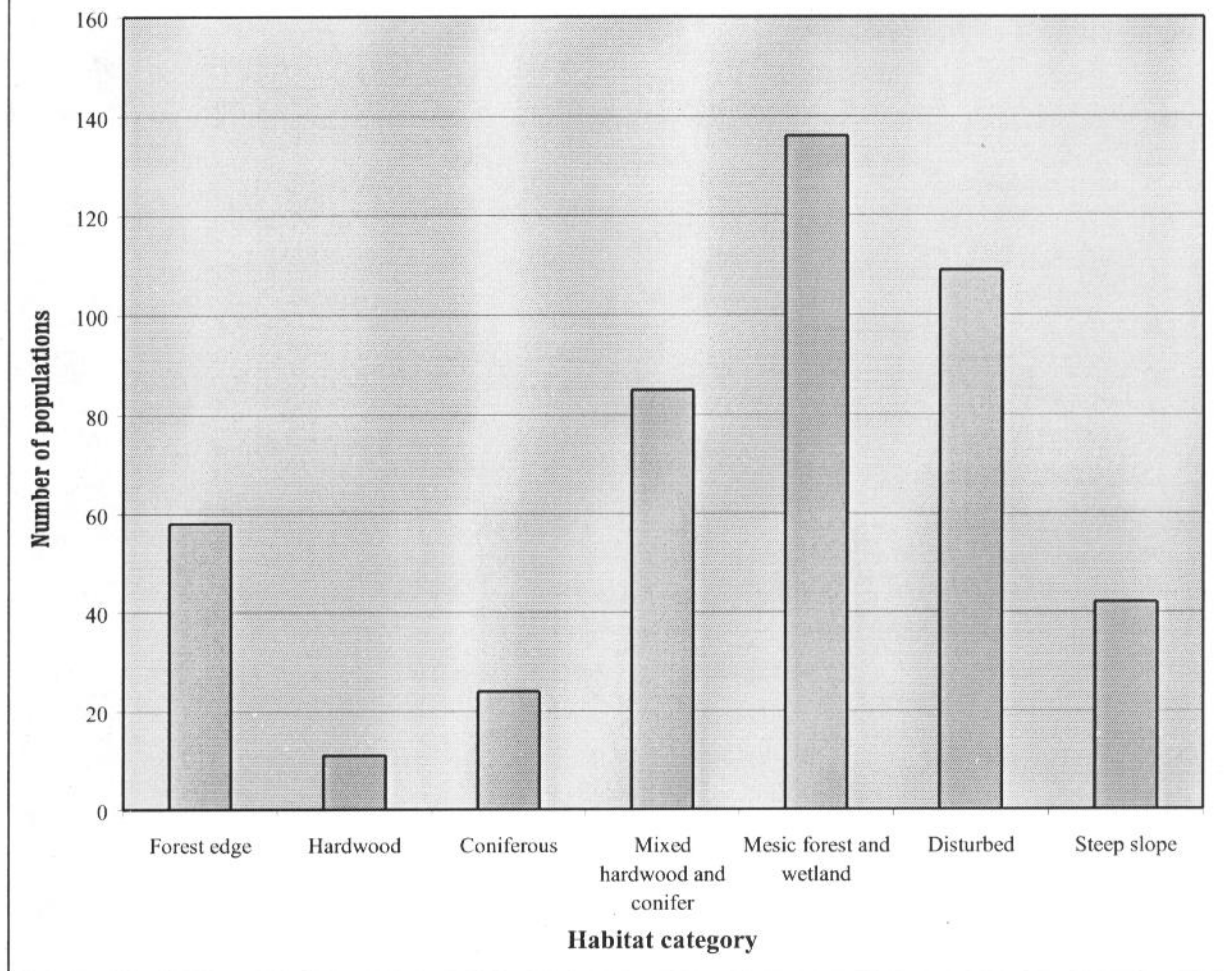


Figure 17: Location of Exotic Populations by Habitat Type



Of the thirteen mapped species, four were previously not documented to be present in the park: autumn olive, common buckthorn, glossy buckthorn, and multiflora rose. A fifth species, oriental bittersweet, was not documented by the Cronan et al. (1981) or Gilman (1997) vascular plant surveys of the park, but a voucher specimen was collected from the formal gardens in 1993, indicating a past presence in the park. All autumn olive and most multiflora rose populations were found at the former Covell property that was added to the park in 1998; therefore, those populations would not have been documented in 1981 or 1997. The glossy buckthorn populations within the park were all immature individuals that were presumably recent recruits. Common buckthorn was not widespread, but some individuals were large and reproductive, so it is surprising that these populations were missed in previous surveys.

DISCUSSION

The exotic plant populations in natural areas at SAGA were too extensive and well established for control of all to be a practical or realistic goal. Prioritizing which populations to control allows for the best use of park resources, and each species must be considered individually. Randall and Meyers-Rice (1998) have designed a rubric to determine the best sequence of exotic species removal using four criteria: the extent of the species, the potential impacts, the value of the infested habitat, and the difficulty of control. Under this method, species prioritized for

immediate removal include new populations of highly invasive species in natural habitats that can be easily removed using available resources. Species lower down the list consist of those species that are widespread, less severe in environmental impacts, infest highly disturbed areas, or are unlikely to be successfully controlled.

These four criteria of Randall and Meyers-Rice were given equal weight and applied to the thirteen invasive species present at SAGA in Table 1. Following this method, species to remove first include glossy buckthorn, autumn olive, winged burning bush, and oriental bittersweet. Since these populations are so small, control of some members of the eighth rank—black locust, black swallow-wort, common buckthorn, multiflora rose, and yellow flag iris—could also be attempted simultaneously. The next tier includes species more widespread and well established: Japanese barberry and Norway maple. The final two species, morrow honeysuckle and Japanese tree lilac, form large infestations that would take considerable time and resources to control.

Although this is a useful rubric for land managers, assigning the proper level under each category to each exotic species is difficult. This is especially true under the category of “potential impacts.” Very few studies quantitatively document the impacts of specific species of exotic plants, and so the level placements in Table 1 were based primarily on information about the exotics distributed by government and non-profit organizations (Appendix C) and placements used in Brown et al. (2001). These reports describe how the exotic plants have behaved in other environments, which may or may not be applicable to SAGA. Ideally, these categorizations should be based on observations made at or near SAGA; future on-site monitoring of populations will give a better indication of which are most aggressively spreading. Also, levels given for the “ability to control” category may be more accurately assigned after some control is attempted. Therefore, the values conferred within each category may need to be adjusted as more information becomes available.

Adjustments and additions may also need to be made to the GIS database in the future. Possible changes fall into three categories. First, alien plants known to be present in the park other than the thirteen in this study could be mapped. Also, invasive plants not currently documented to be in the park may be discovered and need to mapped. Last, as the thirteen targeted species in this study are controlled—or continue to spread if not controlled—changes in their population size will need to be recorded in the database.

There are several additional nonnative plant species that could have been included in this mapping project. SAGA has a total of 71 documented alien species (excluding garden cultivars) within the park, but most are not listed as invasive species in publications produced by government or non-profit agencies (Table 2). The thirteen species mapped in this project are widely believed to be a threat to native species by most, but there are several other alien plant species that are considered invasive by some groups and not by others. Bittersweet nightshade (*Solanum dulcamara*), Canada bluegrass (*Poa compressa*), celandine (*Chelidonium majus*), dame's rocket (*Hesperis matronalis*), goutweed (*Aegopodium podagraria*), moneywort (*Lysimachia nummularia*), mullein (*Verbascum thapsus*), sheep sorrel (*Rumex acetosella*), and St. John's wort (*Hypericum perforatum*) are all nonnative plants with a documented presence in the park that some regard to be invasive. If the peer-reviewed literature or anecdotal reports from land managers begin to consistently label these species as “invasive,” information about these species should be added to the database.

Table 1: List of Species Prioritized for Control Using Modified Criteria Suggested by Randall and Meyers-Rice (1998) and Brown et al (2001)

Common name	Technical name	Current Extent ^a	Potential Impact ^b	Value of Habitat ^c	Ability to Control ^d	Priority Rank ^e
Glossy buckthorn	<i>Rhamnus frangula</i>	1	2	2	1	6
Autumn olive	<i>Elaeagnus umbellata</i>	1	2	3	1	7
Burning bush	<i>Euonymus alatus</i>	1	3	2	1	7
Oriental bittersweet	<i>Celastrus orbiculatus</i>	1	3	2	1	7
Black locust	<i>Robinia pseudoacacia</i>	2	3	2	1	8
Black swallow-wort	<i>Vincetoxicum nigrum</i>	2	2	2	2	8
Common buckthorn	<i>Rhamnus cathartica</i>	2	3	2	1	8
Multiflora rose	<i>Rosa multiflora</i>	2	3	2	1	8
Yellow flag iris	<i>Iris pseudacorus</i>	2	3	2	1	8
Japanese barberry	<i>Berberis thunbergii</i>	3	1	2	3	9
Norway maple	<i>Acer platanoides</i>	3	2	2	2	9
Morrow honeysuckle	<i>Lonicera morrowii</i>	3	2	2	3	10
Japanese tree lilac	<i>Syringa reticulata</i>	3	3	2	3	11

^a Current Extent:

- 1 = species present as new populations on site
- 2 = species present in small infestations
- 3 = species present in large infestations that continue to spread
- 4 = species present in large infestations that are not spreading

^b Potential Impact:

- 1 = species that alter ecosystem processes such as hydrology or nutrient cycling
- 2 = species that outcompete natives and dominate otherwise undisturbed native communities
- 3 = species that prevent or depress regeneration of native species or eliminate resources

^c Value of Habitat:

- 1 = infestations that occur in areas that contain rare or highly valued species/ communities
- 2 = infestations with potential to infest forest interior, wetlands, lakes, and rivers
- 3 = infestations that occur in less highly valued portions of the site such as towns or restricted to roadsides

^d Ability to Control:

- 1 = species likely to be controlled or eliminated with available technology and resources
- 2 = species difficult to control with available technology and resources
- 3 = species unlikely to be controlled with available technology and resources

^e Priority Rank: indicates higher priority species for removal (lower number)

Table 2: Exotic Plant Species Found at SAGA

Technical name	Common name	Invasive?*
<i>Acer platanoides</i>	Norway maple	yes
<i>Achillea millefolium</i>	yarrow	no
<i>Aegopodium podagraria</i>	goutweed	possible
<i>Alopecurus pratensis</i>	meadow foxtail	possible
<i>Anthoxanthum odoratum</i>	sweet vernal grass	possible
<i>Arctium minus</i>	burdock	no
<i>Asparagus officinalis</i>	common asparagus	no
<i>Berberis thunbergii</i>	Japanese barberry	yes
<i>Bromus inermis</i>	Hungarian bromegrass	possible
<i>Capsella bursa-pastoris</i>	shepherd's purse	no
<i>Celastrus orbiculatus</i>	oriental bittersweet	yes
<i>Cerastium vulgatum</i>	mouse-eared chickweed	no
<i>Chelidonium majus</i>	celandine	possible
<i>Chenopodium album</i>	lamb's-quarters	no
<i>Cynanchum nigrum (louiseae)</i>	black swallow-wort	yes
<i>Dactylic glomerata</i>	orchard grass	possible
<i>Daucus carota</i>	Queen Anne's lace	possible
<i>Echinochloa crus-galli</i>	barnyard grass	possible
<i>Elaeagnus umbellata</i>	autumn olive	yes
<i>Epipactis helleborine</i>	helleborine	no
<i>Erysimum cheiranthoides</i>	treacle-mustard	no
<i>Euonymus alatus</i>	winged burning bush	yes
<i>Festuca ovina</i>	sheep fescue	possible
<i>Galinsoga parviflora</i>	galinsoga	no
<i>Glechoma hederacea</i>	gill-over-the-ground	no
<i>Hemerocallis fulva</i>	orange daylily	no
<i>Hesperis matronalis</i>	dame's rocket	possible
<i>Hieracium aurantiacum</i>	orange hawkweed	no
<i>Hieracium floribundum</i>	king devil	no
<i>Hypericum perforatum</i>	St. John's wort	possible
<i>Iris pseudocorus</i>	yellow flag iris	yes
<i>Lapsana communis</i>	nipplewort	no
<i>Linaria canadensis</i>	blue toadflax	no
<i>Linum perenne</i>	garden flax	no
<i>Lonicera morrowii</i>	morrow honeysuckle	yes
<i>Lysimachia nummularia</i>	moneywort	possible
<i>Lythrum salicaria</i>	purple loosestrife	yes
<i>Medicago lupulina</i>	black medic	no
<i>Myosotis scorpioides</i>	forget-me-not	possible
<i>Phleum pratense</i>	timothy	no
<i>Picea abies</i>	Norway spruce	no
<i>Plantago lanceolata</i>	English plantain	no
<i>Plantago major</i>	plantain	no
<i>Poa annua</i>	annual bluegrass	no
<i>Poa compressa</i>	Canada bluegrass	possible
<i>Polygonum aviculare</i>	barnyard knotweed	no
<i>Populus nigra var. italica</i>	Lombardy popular	no
<i>Potentilla recta</i>	cinquefoil	no
<i>Ranunculus acris</i>	common buttercup	no
<i>Robinia pseudo-acacia</i>	black locust	yes
<i>Rosa multiflora</i>	multiflora rose	yes

Table 2: Cont.

