

INTRODUCTION

Many plant species have been introduced to the United States by humans since European settlement, sometimes deliberately and sometimes inadvertently, such as in contaminated crop seed or soil. Some species have successfully escaped cultivation and become invasive, spreading and establishing new populations distant from original population centers. Indeed, introduced plant species have forever changed the vegetative landscape of North America.

Not every plant that arrives on the scene becomes established and not every established plant becomes a problem invasive. A specific pattern of site and timing is generally needed for an exotic to take hold in an ecosystem. However, while many introduced plants do not exhibit invasive qualities for long periods after introduction, some reach a point of naturalization when they become invasive where they had previously been benign (Mack 2003). Once established, invasive plants can threaten the sustainability of native forest community composition, structure, function, and resource productivity (Webster and others 2006). Native forest ecosystems that developed over centuries were (and are) limited in their ability to compete against these invaders.

There is an economic cost attributable to the control or management of invasive plants in forest ecosystems. Some authors have put the cost nationwide of all invasive species in the billions (Pimentel and others 2005); certainly the cost to Upper Midwest and Northeastern forests is substantial.

Today, introduced plants are expanding their distributions across this region. These plants occur in all the major life forms found in forest ecosystems: trees, shrubs, vines, herbs/forbs, and grasses. As forests are more and more impacted by fragmentation and other forest health stressors, they become more susceptible to trans-regional and trans-national plant invasion, often at the expense of the indigenous species. Generally, pathways that contribute to the spread of introduced plants, contribute to the spread of more than one species or life form.

Fragmentation is a process of site disturbance whereby intact pieces of forest land are broken up either by active human-influenced processes, like roads and urban development, or by parcelization of ownerships, which introduces more subtle, but still significant, management changes. Fragmentation is important because it is generally recognized that introduced species are more common on forest edges than in the interior of undisturbed forests (Kuhman and others 2010, Moser and others 2009, Vilà and Ibàñez 2011).

CHAPTER 7. Regional Distribution of Introduced Plant Species in the Forests of the Northeastern United States

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Yet, other factors can influence the pace and impact of plant invasions in forests. Some have linked the number of introduced species to overall species richness (Stohlgren and others 1999). Others have shown that absolute or temporal availability of resources is important; invasive species are known to thrive on higher productivity sites (Richardson and Pyšek 2006). Spatial scale is important when considering basic predictors of where introduced species are likely to be found (Kuhman and others 2010, Stohlgren and others 1999).

In addition to local surveys and studies, a regional perspective is central to understanding the factors influencing introduced plant distribution. A regional perspective may assist land managers tasked with minimizing the spread of non-native plants by helping them to prioritize the use of limited resources. One goal of this report is to examine factors important in determining the regional distribution of invasive plants in the upper Midwestern and Northeastern United States.

The Forest Health Vegetation Indicator (VEG) species data include a census of all vascular plants on a subset of the plots maintained by the Forest Inventory and Analysis (FIA) Program of the Forest Service, U.S. Department of Agriculture, and are appropriate for regional- or national-scale reporting (Schulz and others 2009). Forest Health Indicators are collected on a one-sixteenth subset (phase 3) of FIA phase 2

plots, or about one plot to every 96,000 acres (Bechtold and Patterson 2005). VEG data have been collected discontinuously since 2001; the FIA unit managed by the Northern Research Station of the Forest Service has collected VEG data more consistently across broader areas than other FIA regions. The data can be used to examine introduced species as a group and by growth habits in addition to measurements of individual species distribution. Overall occupancy of nonnative plants in forests can be estimated as percentage and relative cover of introduced species, as suggested by Noss (1999) and anticipated by the Heinz Center (2006). Ecological provinces are defined by climatic, broad vegetation classes (Cleland and others 2005) and are useful for distinguishing populations at regional scales. They are especially well-suited for reporting forest health indicator results because they are large enough to encompass the sparse FIA phase 3 grid to provide adequate sample sizes, while designating areas that provide similar climatic influences on vegetation.

Our objective is to examine the presence and abundance of introduced species across the forests of the Northeastern United States to determine what broad-scale factors can be used to predict their distribution. Specifically, we look at introduced species distribution over the entire region that falls under the purview of the Northern Research Station FIA unit, by a coarse measure of forest fragmentation

(forest intactness), using ecoregion provinces as subpopulations. We examine introduced species as a group, by growth habits, and a selected list of individual species.

METHODS

The Northern Research Station FIA unit collects forest-related data throughout a 24-State region in the Northeastern United States. Standard forest inventory data were collected on phase 2 plots; additional variables related to forest health were collected on phase 3 plots (Bechtold and Patterson 2005), including VEG.

All vascular plants rooted in or hanging over the four subplots (chapter 1, fig. 1.2) were identified. Plant identifications were recorded using plant symbols defined by the Natural Resource Conservation Service (NRCS) PLANTS database (USDA NRCS 2000). For each species on the subplot, total percent canopy cover was estimated and recorded. Species rooted in or overhanging each of three permanently positioned 1m² quadrats on each subplot were also recorded. Unknown species were collected near the plot and identified later by an FIA vegetation specialist or submitted to a qualified herbarium.

Each phase 3 plot is also a phase 2 plot. All phase 2 data were available for each plot. The phase 2 data included detailed tree and forest stand data, along with physical site information.

We examined initial data from 1,305 plot visits where vegetation data were collected; this represented about three-fifths of the total phase 3 grid for the region.

The FIA sampling design was focused on accessible forested lands; this resulted in some plots with less area sampled than the four full subplots, i.e., some portion of subplot area was non-forested. These plots provided valuable information, but plot summaries and population estimations must be calculated and presented appropriately. Calculations for attributes that are dependent on fixed area measurements exclude sample units that were not 100 percent within accessible forest lands.