Technical name	Common name	Invasive?
<i>Rumex acetosella</i>	sheep sorrel	possible
<i>Rumex crispus</i>	yellow dock	no
<i>Salix purpurea</i>	basket willow	no
<i>Silene armeria</i>	catchfly	no
<i>Solanum dulcamara</i>	bittersweet nightshade	possible
<i>Stellaria graminea</i>	stichwort	no
<i>Stellaria media</i>	chickweed	no
<i>Syringa reticulata</i>	Japanese tree lilac	possible
<i>Thymus serpyllum</i>	thyme	no
<i>Trifolium aureum</i>	yellow hop-clover	no
<i>Trifolium arvense</i>	rabbit-foot clover	no
<i>Trifolium pratense</i>	red clover	no
<i>Trifolium repens</i>	white clover	no
<i>Tussilago farfara</i>	colt's foot	no
<i>Urtica dioica</i>	nettle	no
<i>Verbascum thapsus</i>	mullein	possible
<i>Veronica persica</i>	bird's-eye speedwell	no
<i>Vicia cracca</i>	vetch	no

*"Yes" indicates that this species is consistently labeled to be invasive in lists produced by government and non-profit organizations. "Possible" indicates that the species is considered invasive by some and not by others. "No" indicates that the species is consistently not considered to be invasive.

The fact that populations of four invasive plant species were found within SAGA during this study serves to reinforce that monitoring should focus on seeking new invasions as well as describing known infestations. Park resource managers need to know the distinguishing characteristics of all invasive plants that could potentially invade SAGA. Information about some of these species can be found in Appendix D.

Finally, the data on the thirteen mapped species will need to be updated periodically, especially as control measures are implemented. Future mapping of the extent of the populations will provide useful information about whether the populations are continuing to spread with or without control. Records on which populations have been removed and when are also needed.

Specific suggestions on methods to control species are given in Appendix C. Recommended work plans for the next two years are included in Appendix E. In order to implement any portion of this plan calling for the active control or removal of exotic vegetation, the park must ensure that all required areas of compliance are considered and satisfied. This may include the preparation of documents in accordance with the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act (NHPA). In addition, SAGA will comply with all requisite National Park Service policies and guidelines, as well as applicable state, federal, and local regulations. Should pesticides be selected as part of the control plan, state law requires that the applicator is licensed for applying pesticides in New Hampshire wetlands (Section Pesticide-300, New Hampshire Department of Agriculture, Markets and Food, 2001). As with any pesticide use in wetlands, a state permit would be required (Pes601.01 (d) 5) with a specified process for public notification, possible hearings, etc.

CONCLUSIONS

Invasive plant species pose a threat to the natural habitats at SAGA. While there are many invasive species at the site, only a few are widespread throughout the park and may be displacing native vegetation. These include Morrow honeysuckle, Japanese barberry, Norway maple, and Japanese tree lilac. Attempts to control these populations may be costly and unsuccessful, so small populations of other invasive species should be removed first. Whatever exotic control plans SAGA decides to adopt, long-term monitoring of natural areas of the park will be necessary to detect new exotic populations and document any spread in old populations.

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APPENDIX A: BLANK SURVEY FORM

Saint-Gaudens NHS Invasive Plant Survey Form

Date: ____/____/____

Survey section:

UTM coordinates:

Locality description:

Neighboring vegetation:

Species	GPS file	Habitat type	Size of infestation	Abundance					Distribution				
				Single plant	2-19	20-99	100-999	More than 1000	1) Growing singly	2) Sparsely throughout (small patches)	3) Large patches	4) Broken mat	5) Extensive mat

Species Key:

AO – autumn olive
BB – burning bush
BL – black locust
BS – black swallow-wort
CB – common buckthorn

GB – glossy buckthorn
JT – Japanese tree lilac
JB – Japanese barberry
OB – oriental bittersweet

NM – Norway maple
MH – Morrow honeysuckle
MR – multiflora rose
YF – yellow flag iris

Habitat Key:

(1) forest edge
(2) upland hardwood
(3) hardwood/hemlock
(4) pine/ hardwood
(5) mixed conifer

(6) herbaceous wetland
(7) shrub wetland
(8) forest wetland
(9) aquatic
(10) streambank

(11) field/ open area
(12) roadside
(13) utility right-of-way
(14) cultivated area
(15) steep slope

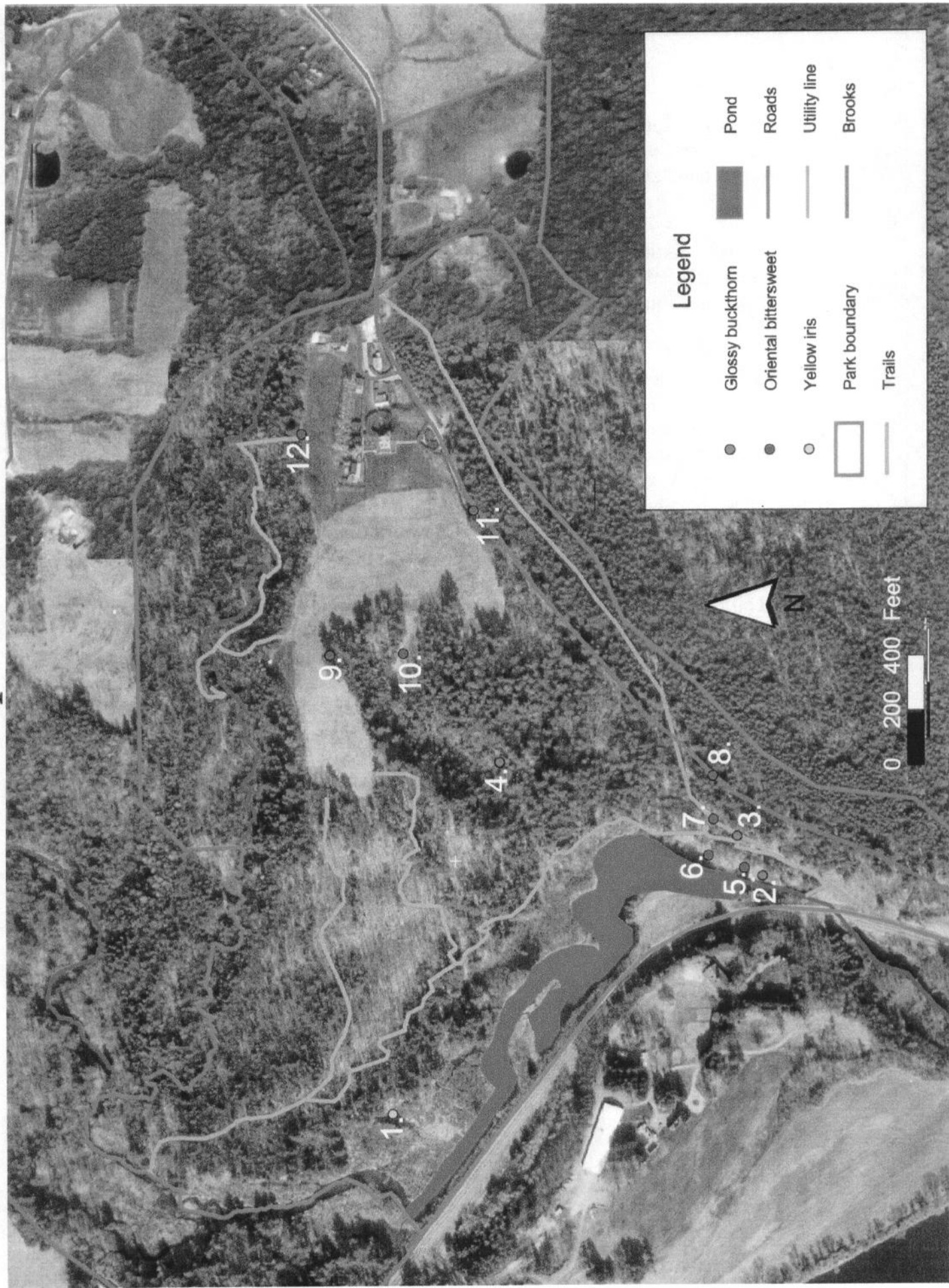
Comments:

APPENDIX B: UNIDENTIFIED SPECIES LOCATIONS

Some plant populations could not be classified with absolute certainty because they were not in flower or fruit. These were mapped and tentatively identified to be glossy buckthorn, oriental bittersweet, or yellow flag iris. However, the populations should be reexamined and properly identified when possible. The UTM coordinates and data page numbers for each of the 12 unidentified populations shown on page 31 are listed below. The indicated data pages can be found in the 2001 Exotic Plant Mapping Field Data.

Population number	Possible species identification	Data page number	East (m)	North (m)
1	yellow flag iris	80	711,933	4,819,770
2	glossy buckthorn	51	711,201	4,819,347
3	glossy buckthorn	121	712,243	4,819,373
4	glossy buckthorn	148	712,330	4,819,638
5	oriental bittersweet	51	712,208	4,819,371
6	oriental bittersweet	54	712,224	4,819,404
7	oriental bittersweet	121	712,264	4,819,404
8	oriental bittersweet	124	712,313	4,819,404
9	oriental bittersweet	27	712,452	4,819,828
10	oriental bittersweet	29	712,449	4,819,746
11	oriental bittersweet	173	712,611	4,819,666
12	oriental bittersweet	23	716,698	4,819,861

Unidentified Species Locations



APPENDIX C: SPECIES SPECIFIC CONTROL PLANS

Attached are control plans that include descriptions of the characteristics, environmental threats, and potential removal methods for each of the thirteen invasive plant species mapped at SAGA in 2001. These plans are designed to be frequently updated as more information becomes available and control actions implemented.

The action plans outlined for each species are proposed with the assumption that SAGA will receive additional funding and volunteers or paid assistance to help implement the control measures. The current goals outlined in the control plans cannot be met with the park's existing staffing and funding.

A suggested timetable for implementing the control plans is presented in Appendix E.

Many of the control plans recommend the use of herbicides to control species, predominately glyphosate. This systemic herbicide, which is the active ingredient in Roundup® and Rodeo®, is taken into the roots and kills the entire plant. Although glyphosate is biodegradable (breaks down into harmless components when it contacts the soil), it degrades more slowly in anaerobic versus aerobic conditions. It is also a non-selective herbicide that should be used cautiously if at all in areas of high ecological quality. In comparison, triclopyr is a systemic herbicide (the active ingredient in Garlon® and Ortho's Bush-Be-Gone®) that kills dicots (broad-leaved plants) but does little harm to monocots (grasses). Most recommend treating plants with herbicides in late summer and fall when plants are actively translocating nutrients to their roots in preparation for dormancy. Others recommend using herbicides in the winter, when most plants, especially herbaceous species, are dormant and less likely to be damaged by a small accidental exposure. The effectiveness of treatments is generally lower during the growing season.

AUTUMN OLIVE (*Elaeagnus umbellata* Thunb.) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Seven

B. DESCRIPTION

(Information from Gleason and Cronquist 1991; Sather and Eckardt 1987; Virginia DCR 1994)
Autumn olive is a deciduous shrub that can reach 20 feet in height and has nitrogen-fixing capabilities. The leaves are 1-3 inches long, simple, alternate, and have smooth edges. A key distinguishing feature of this species is the silvery scales that cover the undersides of the leaves. The top surface is green or grayish-green. The closely related Russian olive (*Elaeagnus angustifolia* L.), which is also an exotic species, has silvery scales on both surfaces of the leaves. The tubular, yellow flowers are arranged in small clusters and bloom in late April or May. The fruits are round, juicy drupes that turn speckled red when ripe in September or October. Birds eat and disperse the fruits.

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 12

D. DAMAGE & THREATS

The autumn olive population at SAGA consists of two bushes by the farm pond. These bushes by themselves are unlikely to pose a threat to native species; however, since birds help disperse this species, allowing a seed source to persist may help this species invade other areas of the park.

The Virginia DCR (1994) reports that autumn olive thrives in disturbed areas, roadsides, grasslands, and open woodlands. Its nitrogen-fixing ability allows it to survive in poor soils, but it does not successfully grow in wetlands or dense forests. Sather and Eckardt (1987) contend that autumn olive has the potential to be a highly invasive species since it grows rapidly, produces large fruit crops, and is widely distributed by birds. It may crowd out native vegetation or alter the trajectory of succession by changing the nitrogen dynamics of the infested area. Nevertheless, autumn olive has been the subject of very little scientific research, so the extent of its impacts on native species and natural processes remains unknown.

E. GOALS

1. Remove all known autumn olive populations and monitor for new populations.

F. OBJECTIVES

1. Remove all known, on-site populations within 3 years.

K. RESULTS OF EVALUATION

L. REFERENCES

- Eckardt, N. 1987. Element stewardship abstract for *Elaeagnus umbellata*. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.
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- Virginia Department of Conservation and Recreation and The Virginia Native Plant Society. 1994. Invasive alien plant species of Virginia: autumn olive and Russian olive. Richmond, Virginia.

researchers suggest that black locust infestations may influence the trajectory of succession of disturbed sites.

E. GOALS

1. Remove all known black locust populations and monitor for new populations.

F. OBJECTIVES

1. Remove all known, on-site populations within 4 years.

G. MANAGEMENT OPTIONS

(Information from Converse 1984; Sabo 2000; Wisconsin DNR 1999)

Viable control options include:

5. No treatment
6. Mechanical control
7. Combination mechanical and chemical control
8. Chemical control

Option 1 (no treatment) would result in no active management of black swallow-wort, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because black locust currently does not seem to be significantly impacting native communities at SAGA. Compared to the other options, this option is the least time and resource intensive and leaves habitats undisturbed.

Option 2 (mechanical control) includes mowing, clipping, or uprooting black locust. None of these options are widely recommended, because black locust resprouts easily with increased vigor when disturbed. Mowing can help seed germination by scarifying the thick seed coats. This option is more labor intensive than option 1 or 4 and compared to all options, has the least promise to increase the quality of natural habitats.

Option 3 (mechanical and chemical control) involves cutting down black locust saplings and trees and applying herbicide to the stump. Solutions of 20% glyphosate applied immediately after cutting in the late summer, early fall, or during dormancy have been effective. Others have had success with cut-stump applications in the spring, though some have reported problems with resprouting the following year after treatments. This option promises to be more effective than option 2, decreases the chance of non-target herbicide exposure (compared to option 4), and will remove black locust before it becomes well established and can alter natural processes.

Option 4 (chemical control) involves basal bark or foliar applications of herbicide. For basal stem treatments, the herbicide should be applied in a 6-inch band surrounding the trunk about a foot above the ground. Triclopyr diluted in mineral oil or a 2% solution of Remedy® (active ingredient is triclopyr) has been recommended for this technique, which is especially successful for use on young trees that are still thin-barked. Solutions of 1-1.5% glyphosate or triclopyr can be effectively sprayed on saplings during the growing season. Since all branches and stems need to be treated, foliar treatments are not recommended for use in areas of high biological quality where non-target exposure is a concern. These methods are less labor intensive than options 2 and 3 but promise to be as effective in removing black locust as option 3.

BLACK SWALLOW-WORT (*Vincetoxicum nigrum* (L.) Moench) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Eight

B. DESCRIPTION

(Information from Lawlor 2001)

There are two species of *Vincetoxicum* with the common name "black swallow-wort" that are invasive and present in the northeastern United States: *V. nigrum* (L.) Moench and *V. rossicum* (Kleoe.) Barb. They are distinguished by white hairs on the top surface of *V. nigrum* flowers that are absent on *V. rossicum* flowers and longer peduncles on *V. nigrum* compared to *V. rossicum* (5-30 mm versus 2-5 mm, respectively). Since *V. nigrum* is predominately found in New England and particularly in the Connecticut River Valley, all *Vincetoxicum* species located at SAGA were classified as *V. nigrum* for management purposes. Swallow-wort plants may be examined when flowering to determine if *V. rossicum* is present in the park. However, there is no pressing need to accomplish this, since taxonomy of this genus in the scientific literature has been inconsistent and both species are invasive.

Both species are green, herbaceous vines with opposite, simple, glabrous leaves. Each leaf is about 5-10 cm long and has smooth edges, a glossy sheen, and tapers to a point. These vegetative characteristics easily distinguish black swallow-wort from other vines present at SAGA. Small, purple-black flowers with five, fleshy petals appear from late May through July. The fruits are typical of other members of the milkweed family: narrow pods that open lengthwise to release seeds that are wind-dispersed on tufts of hairs. The fruits are usually paired and ripen in July and August. Plants growing in full sunlight produce more fruits than those growing in full or partial shade. Most seeds germinate close to the parent population, but some seeds can spread significant distances downwind. The pods persist on the vines in fall and turn bright yellow.

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 8.

D. DAMAGE & THREATS

Most dense populations of black swallow-wort at SAGA are located near the BMD Pond along NH State Route 12A. Here, the native species it appears to be predominately crowding out is poison ivy. Dense, mature populations of black swallow-wort cover the ground, perhaps to the exclusion of all other species.

Black swallow-wort has been the subject of very little quantitative research; most available information about its ecology is based on observations from land managers. According to Lawlor (2001), black swallow-wort succeeds in disturbed areas, riparian corridors, shrub communities, and upland forests. While they are more reproductively successful in open environments, they can persist in the shade. Black swallow-wort can form mono-specific stands and smother herbs or shrubs. A concern exists that this species may negatively impact monarch butterflies (*Danaus*

populations should be killed with foliar or cut-stem herbicide applications. Repeated follow-up treatments and monitoring will be necessary. Especially careful monitoring for new populations should be performed in locations downwind of populations that are currently reproductive.

I. HOW ACTIONS WILL BE EVALUATED

Actions will be considered successful if black swallow-wort is essentially eradicated from the park within 4 years with minimal resprouting from removal areas. If vigorous resprouting occurs in areas where uprooting was attempted, chemical control may need to be used instead.

J. RESOURCE NEEDS

Staff time, volunteers, work gloves, shovels/spades, clippers, herbicide, herbicide applicator, a place to store clipped vines/root crowns, considerable time commitment

K. RESULTS OF EVALUATION

L. REFERENCES

Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. *New England Wild Flower*. 2: 19-26.

Lawlor, F. 2001. Element stewardship abstract for *Vincetoxicum nigrum* (L.) Moench & *Vincetoxicum rossicum* (Kleo.) Barb.. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.

G. MANAGEMENT OPTIONS

(Information from Brunelle and Lapin 1996; Archibold et al. 1997)

Viable control options include:

9. No treatment
10. Mechanical control
11. Combination mechanical and chemical control

Option 1 (no treatment) would result in no active management of common buckthorn, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because common buckthorn currently does not seem to be negatively impacting native communities at SAGA. Compared to the other options, this option is the least time and resource intensive and leaves habitats undisturbed.

Option 2 (mechanical control) may include mowing, clipping, or uprooting. Mowing repeatedly can be effective in open areas. Some recommend cutting stems to the ground twice each season for 2-3 years, but this method may not be effective since common buckthorn readily resprouts. Special priority should be given to removing the pistillate ("female") trees before the staminate trees. Uprooting seedlings up to 1½ inch in diameter is effective if most of the roots are removed. Compared to option 1, mechanical removal would control common buckthorn before it becomes well established and begins to negatively impact native vegetation. Compared to option 3, this option would not expose surrounding vegetation to herbicides.

Option 3 (mechanical and chemical control) involves applying herbicide to cut stumps. Solutions of 20- 25% glyphosate or triclopyr applied to stems cut late in the growing season (July-September) or during dormancy normally achieves root kill. Some consider application during dormancy to be preferable since this reduces the likelihood of exposing other species to herbicide. Archibold et al. (1997) found that only 6% of common buckthorn stumps treated with glyphosate in winter resprouted. Compared to option 1, chemical control would remove plants that could become a threat to native flora and fauna. Compared to option 2, this method is less labor intensive, requires less soil disturbance, and promises to be more effective.

H. ACTIONS PLANNED

Removal of common buckthorn will begin in 2003. First, common buckthorn trees bearing fruit will be removed using option 3 from July to September. Next, seedlings will be removed by uprooting. Mowing may successfully control common buckthorn seedlings located along the field edge by the farm pond. Removal sites will be inspected in subsequent seasons for resprouts.

I. HOW ACTIONS WILL BE EVALUATED

Actions will be considered successful if common buckthorn is essentially eradicated from the park within 3 years with minimal resprouting from removal areas.

J. RESOURCE NEEDS

Staff time, work gloves, clippers, weed wrench, hand saws, herbicide, herbicide applicator

K. RESULTS OF EVALUATION

GLOSSY BUCKTHORN (*Rhamnus frangula* L.) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Six

B. DESCRIPTION

(Brunelle and Lapin 1996; Catling and Porebski 1994; Vermont DEC 1998)

Glossy buckthorn is a deciduous shrub or small tree that can grow up to 23 feet high. This species has prominent lenticels on brown-green bark, its young twigs are fuzzy, and it lacks thorns. The leaves are simple, 1-3 inches long, alternate or sub-opposite, and have smooth margins. Each leaf has more than five pairs of veins. The small, yellow-green flowers each have five petals and bloom from May through September. The fleshy berry-like drupes are initially red but turn black when mature in August or September. The fruits each contain 2-3 seeds and are dispersed by bird species such as American robins (*Turdus migratorius*), cedar waxwings (*Bombycilla cedrorum*), rose-breasted grosbeaks (*Pheucticus ludovicianus*), and European starlings (*Sturnus vulgaris*)

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 15

D. DAMAGE & THREATS

Currently at SAGA, glossy buckthorn is not impacting native flora or fauna, since all populations are very small and immature.

A study conducted in a riparian zone in Pennsylvania (Possessky et al. 2000) found that the presence of glossy buckthorn was associated with decreased cover of herbaceous species and different assemblages of dominant herbs compared to uninvaded sites. The researchers also state that glossy buckthorn succeeds in roadsides, forest edges and old fields, but is an especially aggressive invader of wetlands. Catling and Porebski (1994) report that glossy buckthorn has been listed second to purple loosestrife in a Canadian survey that ranked invasive species according to the severity of impacts on natural habitats. These authors also believe that glossy buckthorn may become more of a concern than purple loosestrife, since glossy buckthorn has a broader habitat range and does not require habitat disturbance for establishment in marshes, fens, swamps, and mesic forest edges.

E. GOALS

1. Remove all known common buckthorn populations and monitor for new populations

F. OBJECTIVES

1. Remove all known, on-site populations within 2 years.

Possessky, S. L., C. E. Williams, and W. J. Moriarity. 2000. Glossy buckthorn, *Rhamnus frangula* L.: a threat to riparian plant communities of the Northern Allegheny Plateau (USA). *Natural Areas Journal*. **20**: 290-292.