Introduced species were designated using NRCS PLANTS database and refined with local knowledge. As the distribution of introduced species was evaluated, it is important to note that many plants observed were never identified to species due to their phenological stage at the time of plot visits. We assumed that the proportion of introduced species among the unidentified plants to be similar to their proportion of all plants identified to species.

For each plot, species richness and the number of introduced species were compiled. We then calculated the percentage of number of introduced species and relative cover of introduced species. The percentage of number of introduced species is simply the sum of

introduced species divided by the number of all species identified to species per plot, multiplied by 100. The relative cover of introduced species is the sum of subplot cover of all introduced species divided by the sum of subplot cover by all taxa (species, genera, or unidentified plants) for each plot. Estimates and variances for population level summaries were computed using methods described in Schulz and others (2009) and results were compiled for each ecological province with at least 20 intact plots. The student's *t*-test was used to test for significant differences.

Condition type was derived from FIA phase 2 condition classifications, as a coarse measure of intactness. Conditions were designated by virtue of the following criteria: forest type, stand-size class, land use, regeneration status, reserved status, ownership, and tree density (Bechtold and Patterson 2005). Each plot was designated to one of three condition types based on the number and types of condition classes assigned. If the plot was 100 percent forest and was determined to be a single condition, it was designated as an "intact" stand. Plots that were 100 percent forest but had more than one condition assigned, were designated as a "multiple condition." Plots that were less than 100 percent forest were designated as "forest edge."

Plants identified to species were assigned growth habits based their primary designations in the NRCS PLANTS database, and then compiled into four basic forms: forbs, graminoids (grass-like), shrubs, and trees. Species designated as herbaceous vines were included as forbs, species designated as subshrubs and woody vines were included as shrubs. The chi-square test of independence was used to determine if the categories "origin" and "growth habit" were independent; that is, if distribution of introduced species by growth habits was the same as the distribution of native species by growth habit within the same ecological province.

Individual species selected for distribution analysis were chosen for several reasons; all were among the most common species encountered, some were listed as species of concern for phase 2 plot sampling, and some were so naturalized that many people do not recognize them as nonnative species. We also included species from a variety of growth habits and geographic ranges.

RESULTS

A total of 2,570 taxa (unique species, genera, and unknown codes) were recorded, with 2,210 identified to species. Of the 2,210 species, 303 were considered to be introduced in the NRCS PLANTS database. We included two additional

grass species, reed canary grass (*Phalaris arundinacea* L.) and common reed (*Phragmites australis* (Cav.) Trin. ex Steud.) with invasive populations that are of concern in the region as introduced species, bringing the total number of species considered as introduced to 305. The appendix to this chapter lists the introduced species in order of highest constancy (percentage of plots where observed). Of the 1,302 plots included in analysis, 864, or about 66 percent, had at least one introduced species present.

The northeastern corner of the United States, where the Northern Research Station FIA unit conducts forest inventory, encompasses, in total or in part, 14 ecoregion provinces.

Forest Intactness

Plots were summarized by condition type to compare the occupancy of introduced species to the level of forest stand intactness. Plots located on the forest edges have the greatest percentage of plots with introduced species. Compared to the 66.4 percent

of all 1,302 plots, 58.75 percent of the 720 intact forest plots, 68 percent of the 120 multiple condition plots, and 77.7 percent of the 462 plots with some non-forest had at least one introduced species. On the 864 plots where at least one introduced species was recorded, the percentage of identified species that are introduced is least in intact stands and greatest on plots with some non-forest. This same trend is observed for the relative cover of introduced species (fig. 7.1). Each condition type is significantly different from the others for both measures ($\alpha < 0.05$).

Populations Defined by Ecoregion Provinces

The 14 ecoregion provinces are listed in table 7.1, along with the percentage of plots with at least one introduced species (PPWI)

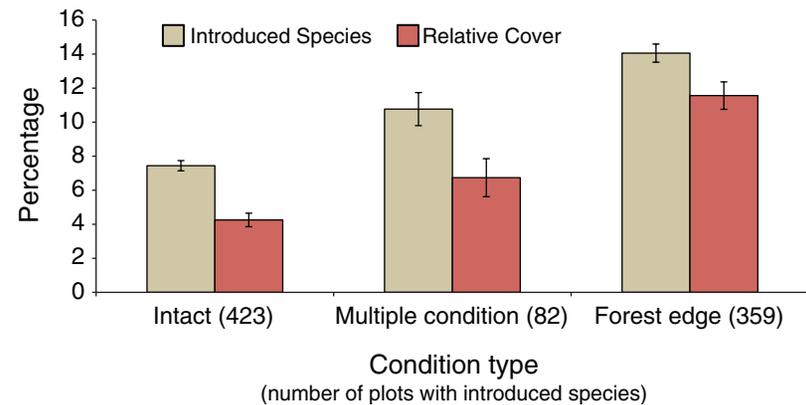


Figure 7.1—Average percentage of introduced species and relative cover by condition type for plots with introduced species. Error bars represent “plus one” and “minus one” standard error.