Reinartz, J. A. 1997. Controlling glossy buckthorn (*Rhamnus frangula* L.) with winter herbicide treatments of cut stumps. *Natural Areas Journal*. **17**: 38-41.

Vermont Departments of Environmental Conservation and Fish & Wildlife and The Nature Conservation of Vermont. 1998. Vermont invasive exotic plant fact sheet: common buckthorn and glossy buckthorn. Waterbury, Vermont.

changed the soil properties in the areas it has invaded in northern New Jersey. The soil under barberry had higher pH values and nitrification rates than soils under native species, and these results were replicated in greenhouse experiments by growing barberry and a native shrub in pots of previously uninvaded soils. Kourtev et al (1999) observed higher exotic earthworm concentrations in soils under barberry and raised the concern that changes in soil properties in northern New Jersey caused by Japanese barberry may facilitate the invasion of other exotic species. Additionally, native flora may be inhibited by the high nitrate concentration remaining in the soil even after barberry is removed.

E. GOALS

1. Reduce Japanese barberry cover so it does not impair native species or natural processes

F. OBJECTIVES

1. Reduce percent cover of Japanese barberry by 75% within 5 years.

G. MANAGEMENT OPTIONS

(Information from Brunelle and Lapin 1996; Silander 1999)

Viable options include:

1. No treatment
2. Mechanical removal
3. Combination mechanical and chemical removal

Option 1 (no treatment) would result in no active management of Japanese barberry, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because Japanese barberry is so prevalent at SAGA that even if it were removed in one area, seeds may continue to disperse into the restoration area from seed sources both within and outside the NPS boundary. At this time control outside the park boundary is not a viable option. This option is the least time and resource intensive and leaves habitats undisturbed compared to the other three options.

Option 2 (mechanical control) includes clipping or uprooting plants. No discussions on whether repeatedly cutting barberry to the ground is a potentially successful control option were found; this could be because it is known to be unsuccessful or because it has not been attempted. Uprooting with a hoe or weed wrench can be very effective, and the removed bushes can be left behind as shelter for animals as long as care is taken to not place the roots directly on the soil. This can be done in early spring, since Japanese barberry is one of the first shrubs to leaf out and so can be easily spotted. However, special care must be taken not to trample spring ephemerals. This option is preferable to option 1 because scientific studies clearly indicate that Japanese barberry changes natural processes; therefore, action should be taken to remove it. Compared to option 3, there is the advantage of not risking non-target herbicide exposure.

Option 3 (mechanical and chemical control) requires clipping bushes near the base and applying herbicide to the stump. Silander recommends cutting Japanese barberry to the ground in May and then returning in early July to spot treat any resprouting stems with an unspecified (possibly full-strength) concentration of glyphosate. This method achieves control of an invasive species with

JAPANESE TREE LILAC (*Syringa reticulata* (Blume) Hara) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Eleven

B. DESCRIPTION

(Information from The Ohio State University)

Japanese tree lilac is a deciduous large shrub or small tree that reaches about 25 feet tall. It has a "medium growth rate." It grows best in full sunlight, but can adapt to many soil types and does well in poor soils. Like other members of the olive family, it suffers from few diseases or pests. The gray or yellow bark strongly resembles cherry since it is smooth with prominent lenticels in young individuals, but then becomes fissured with age. The stems are hollow. The leaves are simple, opposite, oval-shaped, and pointed at the tip. The white or yellow, fragrant flowers bloom in early June and are arranged in large inflorescences positioned at the tops of mature shrubs. The fruits are brown capsules that mature in fall.

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 7

D. DAMAGE & THREATS

A row of Japanese tree lilac was planted in the historic garden around 1900 between Aspet (the home of Augustus Saint-Gaudens) and Saint-Gaudens Road. The ornamental shrub has since spread across the road and is now well established in the forest. The seedlings of this species form a dense shrub layer that appears to be crowding out native vegetation. A few individuals are also found elsewhere in the park.

No papers or reports could be found addressing the threats that dense populations of this species may pose to natural areas. Various lists of invasive species produced by government agencies and non-profit organizations do not include Japanese tree lilac. This species was mapped because it appears to be displacing native flora at SAGA, not because it has been observed to negatively impact native species in other natural areas.

E. GOALS

1. Contain Japanese tree lilac within regions where it is already well established
2. Reduce the cover of lilac so it does not impair native species or natural processes

F. OBJECTIVES

1. Remove all lilac from regions distant (more than approximately 100 m) from formal gardens
2. Reduce percent cover of lilac in regions by formal gardens by 80% within 10 years
3. Remove seed-producing individuals from all areas other than those cultivated as part of the historic cultural landscape.

H. ACTIONS PLANNED

Since this species is currently ranked as the lowest priority in the park, control of Japanese tree lilac will not begin until the control plans for the other species are begun. Small, isolated populations by the BMU and BMD Brooks should be removed first, followed by adult, fruit-bearing individuals by Saint-Gaudens Road. Control of these individuals could begin as early as 2004. Seedlings should be carefully uprooted. Control option 3 should be used on larger shrubs and trees if volunteers are unavailable, since this is the least time intensive control method. Otherwise, testing the effectiveness of repeated clippings (option 2) would be preferable if park resources allow for the required monitoring in subsequent seasons. Next, removal of the dense patches of immature lilac shrubs by Saint-Gaudens Road could be attempted. Option 4 may be preferable, since these areas may become nearly bare of vegetation once the lilac shrubs are removed. Whether these shrubs should be initially removed using option 2 or 3 should depend on which seemed more effective during previous control efforts.

I. HOW ACTIONS WILL BE EVALUATED

Actions will be considered successful if Japanese tree lilac is contained near the formal gardens where it is maintained as an uncommon species. Control methods should be selected so that they minimize the use of herbicides, soil disturbance, and human trampling in natural areas.

J. RESOURCE NEEDS

Staff time, volunteers trained to identify Japanese tree lilac, work gloves, clippers, weed wrench, hand saws, herbicide, herbicide applicator, native shrubs ready to plant, a place to store clipped shrubs, considerable time commitment

K. RESULTS OF EVALUATION

L. REFERENCES

The Ohio State University. *Syringa reticulata*: Japanese tree lilac. Accessed on 1/11/02.
[available at http://www.hcs.ohio-state.edu/pocketgardener/description/sy_ulata.html]

fecundity of three native annual herbs. Another study in Illinois (Schmidt and Whelan 1999) found that American robins had higher daily nest mortality rates when nesting in *L. maackii* than native shrubs and trees.

E. GOALS

3. Contain honeysuckle within regions where it is already well established
4. Reduce the cover of honeysuckle so it does not impair native species or natural processes

F. OBJECTIVES

4. Reduce the percent cover of honeysuckle in regions east of the BMD Trail by 90% within 5 years
5. Reduce the percent cover of honeysuckle in regions west of the BMD Trail and surrounding the BMD Pond by 50% within 10 years

G. MANAGEMENT OPTIONS

(Information on control from Batcher and Stiles 2000)

Viable control options include:

8. No treatment
9. Mechanical removal
10. Combination mechanical and chemical removal
11. Removal and revegetation

Option 1 (no treatment) would result in no active management of morrow honeysuckle, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because morrow honeysuckle is so abundant that if it were removed in a region, seeds would continue to disperse into the restoration area from seed sources both within and outside the NPS boundary. At this time control outside the park boundary is not a viable option. Also, where it is already well established, honeysuckle may not be spreading. However, disturbing vegetation and soils by removing honeysuckle may aid germination and allow it to spread farther. This option is the least time and resource intensive and leaves habitats undisturbed compared to the other three options. Considering the abundance of this species and the limited resources of SAGA, this option will be used out of necessity for some populations within SAGA for the next several years.

Option 2 (mechanical control) involves removing honeysuckle by either clipping stems to the ground or uprooting the entire plant. Both methods can be labor intensive, because the former requires continuous reclipping of resprouts, and the latter option requires removal of all roots to be effective. If clipping is selected, removal should not be attempted during the winter since this encourages vigorous resprouting. If the shrubs grow in shaded environments, clipping once a year may be effective, while in open environments clipping is required every year once in early spring and again in late summer. Removed plants should be either taken to another location or placed upside down so that the roots will not reestablish. Compared to option 1, by reducing honeysuckle density, negative effects on native flora and fauna will be decreased. Compared to option 3, there is no risk of exposing native vegetation to herbicides.

K. RESULTS OF EVALUATION

L. REFERENCES

- Batcher, M. S., and S. A. Stiles. 2000. Element stewardship abstract for the bush honeysuckles. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.
- Gleason, H. A., and A. Cronquist. 1991. Manual of vascular plants of Northeastern United States and adjacent Canada. Second edition. The New York Botanical Garden, New York.
- Gould, A. M., and D. L. Gorchov. 2000. Effects of the exotic invasive shrub *Lonicera maackii* on the survival and fecundity of three species of native annuals. *American Midland Naturalist*. **144**: 36-50.
- Mehrhoff, L. 2001. The non-native honeysuckles occurring without cultivation in Connecticut. [available at <http://www.eeb.uconn.edu/collections/herbarium/herbariumother/lonicera.html>]
- Schmidt, K. A., and C. J. Whelan. 1999. Effects of exotic *Lonicera* and *Rhamnus* on songbird nest predation. *Conservation Biology*. **13**: 1502-1506.
- Woods, K. D. 1993. Effects of invasion by *Lonicera tatarica* L. on herbs and tree seedling in four New England forests. *American Midland Naturalist*. **130**: 62-74.

G. MANAGEMENT OPTIONS

(Information from Eckardt 1987; Wisconsin DNR 1999)

Viable control options include:

15. No treatment
16. Mechanical control
17. Combination mechanical and chemical control
18. Chemical control

Option 1 (no treatment) would result in no active management of multiflora rose, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because multiflora rose currently does not seem to be negatively impacting native communities at SAGA. Compared to the other options, this option is the least time and resource intensive and leaves habitats undisturbed.

Option 2 (mechanical control) may include mowing, clipping, or uprooting shrubs. Mowing can be effective where grass cover is dense, although mowing several times a year (6 times a year for 2 years) may be required to control seedlings. If shrubs have already reached their mature size, clipping will be required before mowing. Caution must be used when mowing, because multiflora rose thorns have been known to puncture rubber tires. Clipping alone frequently proves ineffective, since roses resprout vigorously. Scattered populations can be effectively controlled by digging if all roots are carefully removed. Checking for resprouts after any form of mechanical control will be necessary for several seasons. Compared to option 1, mechanical removal would control multiflora rose before it becomes well established and begins to negatively impact native vegetation. Compared to options 3 and 4, this option would not expose surrounding vegetation to herbicides.

Option 3 (mechanical and chemical control) involves cut-stump applications of herbicide. Solutions of 10-20% glyphosate or triclopyr applied to stems cut late in the growing season (July-September) or during dormancy can achieve control. Some consider application during dormancy to be preferable since this reduces the likelihood of exposing other species to herbicide. Triclopyr must be applied within a few hours of cutting. Compared to option 1, chemical control would remove plants that could become a threat to native flora and fauna. Compared to option 2, this method is less labor intensive, requires less soil disturbance, and promises to be more effective. Compared to option 4, cut-stump herbicide applications generally involve much less non-target chemical exposure than foliar sprays.

Option 4 (chemical control) requires foliar applications of herbicide. A foliar spray of 2% fosamine is effective from July through September, although dieback may not be apparent until the following summer. Fosamine is a preferred foliar herbicide because it is non-volatile and only damages woody species; however, foliar sprays should not be used in undisturbed natural areas. This method is an effective means of controlling multiflora rose, and is less labor intensive than options 2 or 3.