Table 7.1—Proportion of plots with at least one introduced species (proportion of plots with introduced, or PPWI) and the number of plots in each condition type by ecological province

Ecological province		PPWI	Condition type		
<i>Code</i>	<i>Name</i>		<i>Percentage</i>	<i>Intact</i>	<i>Multiple condition</i>
211	Northeastern Mixed Forest	62.7	80	12	34
M211	Adirondack-New England Mixed Forest – Coniferous Forest – Alpine Meadow	41.6	65	12	12
212	Laurentian Mixed Forest	45.5	207	40	76
221	Eastern Broadleaf Forest	87.5	85	18	65
M221	Central Appalachian Broadleaf Forest – Coniferous Forest – Meadow	57.7	50	3	18
222	Midwest Broadleaf Forest	87.2	49	11	81
223	Central Interior Broadleaf Forest	70.2	112	14	65
231	Southeastern Mixed Forest	80	5	0	0
232	Outer Coastal Plain Mixed Forest	64.6	28	4	33
251	Prairie Parkland (Temperate)	85.5	24	4	55
255	Prairie Parkland (Subtropical)	100	3	1	0
331	Great Plains – Palouse Dry Steppe	100	3	0	11
332	Great Plains Steppe	100	5	1	9
M334	Black Hills Coniferous Forest	85.7	4	0	3

and number of plots in each condition type. The five ecoregion provinces with fewer than 20 intact plots are excluded from analyses that compare plot species richness to PPWI. Average species richness at the quadrat, subplot, and plot level (fig. 7.2) and occupancy by introduced species (fig. 7.3) varied across the nine ecoregion provinces.

The values of PPWI for each ecoregion province with more than 20 intact plots were strongly related with the proportion of forest edge plots (fig. 7.4A) and with the average plot species richness (fig. 7.4B). At the broad regional scale, the proportion of forest edge plots explains a greater proportion of variation of PPWI than average species richness.

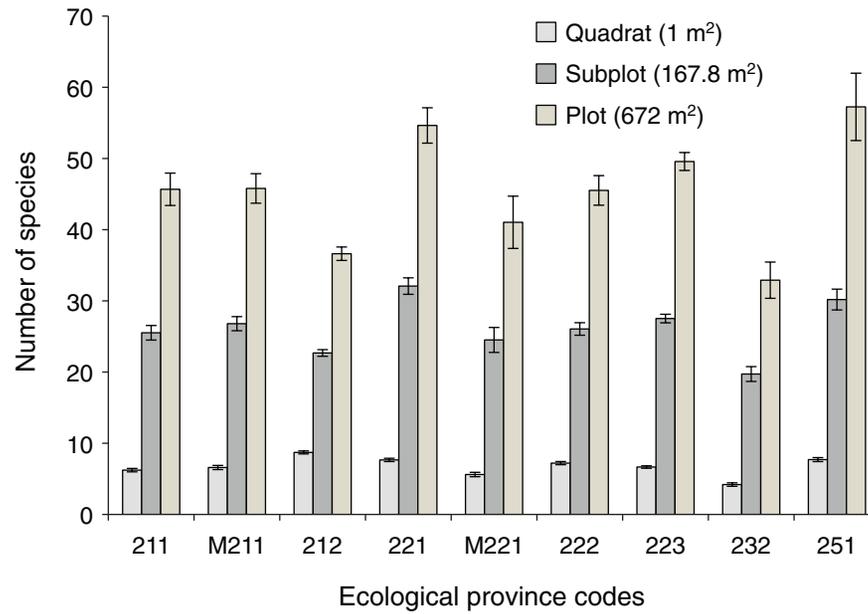


Figure 7.2—Average species richness for quadrats, subplots, and plots of 100-percent forested by ecoregion province. Error bars represent “plus one” and “minus one” standard error.

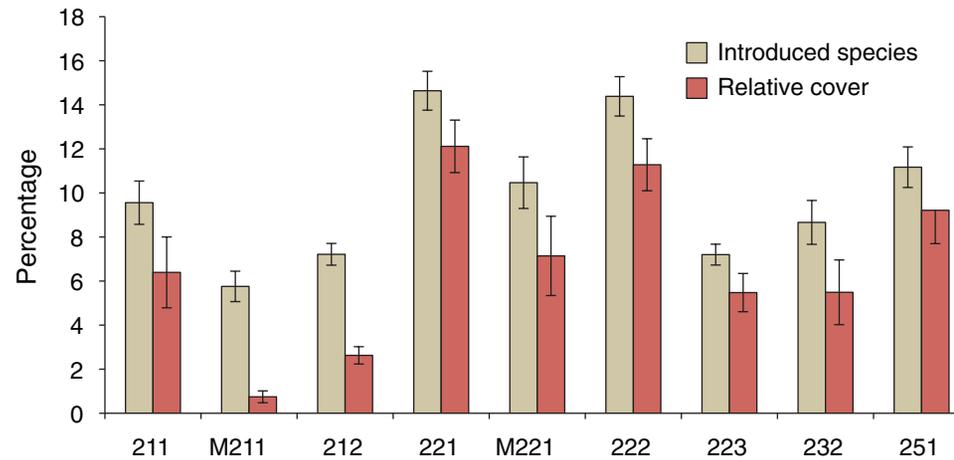


Figure 7.3—Occupancy of introduced species by ecological province, expressed as a percentage of total species richness and cover. Error bars represent “plus one” and “minus one” standard error.