H. ACTIONS PLANNED

Removal of all multiflora populations within SAGA will be attempted in 2002. First, small, immature populations (found predominately near the BMU brook) should be removing by

NORWAY MAPLE (*Acer platanoides* L.) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Nine

B. DESCRIPTION

(Information from Grimm 1983)

Norway maple is a deciduous tree that commonly reaches a mature height of 40-60 feet. Its bark is dark gray and has shallow fissures and narrow ridges. The leaves are like other common members of the maple family: simple, lobed, and oppositely arranged. Norway maple leaves closely resemble sugar maple (*Acer saccharum* Marsh.) since both are five-lobed and sparingly toothed. However, Norway maple can be distinguished by having larger leaves (4-7 inches long compared to sugar maple's 3-5 inches) that are darker green and exude a milky sap when petioles are detached from branches. The petioles are 3-4 inches long. Norway maples are particularly easy to spot in the late fall, because they hold their leaves about two weeks longer than native maples. The yellow-green flowers are inconspicuous and bloom in spring about when the leaves appear. The fruits are typical winged samaras of the maple family; they are 2 inches long and mature in early autumn. They are wind dispersed.

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 6.

D. DAMAGE & THREATS

Norway maples are found only in the southern half of the park, but they may be spreading north. There is a particularly large Norway maple by the historic mill that could be the seed source of the other Norway maples. It is possible that they are displacing native trees such as sugar maples, but there is no quantitative data available to support this hypothesis.

Norway maples are popular ornamental trees because they grow rapidly, are tolerant of shade and pollution, and are highly resistant to pests and diseases (Grimm 1983). These same characteristics can allow this species to be a successful invader. The dominance of Norway maple was examined in a forest preserve in New Jersey where Norway maple was introduced 30-50 years after pasture abandonment in the last quarter of the 19th century (Webb and Kaunzinger 1993). A survey of trees found that Norway maple was the second most abundant, the fourth most dominant, and had the highest density of saplings and seedlings. Norway maple was also present at this site with a greater density, dominance, and number of saplings and seedlings than sugar maple; however, this could be because sugar maple colonized this site later than Norway maple. Another study near Ithaca, New York, (Martin 1999) found that although sugar maples at this site were older than Norway maples, which were apparently introduced later, the Norway maples were the most prominent tree species. The researcher also found that the average sapling species richness was lower under stands of Norway versus sugar maple, and that while Norway maples saplings were commonly found under sugar maples (57% of the time), no sugar maple sapling were found under Norway maples, and similar results were found for Norway and sugar

H. ACTIONS PLANNED

Removal of large Norway maple trees using option 2 will begin in 2002. It would be preferable to cut down mature Norway maples in spring or early summer before they produce mature seeds. Removal of Norway maple seedlings using option 2 will continue in subsequent seasons until they become a rare member of the understory.

I. HOW ACTIONS WILL BE EVALUATED

Actions will be considered successful if Norway maple is maintained as an uncommon species within the park. If vigorous resprouting occurs in areas where Norway maple was removed using option 2, option 3 may need to be tried.

J. RESOURCE NEEDS

Staff time, volunteers trained to identify Norway maple, weed wrench, hand saws, considerable time commitment

K. RESULTS OF EVALUATION

L. REFERENCES

- Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. *New England Wild Flower*. 2: 19-26.
- Grimm, W. C. 1983. *The illustrated book of trees*. Stackpole Books. Harrisburg, PA.
- Martin, P. H. 1999. Norway maple (*Acer platanoides*) invasion of a natural forest stand: understory consequence and regeneration pattern. *Biological invasions*. 1: 215-222.
- Webb, S. L., and C. K. Kaunzinger. 1993. Biological invasion of the Drew University (New Jersey) Forest Preserve by Norway maple. *Bulletin of the Torrey Botanical Club*. 120: 343-349.

vines, and decreased the overall plant species diversity. Another study in eastern Pennsylvania found that oriental bittersweet can be highly tolerant of shade for long periods and then grow rapidly if exposed to more sunlight, and it succeeds primarily in forest edges, old fields, thickets, and open woods (Robertson 1994). Dreyer (1994) reports that oriental bittersweet has been found to hybridize with American bittersweet, which may threaten the genetic integrity of this relatively rare native species.

E. GOALS

2. Remove all properly identified oriental bittersweet populations and monitor for new populations

F. OBJECTIVES

2. Remove all known, on-site populations within 4 years.

G. MANAGEMENT OPTIONS

(Information from Dreyer, 1994)

Viable control options include:

22. No treatment
23. Mechanical control
24. Combination mechanical and chemical control

Option 1 (no treatment) would result in no active management of oriental bittersweet, although subsequent monitoring and mapping efforts will be conducted. This alternative is considered because oriental bittersweet currently does not seem to have a significant impact on native communities at SAGA. Also, since this species cannot be differentiated from American bittersweet until it produces flowers, immature *Celastrus* vines will have to remain untreated until properly identified. Compared to the other options, this option is the least time and resource intensive and leaves habitats undisturbed.

Option 2 (mechanical control) may include mowing, clipping, or uprooting vines. Mowing only achieves control if repeated weekly. Clipping is generally ineffective because the cut vines resprout vigorously. Uprooting small individuals can be effective if care is taken to remove all roots. Subsequent monitoring for resprouts will be necessary. For small populations, this option can achieve control of a potentially highly invasive species without the use of herbicides.

Option 3 (mechanical and chemical control) involves clipping oriental bittersweet and then applying herbicides. Dreyer (1994) reports that the most effective method of control is to first clip vines to the ground in spring or early summer. A month later, spray resprouts with a 1-2% solution of triclopyr. Alternatively, if vines are particularly large, cutting and treating the stump immediately with a high concentration solution of triclopyr or glyphosate can be effective. For both methods, treatment sites will need to be checked for resprouts later in the season or the following year. Option 3 is the most effective means of controlling large patches of oriental bittersweet that otherwise may overtop and smother native vegetation.

WINGED BURNING BUSH (*Euonymus alatus* [Thunb.] Siebold) CONTROL PLAN

Updated:

January 2002

A. PRIORITY

Seven

B. DESCRIPTION

(Information from Gleason and Cronquist 1991; Virginia NHP; Morisawa 2000)

Winged burning bush is a deciduous shrub that can grow up to 20 feet tall. It is easily distinguished by the presence of 2-4 corky wings running along the sides of branches. The leaves are simple, opposite, elliptical, 1-3 inches long, and 0.5-1 inches wide with serrated edges. The foliage turns bright red in fall, which has made this species a popular ornamental plant. The very small greenish-yellow flowers have four petals and bloom from May to June. The smooth purplish fruits each contain approximately 4 seeds and mature in September or October. The fruits are eaten and dispersed by birds.

C. CURRENT ON-SITE DISTRIBUTION

Shown in Figure 14.

D. DAMAGE & THREATS

The one winged burning bush present at SAGA is currently not impacting the park's natural systems. However, since birds help disperse this species, allowing a seed source to persist may help this exotic shrub invade other areas of the park.

Winged burning bush has been the subject of very little research. The Virginia Natural Heritage Program believes it has potential to become a particularly troublesome invasive species because it is highly tolerant of full shade, popularly used as an ornamental plant, adaptable to many soil types, and it produces large quantities of bird-dispersed fruits. Clark et al. (1998) report that winged burning bush does not spread as rapidly as other invasive plants, but the combination of its dense foliage and root system can effectively crowd out other vegetation.

E. GOALS

2. Remove all known winged burning bush populations and monitor for new populations.

F. OBJECTIVES

1. Remove all known, on-site populations within 2 years.

G. MANAGEMENT OPTIONS

(Information from Morisawa 2000)

Viable control options include:

25. No treatment
26. Mechanical control
27. Combination mechanical and chemical control

Morisawa, T. 2000. Weed alert! *Euonymus alatus* (Thunb.) Siebold. The Nature Conservancy. Wildland Invasive Species Program. Arlington, VA. [available at <http://tncweeds.usdavis.edu/alert/alrteuon.html>]

Virginia Native Plant Society and the Virginia Natural Heritage Program. Invasive alien plant species of Virginia: winged burning bush (*Euonymus alatus* (Thunb.) Siebold). Richmond, VA. Accessed on 1/11/02. [available at <http://www.vnps.org/invasive/invfseual.htm>]

because yellow flag iris may not be negatively impacting the natural communities at BMD Pond and is an aesthetically pleasing plant. Compared to the other options, this option is the least time and resource intensive and leaves habitats undisturbed.

Option 2 (mechanical control) includes clipping and uprooting plants. Since yellow flag iris spreads by rhizomes, clipping is unlikely to be successful. Clark et al. (1998) recommend uprooting as the best means of control. Care should be taken to remove as much of the root as possible. Controlling yellow flag iris may be desirable because they occupy habitat that could be populated by native irises, which are as aesthetically pleasing as the exotic irises. This option is less labor intensive than option 4 and does not risk exposing wetlands to herbicide like option 3.

Option 3 (chemical control) includes spraying or painting the exotic irises with herbicide. This option could provide effective control of an exotic plant in a manner that is less labor intensive and involves less soil disturbance than options 2 or 4. However, chemical control is not the recommended method to control this species, and spraying herbicides directly in wetland habitat is not sensible.

Option 4 (removal and revegetation) involves eliminating yellow flag iris by uprooting and then planting native vegetation (such as irises or cattails) in the areas where the exotic iris was removed. Compared to the other options, revegetation is the most time consuming. However, this option may provide the best control of yellow flag iris. If native vegetation is established, then the exotic iris may have a more difficult time trying to reinfest areas where it was removed.

H. ACTIONS PLANNED

Removal of all yellow flag iris populations will be attempted in June and July of 2002. When the plants are in full bloom and can be easily identified, they will be uprooted and removed to another location. Ideally, native vegetation should be planted in the removal areas. It will be necessary to monitor for resprouts in subsequent summers.

I. HOW ACTIONS WILL BE EVALUATED

Actions will be deemed successful if all known yellow flag iris populations are essentially eradicated from the park within 3 years with little resprouting from the removal areas. If resprouting allows yellow flag iris to reinfest BMD Pond, chemical control may be considered. Alternatively, waiting until scientific studies elucidate whether/how this species is a threat to wetlands may be appropriate before attempting chemical control.

J. RESOURCE NEEDS

Staff time, volunteers trained to identify yellow flag iris, work gloves, shovels

K. RESULTS OF EVALUATION

L. REFERENCES

- Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. *New England Wild Flower*. 2: 19-26.
- Gleason, H. A., and A. Cronquist. 1991. *Manual of vascular plants of Northeastern United States and adjacent Canada*. Second edition. The New York Botanical Garden, New York.

APPENDIX D: INVASIVE PLANTS NOT CURRENTLY FOUND AT SAGA

Species commonly invasive in New Hampshire and Vermont

Common reed (*Phragmites australis* (Cav.) Trin.)

Vegetative features: Common reed is an herbaceous perennial grass species that can reach 15 feet in height, although its stems are more commonly 8-10 feet high. These vertical stems arise from horizontal stems that spread above or below the ground. The leaves reach up to 2 feet long and fall off in autumn. The stems remain standing in early winter.

Reproductive features: This species spreads primarily by underground rhizomes or aboveground stolons to form colonies, although viable seeds are sometimes produced. The large feathery clusters of flowers that top the stems are a distinguishing characteristic. These purplish-brown clusters first appear in late July, but turn gray in August when the seeds are mature.

Habitat: Common reeds are found in wetlands, roadside ditches, and virtually any area with standing water. It thrives in sunny areas and can tolerate a wide pH range as well as both fresh and brackish water, but this species cannot withstand running water since the stems break easily. Human disturbance favors establishment since it succeeds in disturbed or polluted soils.

Threats: If left uncontrolled, this species forms monospecific stands similar to purple loosestrife. This species may be native, but an invasive strain may have been introduced around 1900.

References:

Clark, F. H., C. Matlack, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. *New England Wild Flower*. 2: 19-26.

LaFleur, A. 1996. Invasive plant information sheet: common reed. The Nature Conservancy of Connecticut. Middletown, CT.

Vermont Departments of Environmental Conservation and Fish & Wildlife and The Nature Conservancy of Vermont. 1998. Vermont invasive exotic plant fact sheet: giant or common reed. Waterbury, Vermont.

Eurasian watermilfoil (*Myriophyllum spicatum* L.) and variable watermilfoil (*M. heterophyllum* Michx.)