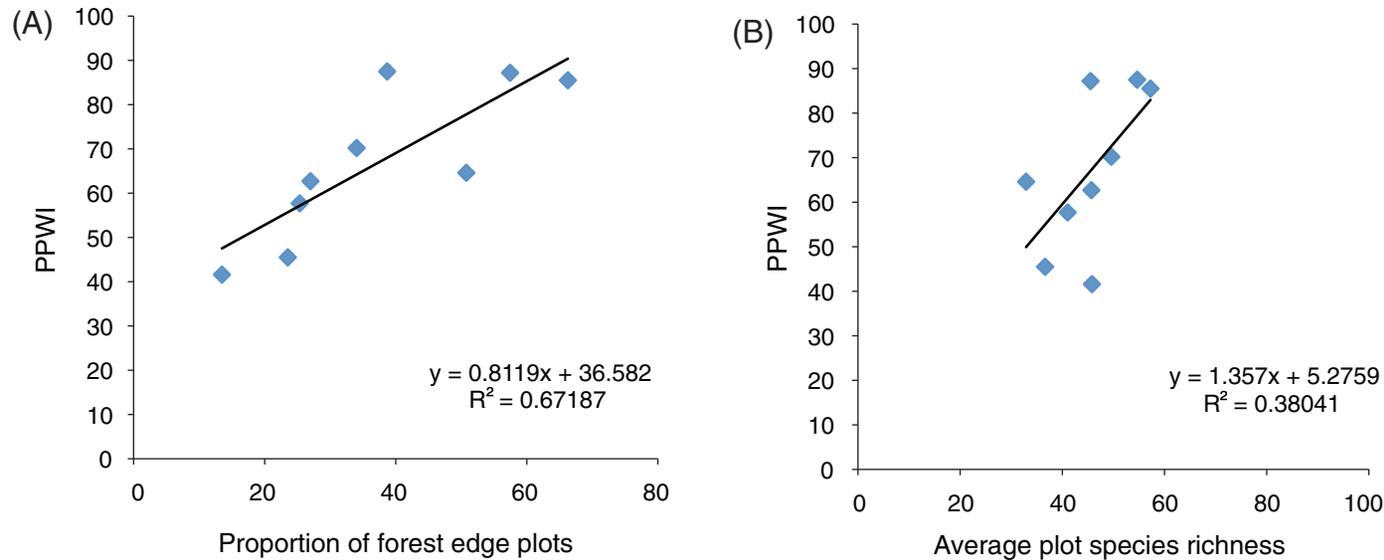


Figure 7.4—Relationship between proportion of plots with introduced species (PPWI) and proportion of forest edge plots (A) and average plot species richness (B) across ecological provinces.

Average plot species richness compilations do not include forest edge plots because species richness is related to area sampled, and forest edge plots are not fully forested. However, percentage of introduced species and relative cover are not area-sensitive metrics, unlike direct assessments of species richness, so all plots within each ecoregion province are included. Each plot does have at least one fully forested subplot, however. The relationship between

subplot species richness and PPWI was not as strong ($r^2 = 0.32$), as that for plot species richness and PPWI.

The ecoregion provinces also varied from one another by the most common introduced species recorded (table 7.2). The constancies for this short list of species drops quickly in those ecoregion provinces with lower introduced species occupancy measures (M211, 212).

Table 7.2—The five most common introduced species per ecological province

Ecological province (number of plots)	Scientific name	Common name	Growth habit	Constancy
211-Northeastern Mixed Forest (n = 126)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	11.90
	<i>Anthoxanthum odoratum</i>	Sweet vernalgrass	Graminoid	10.32
	<i>Epipactis helleborine</i>	Helleborine	Forb/herb	10.32
	<i>Lonicera morrowii</i>	Morrow's honeysuckle	Shrub	9.52
	<i>Hieracium caespitosum</i>	Meadow hawkweed	Forb/herb	7.94
M211-Adirondack-New England Mixed Forest – Coniferous Forest – Alpine Meadow (n = 89)				
	<i>Epipactis helleborine</i>	Helleborine	Forb/herb	12.36
	<i>Phleum pratense</i>	Timothy	Graminoid	6.74
	<i>Leucanthemum vulgare</i>	Oxeye daisy	Forb/herb	5.62
	<i>Vicia cracca</i>	Bird vetch	Vine, Forb/herb	5.62
	<i>Trifolium aureum</i>	Golden clover	Forb/herb	4.49
212-Laurentian Mixed Forest (n = 323)				
	<i>Hieracium aurantiacum</i>	Orange hawkweed	Forb/herb	10.84
	<i>Rumex acetosella</i>	Common sheep sorrel	Forb/herb	4.64
	<i>Polygonum convolvulus</i>	Black bindweed	Vine, Forb/herb	4.33
	<i>Solanum dulcamara</i>	Climbing nightshade	Forb/herb	4.33
	<i>Phleum pratense</i>	Timothy	Graminoid	3.72
221-Eastern Broadleaf Forest (n = 168)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	70.24
	<i>Lonicera japonica</i>	Japanese honeysuckle	Vine	23.21
	<i>Berberis thunbergii</i>	Japanese barberry	Shrub	19.05
	<i>Polygonum persicaria</i>	Spotted ladythumb	Forb/herb	18.45
	<i>Alliaria petiolata</i>	Garlic mustard	Forb/herb	17.86
M221-Central Appalachian Broadleaf Forest – Coniferous Forest – Meadow (n = 71)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	29.58
	<i>Microstegium vimineum</i>	Nepalese browntop	Graminoid	15.49
	<i>Elaeagnus umbellata</i>	Autumn olive	Shrub	15.49
	<i>Berberis thunbergii</i>	Japanese barberry	Shrub	12.68
	<i>Alliaria petiolata</i>	Garlic mustard	Forb/herb	12.68

continued

Table 7.2 (continued)—The five most common introduced species per ecological province

Ecological province (number of plots)	Scientific name	Common name	Growth habit	Constancy
222-Midwest Broadleaf Forest (n = 141)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	45.39
	<i>Alliaria petiolata</i>	Garlic mustard	Forb/herb	24.11
	<i>Glechoma hederacea</i>	Ground ivy	Forb/herb	15.60
	<i>Phalaris arundinacea</i>	Reed canarygrass	Graminoid	13.48
	<i>Phleum pratense</i>	Timothy	Graminoid	12.06
223-Central Interior Broadleaf Forest (n = 191)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	41.36
	<i>Lonicera japonica</i>	Japanese honeysuckle	Vine	19.89
	<i>Daucus carota</i>	Queen Anne's lace	Forb/herb	10.99
	<i>Elaeagnus umbellata</i>	Autumn olive	Shrub	5.76
	<i>Lolium pratense</i>	Meadow ryegrass	Graminoid	5.24
231-Southeastern Mixed Forest (n = 5)				
	<i>Lonicera japonica</i>	Japanese honeysuckle	Vine	60.00
	<i>Microstegium vimineum</i>	Nepalese browntop	Graminoid	60.00
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	40.00
	<i>Rhamnus cathartica</i>	Common buckthorn	Tree, Shrub	20.00
	<i>Commelina communis</i>	Asiatic dayflower	Forb/herb	20.00
232-Outer Coastal Plain Mixed Forest (n = 65)				
	<i>Lonicera japonica</i>	Japanese honeysuckle	Vine	47.69
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	15.38
	<i>Polygonum hydropiper</i>	Marshpepper knotweed	Forb/herb	6.15
	<i>Hypericum perforatum</i>	Common St. Johnswort	Forb/herb	4.62
	<i>Microstegium vimineum</i>	Nepalese browntop	Graminoid	4.62
251-Prairie Parkland (Temperate) (n = 83)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	46.99
	<i>Polygonum convolvulus</i>	Black bindweed	Vine, Forb/herb	16.87
	<i>Phalaris arundinacea</i>	Reed canarygrass	Graminoid	15.66
	<i>Morus alba</i>	White mulberry	Tree, Shrub	15.66
	<i>Lolium arundinaceum</i>	Tall fescue	Graminoid	14.46

continued

Table 7.2 (continued)—The five most common introduced species per ecological province

Ecological province (number of plots)	Scientific name	Common name	Growth habit	Constancy
255-Prairie Parkland (Subtropical) (n = 4)				
	<i>Rosa multiflora</i>	Multiflora rose	Vine, Shrub	50.00
	<i>Morus alba</i>	White mulberry	Tree, Shrub	50.00
	<i>Torilis arvensis</i>	Spreading hedgeparsley	Forb/herb	50.00
	<i>Lespedeza cuneata</i>	Chinese lespedeza	Subshrub, Shrub, Forb	50.00
	<i>Lolium arundinaceum</i>	Tall fescue	Graminoid	25.00
331-Great Plains – Palouse Dry Steppe (n = 14)				
	<i>Tragopogon dubius</i>	Yellow salsify	Forb/herb	35.71
	<i>Melilotus officinalis</i>	Yellow sweetclover	Forb/herb	28.57
	<i>Bromus japonicus</i>	Japanese brome	Graminoid	28.57
	<i>Nepeta cataria</i>	Catnip	Forb/herb	21.43
	<i>Lactuca serriola</i>	Prickly lettuce	Forb/herb	21.43
332-Great Plains Steppe (n = 15)				
	<i>Morus alba</i>	White mulberry	Tree, Shrub	40.00
	<i>Medicago lupulina</i>	Black medick	Forb/herb	26.67
	<i>Melilotus officinalis</i>	Yellow sweetclover	Forb/herb	20.00
	<i>Trifolium repens</i>	White clover	Forb/herb	20.00
	<i>Verbascum thapsus</i>	Common mullein	Forb/herb	20.00
M334-Black Hills Coniferous Forest (n = 7)				
	<i>Poa compressa</i>	Canada bluegrass	Graminoid	28.57
	<i>Cirsium arvense</i>	Canada thistle	Forb/herb	28.57
	<i>Artemisia absinthium</i>	Absinthium	Subshrub, Shrub, Forb	28.57
	<i>Agropyron cristatum</i>	Crested wheatgrass	Graminoid	14.29
	<i>Tragopogon dubius</i>	Yellow salsify	Forb/herb	14.29

Growth Habits of Introduced Species by Ecoregion Provinces

Examination of the distribution of introduced species by growth habits across ecoregion provinces reveals some interesting trends (table 7.3). Overall, forbs made up the largest proportion of both native and introduced species, ranging from about 45 percent of native species in ecoregion province 232 to over 72 percent of introduced species in ecoregion province 212. The proportion of graminoids (grass and grass-like plants) ranged from 10 percent for introduced species in ecoregion province 212 to about 24 percent for introduced species in ecoregion province 251. Proportion of shrubs ranged from 9 percent for introduced species in ecoregion province M211 to 30 percent for introduced species in ecoregion province 232. Tree species made up less than 5 percent of introduced species in ecoregion provinces 232 and 251, but accounted for over 23 percent of native species in ecoregion province 232.

Results of the chi-square test for independence show that in over half of the ecoregion provinces, the distribution of native and introduced species by growth habit were significantly different. The greatest difference was in ecoregion province 212, and there were no significant differences ($\alpha \geq 0.05$) in ecoregion provinces M211, 221, 232, and 251.