Vegetative features: Both are rooted, perennial aquatic plants with feather-like submerged leaves. The leaves of Eurasian watermilfoil are arranged in whorls of four, and each leaf has 12-21 pairs of leaflets. The stems are reddish and toward the tips branch extensively to form dense mats. The submerged leaves of variable-leaved watermilfoil are arranged in whorls of 4-6, and each leaf has 7-11 pairs of leaflets. This species also has blade-like surface leaves with toothed margins.

Reproductive features: Both species have tiny flowers arranged in spikes that are wind pollinated. Both can spread by seed but more frequently multiply by vegetative fragments.

References:

Brunelle, H. J. 1996. Invasive plant information sheet: garlic mustard. The Nature Conservancy of Connecticut. Middletown, CT.

Mattrick, C. 1998. Garlic Mustard: *Alliaria petiolata*. New England Wild Flower. 2: 13-14.

Nuzzo, V. 2001. Element stewardship abstract for *Alliaria petiolata* (*Alliaria officinalis*) Garlic Mustard. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.

Japanese honeysuckle (*Lonicera japonica* Thunb.)

Vegetative features: Japanese honeysuckle is a trailing or twining woody vine that can grow up to 30 feet in length. Older stems have hollow piths and brown bark that can peel off in long strips. The simple, semi-evergreen, opposite leaves are 1½-3 inches long and oval or oblong in shape. This species can easily be distinguished from native honeysuckle vines, which have united leaves at the ends of the vines, while Japanese honeysuckle leaves are all separate.

Reproductive features: The fragrant, tubular, two-lipped flowers are arranged in pairs in the axils of young branches. Each flower is 1-2 inches long and initially white with a purple or pink tinge, but may fade to yellow with age. Flowers appear in late May and continue to bloom throughout the summer. Many seeds are contained in each of the fruits, which are black berries that mature from September through November. Native honeysuckle vines have red or orange fruits. Japanese honeysuckle can also spread vegetatively by runners that root when they contact the soil.

Habitat: This species is mostly found in disturbed habitats like roadsides, trails, fencerows, fields, and forest edges. Japanese honeysuckle can also invade natural communities after a disturbance such as logging, floods, storms, or a disease outbreak.

Threats: With sufficient light, Japanese honeysuckle can grow and spread rapidly to overtop and smother ground cover or strangle trees and shrubs. It can persist in shade and spread later if the canopy opens up due to a disturbance.

References:

Brunelle, H. J. 1997. Invasive plant information sheet: Japanese honeysuckle. The Nature Conservancy of Connecticut. Middletown, CT.

Nuzzo, V. 1997. Element stewardship abstract for *Lonicera japonica*, Japanese honeysuckle. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.

Williams, C. E. 1994. Invasive alien plant species of Virginia: Japanese honeysuckle (*Lonicera japonica* Thunberg). Virginia Department of Conservation and Recreation and The Virginia Native Plant Society. Richmond, Virginia.

References:

- Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. New England Wild Flower. 2: 19-26.
- Vermont Departments of Environmental Conservation and Fish & Wildlife and The Nature Conservancy of Vermont. 1998. Vermont invasive exotic plant fact sheet: Water chestnut. Waterbury, Vermont.
- Vermont Department of Environmental Conservation Water Quality Division. 2001. Aquatic nuisance species: water chestnut. Waterbury, Vermont. [available at: <http://www.anr.state.vt.us/dec/waterq/ans/wcpage.htm>]

Species not yet common in northern New England

Japanese stilt grass (*Microstegium vimineum* (Trin.) A. Camus)

Vegetative features: This annual grass species reaches about 20-24 inches in height. The stems are generally branched, smooth, and hairless. The leaves are 2-3 inches long, tapered at both ends, and have a silvery stripe of reflective hairs along the middle of the upper leaf surface. The membranous ligules are ½-2 mm long. The species has a purplish tinge in the fall.

Reproductive features: The flowers develop in late August in clusters at the tip of long stalks. Seeds mature and are released from late September to early November.

Habitat: Japanese stilt grass prefers moist and shady habitats and is found in riparian zones, floodplains, swamps, roadsides, and woodland thickets. It spreads particularly rapidly in disturbed areas and has not yet reached northern New England.

Threats: This species can spread rapidly to form monotypic stands and displace native herbs.

References:

- Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. New England Wild Flower. 2: 19-26.
- LaFleur, A. 1996. Invasive plant information sheet: garlic mustard. The Nature Conservancy of Connecticut. Middletown, CT.
- Tu, M. 2001. Element stewardship abstract for *Microstegium vimineum*. The Nature Conservancy. Natural Heritage Databases. Arlington, Virginia.

Mile-a-minute (*Polygonum perfoliatum* L.)

Vegetative features: This annual vine can reach 15 feet in height. The simple, alternate blue-green leaves are 1-3 inches wide and triangular. Both the stems and the midribs of leaves have recurved spines. The leaves have a distinctive saucer-shaped sheath at the base of each leaf.

Reproductive features: The berry-like fruits are blue, fleshy, and about pea-sized. Each contains a single seed that can remain viable for five years in the soil. The fruits are dispersed by birds and can also float downstream.

Habitat: Mile-a-minute is most successful growing in direct sunlight and damp soil. It is generally found in roadsides, ditches, stream banks, and wet meadows.

Tree-of-Heaven (*Ailanthus altissima* (Miller) Swingle)

Vegetative features: This medium-sized tree reaches 50-75 feet tall when mature. The trunk has gray, smooth bark and a diameter of 2-3 feet. Because of its long, compound leaves, tree-of-heaven resembles walnut, sumac and elderberry. However this species has an unpleasant smell that is emitted when the staminate trees are in bloom or the leaves are crushed. This smell is described to resemble "burnt peanut butter," and is also faintly released from the twigs. The alternately arranged leaves are 1½-3 feet long and odd-pinnate with 11-25 leaflets. The leaflets are 2-6 inches long and 1-2 inches wide with entire edges (except for 1-3 teeth near the base), short stalks, unequal bases, and tapered tips.

Reproductive features: This species spreads both by suckers (thereby forming dense colonies) and by seeds. Each seed is centrally located in a papery, winged sheath. These fruits are reddish or yellowish-green, 1½ long, and arranged in large clusters. Since the fruits are slightly twisted, they twirl as they fall to the ground.

Habitat: Tree-of-heaven is commonly found in urban areas, roadsides, fields, and meadows. It is resistant to disease and most pests and highly tolerant of poor soils and pollution.

Threats: This species grows and spreads quickly, allowing it to invade forested areas disturbed by storms, insect infestations, etc. Tree-of-heaven also produces chemical compounds that can kill competing native vegetation.

References:

Clark, F. H., C. Mattrick, and S. Shonbrun. 1998. Rogues gallery: New England's notable invasives. *New England Wild Flower*. 2: 19-26.

Grimm, W. C. 1983. *The illustrated book of trees*. Stackpole Books. Harrisburg, PA.

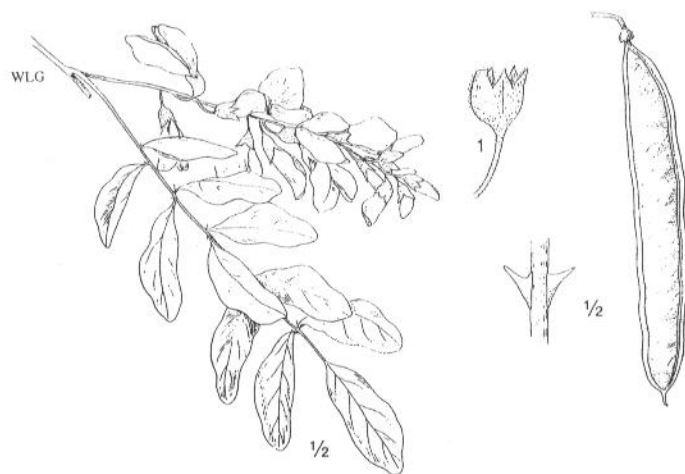
Virginia Department of Conservation and Recreation and The Virginia Native Plant Society. 1994. *Invasive alien plant species of Virginia: tree-of-Heaven*. Richmond, Virginia.

APPENDIX E: INVASIVE PLANT SPECIES PICTURES

Autumn Olive (*Elaeagnus umbellata* Thunb.)



Black Locust (*Robinia pseudoacacia* L.)



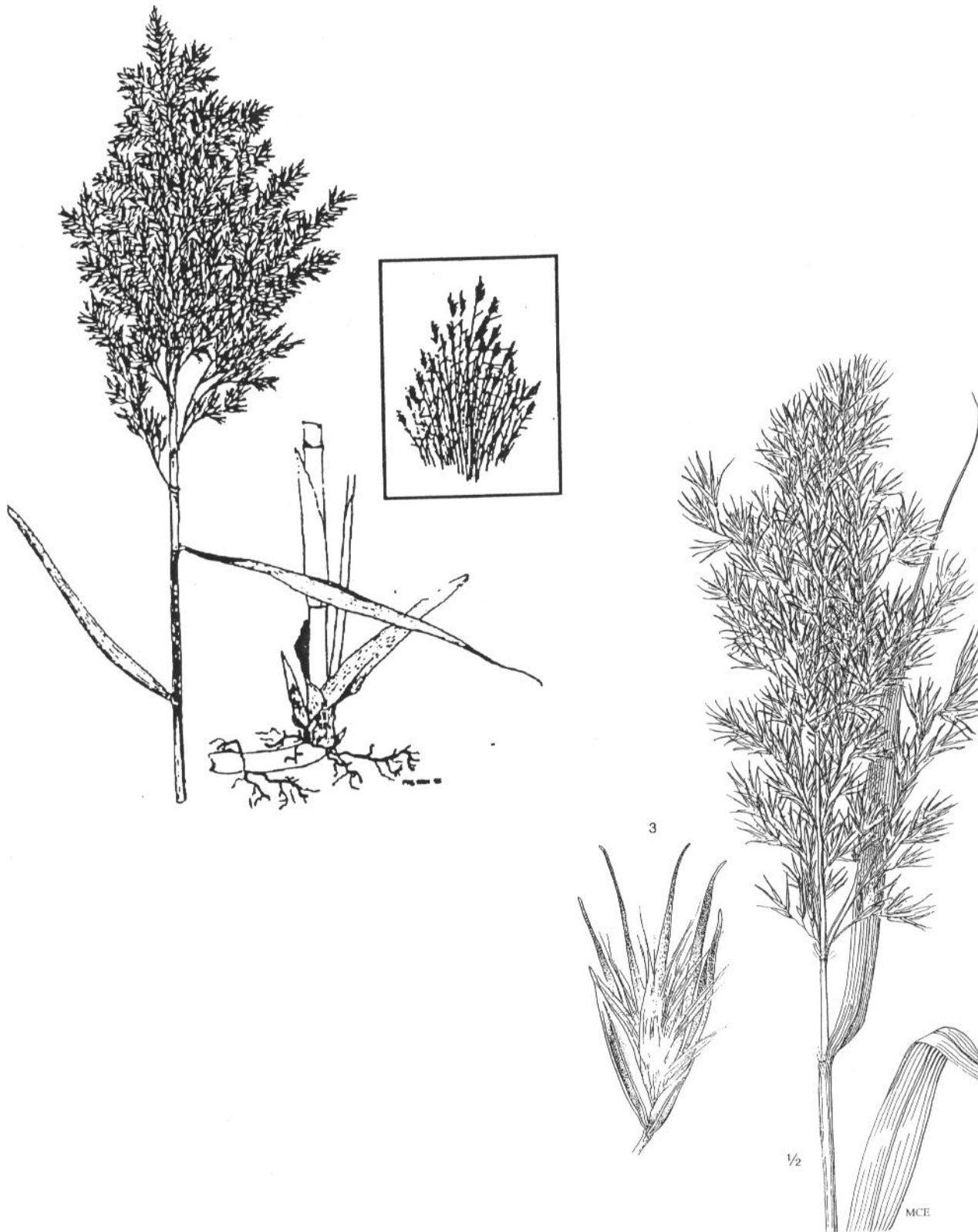
Black Swallow-wort (*Vincetoxicum nigrum* (L.) Moench)



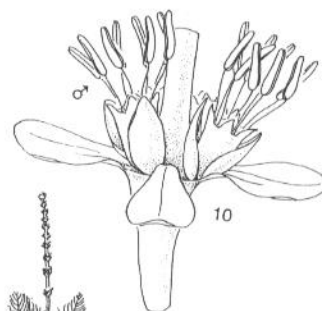
Common Buckthorn (*Rhamnus cathartica* L.)



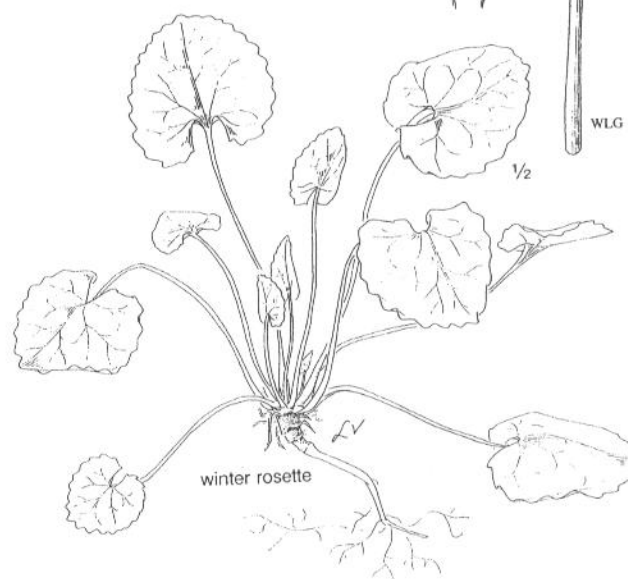
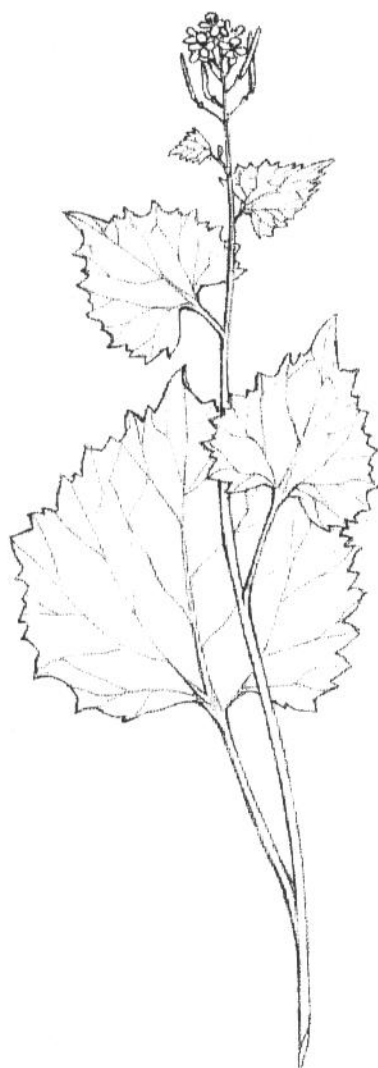
Common Reed (*Phragmites australis* (Cav.) Trin.)



Eurasian Watermilfoil (*Myriophyllum spicatum* L.)



Garlic Mustard (*Alliaria petiolata* (Bieb.) Cavara & Grande)



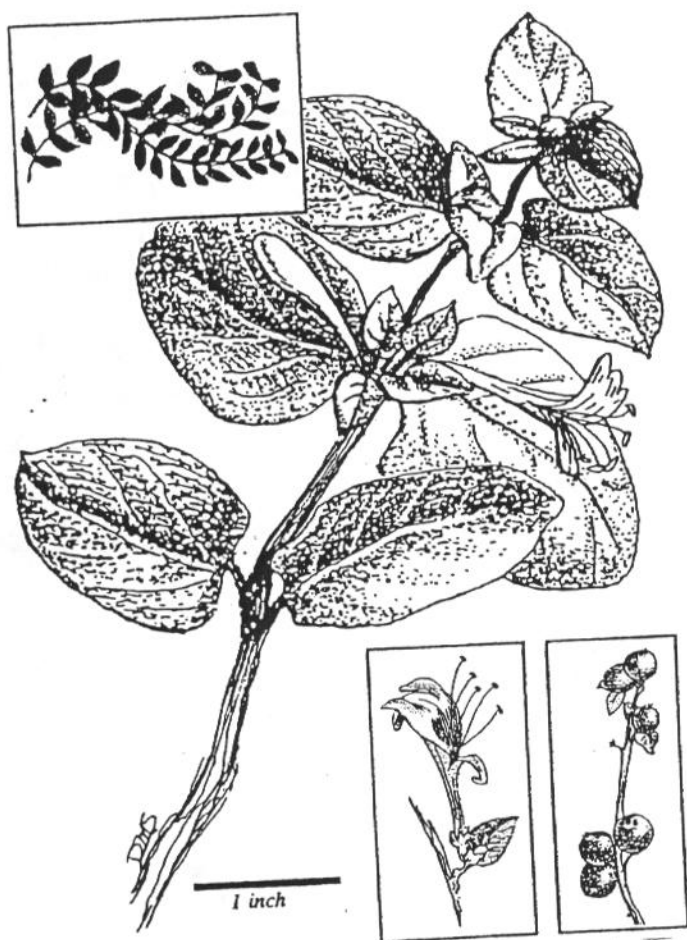
Glossy Buckthorn (*Rhamnus frangula* L.)



Japanese Barberry (*Berberis thunbergii* DC)



Japanese Honeysuckle (*Lonicera japonica* Thunb.)



Japanese Knotweed (*Polygonum cuspidatum* Sieb. & Zucc.)



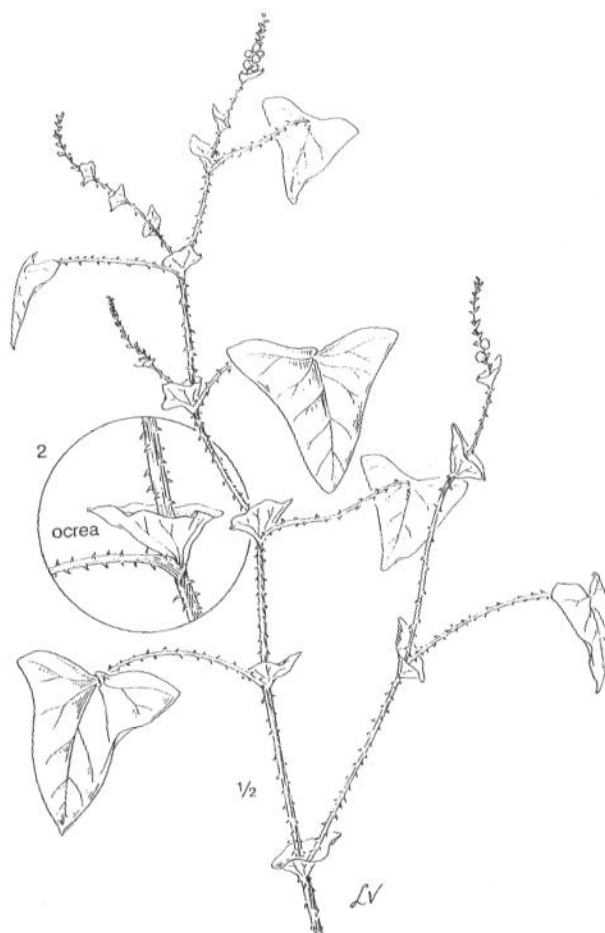
Inset shows flower



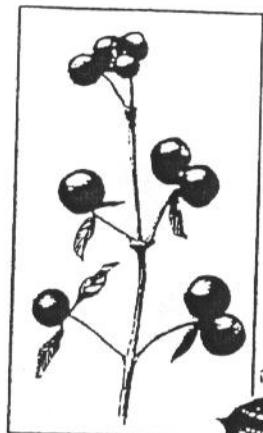
Japanese Stilt Grass (*Microstegium vimineum* (Trin.) A. Camus)



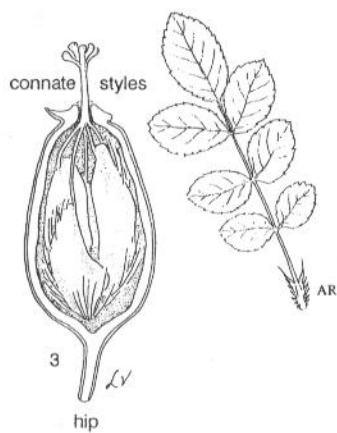
Mile-A-Minute (*Polygonum perfoliatum* L.)



Morrow Honeysuckle (*Lonicera morrowii* A. Gray)



Multiflora Rose (*Rosa multiflora* Thunb.)



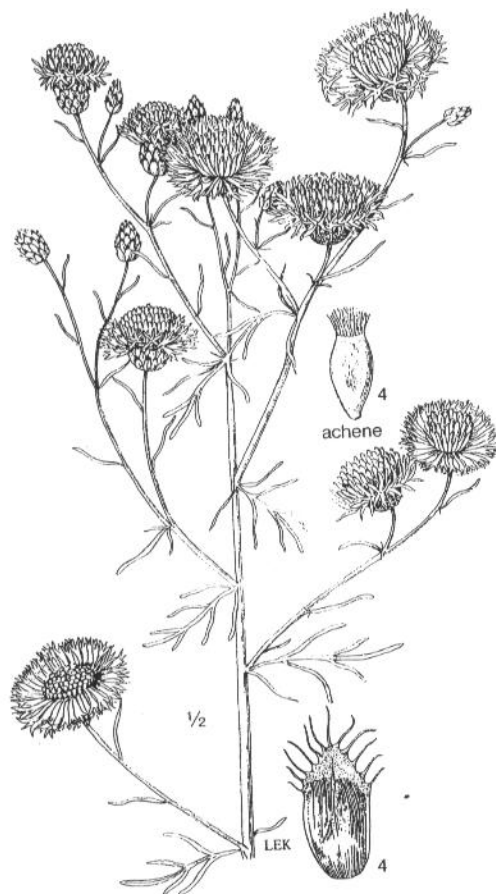
Norway Maple (*Acer platanoides* L.)



Oriental Bittersweet (*Celastrus orbiculatus* Thunb.)