Table 7.3—Percentage of native and introduced species by growth habit and results of chi-squared test of independence (degrees of freedom =3) to determine if species origin and growth habits were independent within each ecological province

Ecological province	Species origin	Growth habit				Chi-square	Significance level (alpha)
		Forb	Graminoid	Shrub	Tree		
-----Percentage-----							
211	Native	46.86	20.93	15.14	17.07		
211	Introduced	59.81	14.02	16.82	9.35	8.9	0.030
M211	Native	46.21	19.19	17.30	17.30		
M211	Introduced	63.64	20.45	9.09	6.82	6.7	0.076
212	Native	47.00	19.07	19.62	14.31		
212	Introduced	72.73	10.00	11.82	5.45	25.1	> 0.001
221	Native	49.49	17.75	14.86	17.89		
221	Introduced	54.74	16.79	17.52	10.95	4.5	0.212
M221	Native	52.21	13.97	13.24	20.59		
M221	Introduced	50.91	16.36	25.45	7.27	9.7	0.022
222	Native	52.72	14.43	15.91	16.94		
222	Introduced	64.79	14.79	11.97	8.45	9.8	0.020
223	Native	58.01	12.78	13.34	15.87		
223	Introduced	60.67	19.10	12.36	7.87	5.9	0.117
232	Native	44.98	14.53	16.96	23.53		
232	Introduced	47.62	16.67	30.95	4.76	10.1	0.018
251	Native	55.18	17.93	12.30	14.59		
251	Introduced	61.90	23.81	9.52	4.76	7.7	0.052

Note: Significant differences are greater for larger chi-square values and indicate that species origin and growth habit are dependent, i.e., native and introduced species have different distributions across growth habits.

Species Distribution by Condition Type

We plotted the constancy of the 23 selected species in each condition type to see if they followed the trend of being more commonly recorded on forest edge plots (fig 7.5). Most species do follow this trend, but several do not. Note how prevalent multiflora rose (*Rosa multiflora*) is across the region.

Regional Distribution of Selected Species

Figures 7.6-7.10 display the regional distribution of selected forbs, grasses, woody shrubs and vines, and trees. Background shadings on maps represent ecoregion provinces (Cleland and others 2005). Some species are widespread throughout the northeastern forests, while others are concentrated in particular ecoregion provinces (table 7.4).

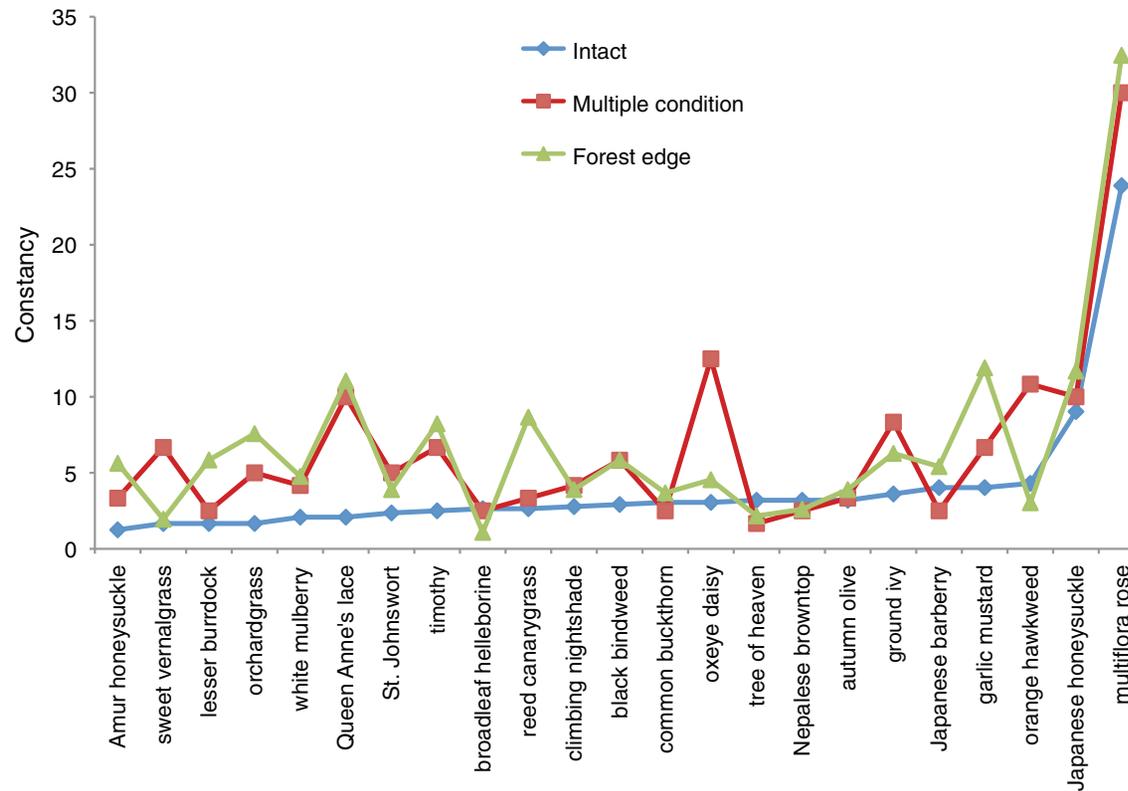


Figure 7.5—Constancy (proportion of plots where recorded) of selected species for condition types, intact forest, multiple condition, and forest edge.

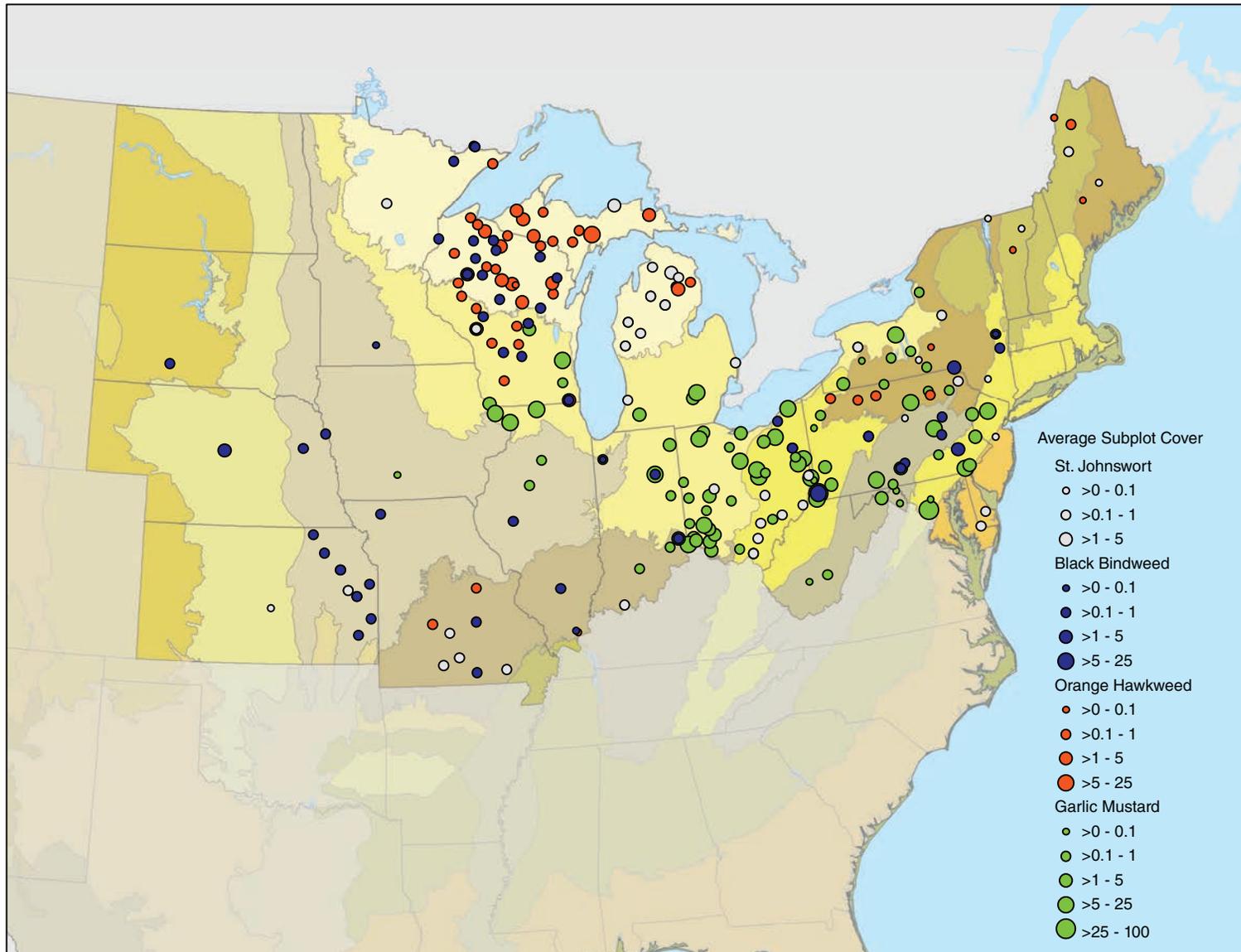


Figure 7.6—Distribution and average subplot cover of four selected forb species: *St. Johnswort*, *black bindweed*, *orange hawkweed*, and *garlic mustard*. Plot locations are approximate.