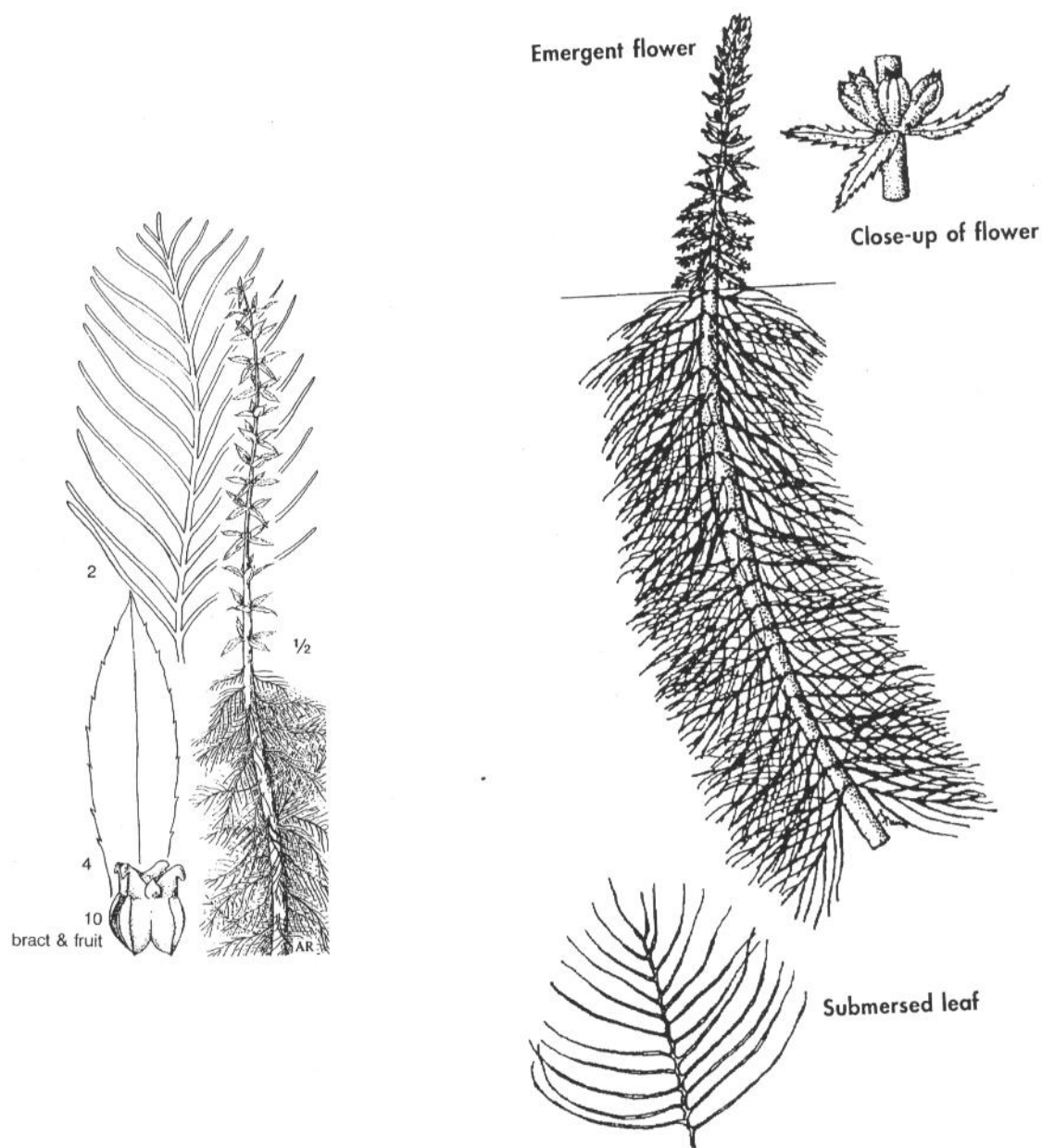
Spotted Knapweed (*Centaurea maculosa* Lam.)



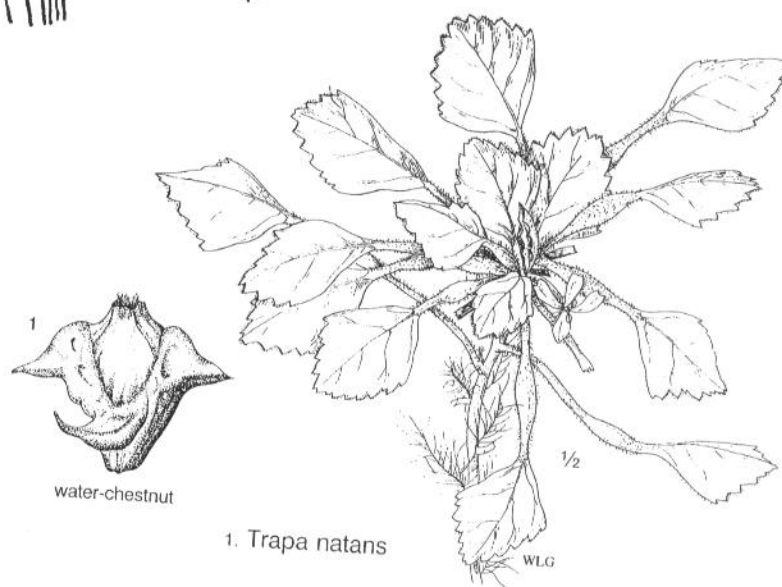
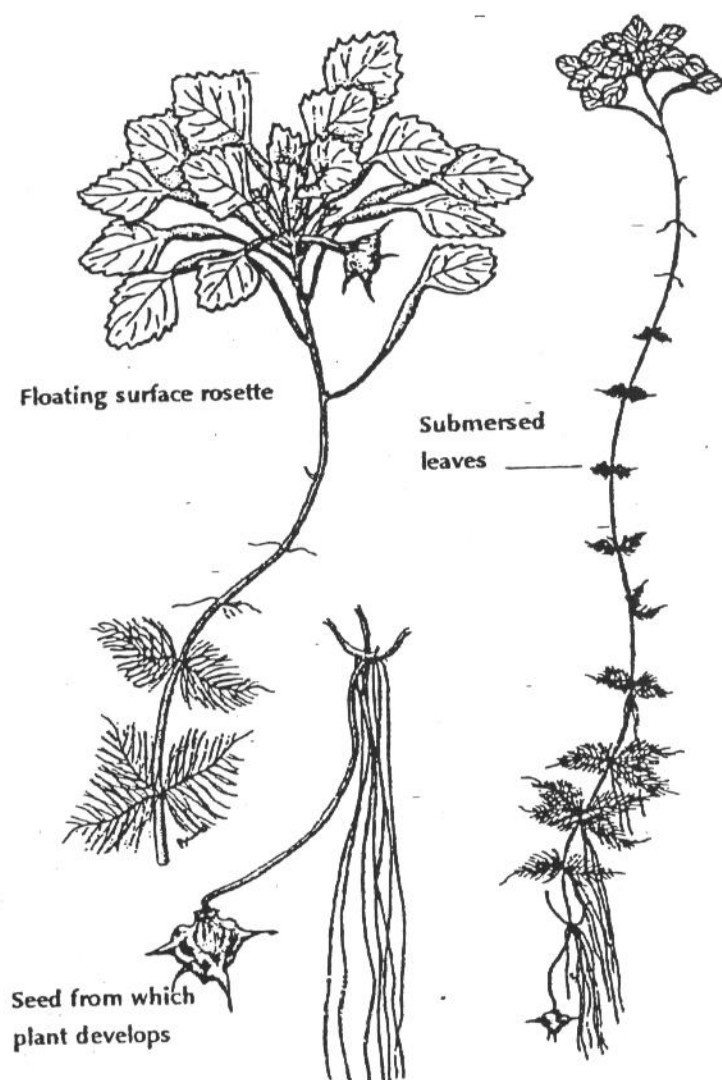
Tree-of-Heaven (*Ailanthus altissima* (Miller) Swingle)



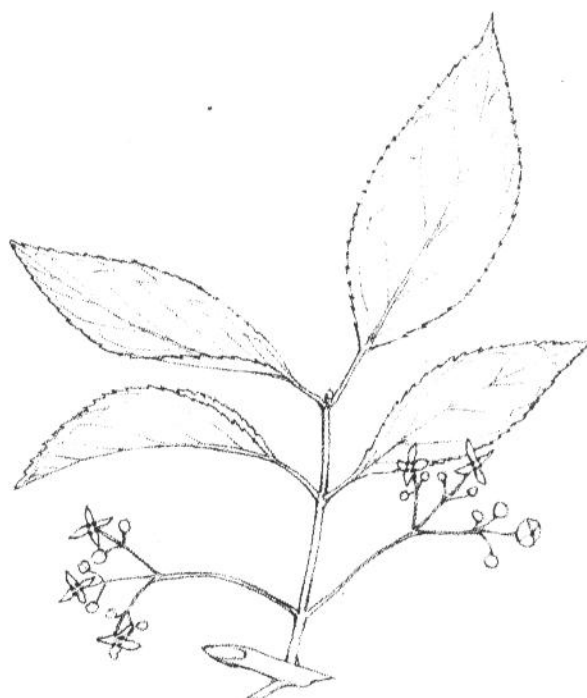
Variable Watermilfoil (*Myriophyllum heterophyllum* Michx.)



Water Chestnut (*Trapa natans* L.)



Winged Burning Bush (*Euonymus alatus* [Thunb.] Siebold)



Yellow Flag Iris (*Iris pseudacorus* L.)



APPENDIX F: Suggested Timetables

Suggested Work Plan for 2002

Species	May	June	July	August	September	October
Autumn olive				Remove populations		Check for resprouts
Black locust				Remove populations	Remove populations	Check for resprouts
Black swallow-wort		Remove isolated populations	Remove larger populations Clip forest edge population by farm pond			
Common buckthorn					Mow forest edge population by farm pond	
Glossy buckthorn	Confirm identification and remove					
Japanese barberry			Clip forest edge population by farm pond		Mow forest edge population by farm pond	
Japanese tree lilac						
Morrow honeysuckle			Clip forest edge population by farm pond		Mow forest edge population by farm pond	
Multiflora rose			Clip forest edge population by farm pond, remove small populations	Remove larger populations	Mow forest edge population by farm pond	Check for resprouts
Norway maple		Remove large trees	Remove large trees			
Oriental bittersweet	Confirm identification if in flower and remove					Check for resprouts
Winged burning bush				Remove population		
Yellow flag iris			Confirm identification and remove populations			
Other	Seek NH pesticide applicator's license, survey park for garlic mustard	Complete invasive plant survey				Update database, revise 2003 work plan and create work plan for 2004

Key: mowing, clipping/cutting, uprooting, cut-stump, foliar spray

Suggested Work Plan for 2003

Species	May	June	July	August	September	October
Autumn olive				Check for resprouts and retreat		
Black locust				Check for resprouts and retreat		
Black swallow-wort		Check for resprouts of isolated & large populations	Continue removing larger populations			
Common buckthorn		Clip forest edge population by farm pond		Remove individuals bearing fruit, then remove seedlings	Mow forest edge population by farm pond	
Glossy buckthorn	Continue confirming identification and removing					
Japanese barberry	Clip large populations along BMD Trail	Clip forest edge population by farm pond	Treat resprouts by BMD Trail	Remove small, isolated populations by BMU Brook	Mow forest edge population by farm pond	
Japanese tree lilac						
Morrow honeysuckle		Clip forest edge population by farm pond			Mow forest edge population by farm pond	
Multiflora rose		Clip forest edge population by farm pond		Check removal sites for resprouts	Mow forest edge population by farm pond	
Norway maple				Remove saplings and seedlings	Remove saplings and seedlings	Remove saplings and seedlings
Oriental bittersweet	Continue confirming identification and removing					
Winged burning bush				Check removal site for resprouts		
Yellow flag iris			Check for resprouts			
Other						Update database, revise 2004 work plan and create work plan for 2005

Key: mowing, clipping/cutting, uprooting, cut-stump, foliar spray

Suggested Five-Year Removal Timetable

Species	2002	2003	2004	2005	2006
Autumn olive	Remove	Check for resprouts	Check for resprouts	Eradicated	Eradicated
Black locust		Remove	Check for resprouts	Check for resprouts	Check for resprouts
Black swallow-wort	Remove	Remove and check for resprouts	Check for resprouts	Check for resprouts	Eradicated
Common buckthorn		Remove	Check for resprouts	Check for resprouts	Eradicated
Glossy buckthorn	Identify and remove	Identify and remove	Eradicated	Eradicated	Eradicated
Japanese barberry		Remove	Remove and check for resprouts	Remove and check for resprouts	Check for resprouts
Japanese tree lilac			Remove	Remove and check for resprouts	Remove and check for resprouts
Morrow honeysuckle			Remove	Remove and check for resprouts	Remove and check for resprouts
Multiflora rose	Remove	Check for resprouts	Check for resprouts	Eradicated	Eradicated
Norway maple	Remove	Remove and check for resprouts	Remove and check for resprouts	Check for resprouts	Eradicated
Oriental bittersweet	Identify and remove	Identify and remove	Check for resprouts	Check for resprouts	Eradicated
Winged burning bush	Remove	Check for resprouts	Eradicated	Eradicated	Eradicated
Yellow flag iris	Remove	Check for resprouts	Check for resprouts	Eradicated	Eradicated

APPENDIX G: PURPLE LOOSESTRIFE PROGRAM

SAGA implemented a quantitative monitoring program for purple loosestrife in 2000. In 2001, an environmental assessment was prepared evaluating various alternative approaches to managing this invasive plant species. Utilizing this planning document to make a management decision, the park opted to implement a biological control program for purple loosestrife in July 2001. The park will continue to monitor the density of purple loosestrife in order to determine the efficacy of the biological control program.

The environmental assessment and data regarding this program are available from the SAGA Division of Natural Resources.