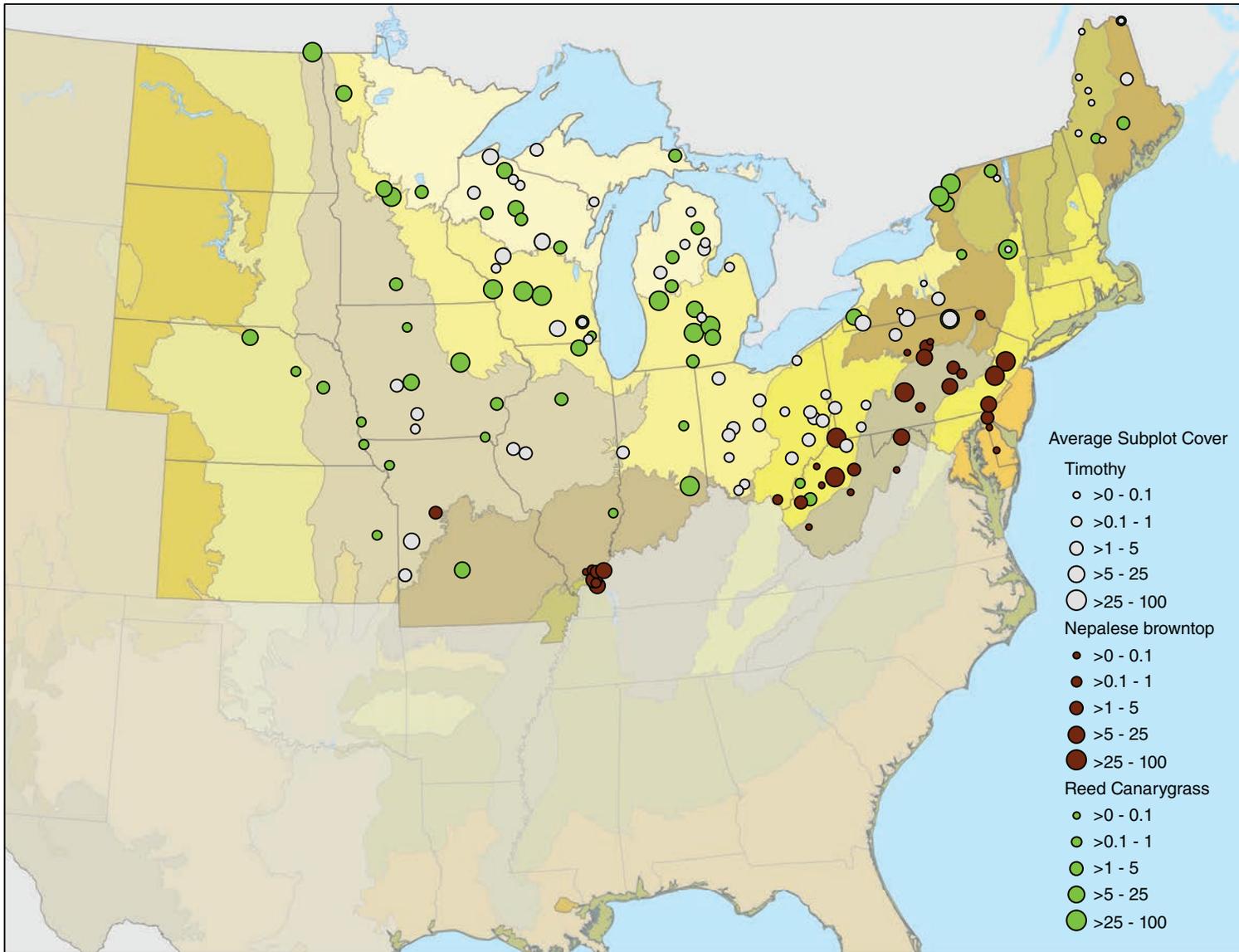


Figure 7.7—Distribution and average subplot cover of three selected grass species: timothy grass, Nepalese browntop, and reed canarygrass. Plot locations are approximate.

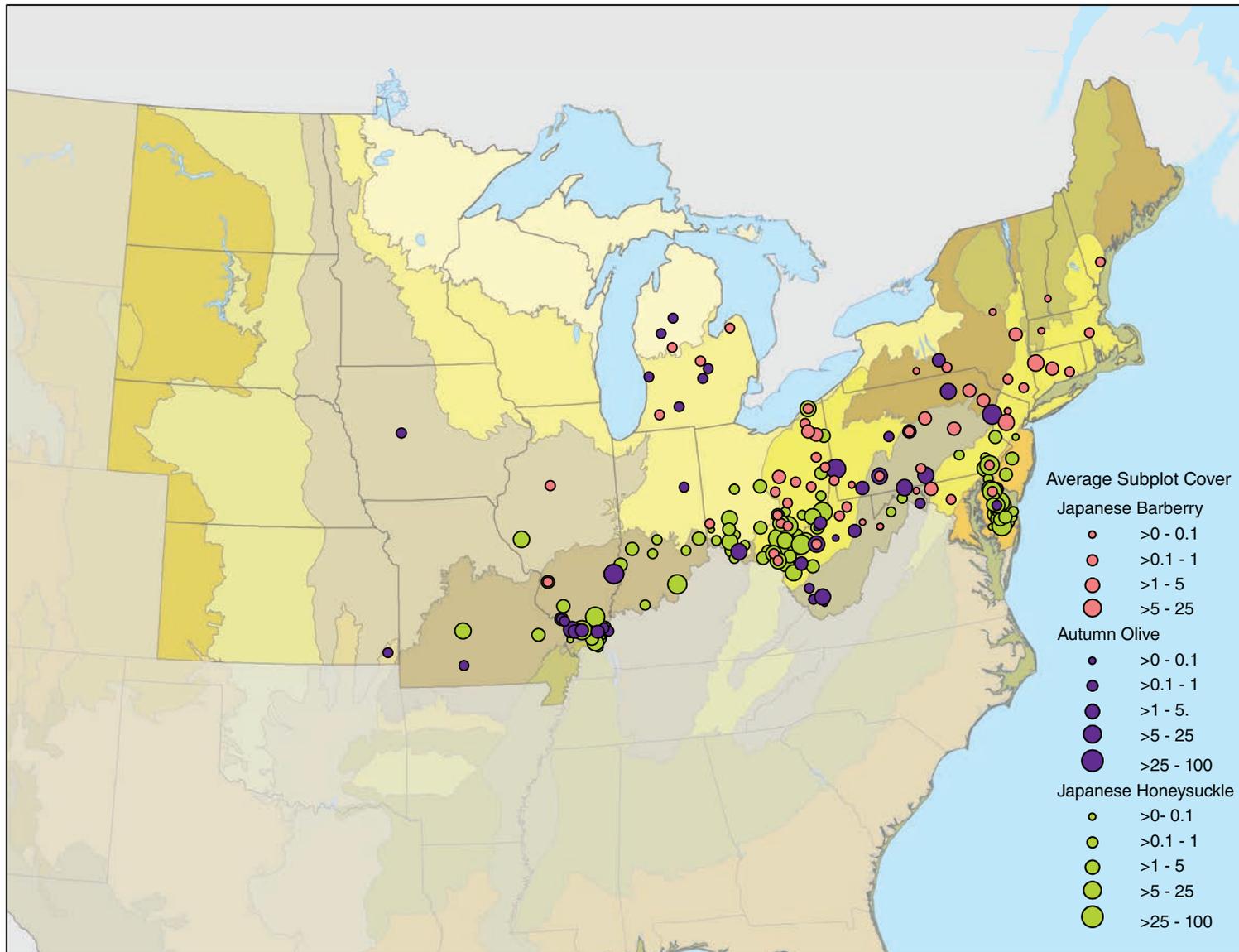


Figure 7.8—Distribution and average subplot cover of three selected introduced non-tree woody plant species: Japanese barberry, autumn olive, and Japanese honeysuckle. Plot locations are approximate.

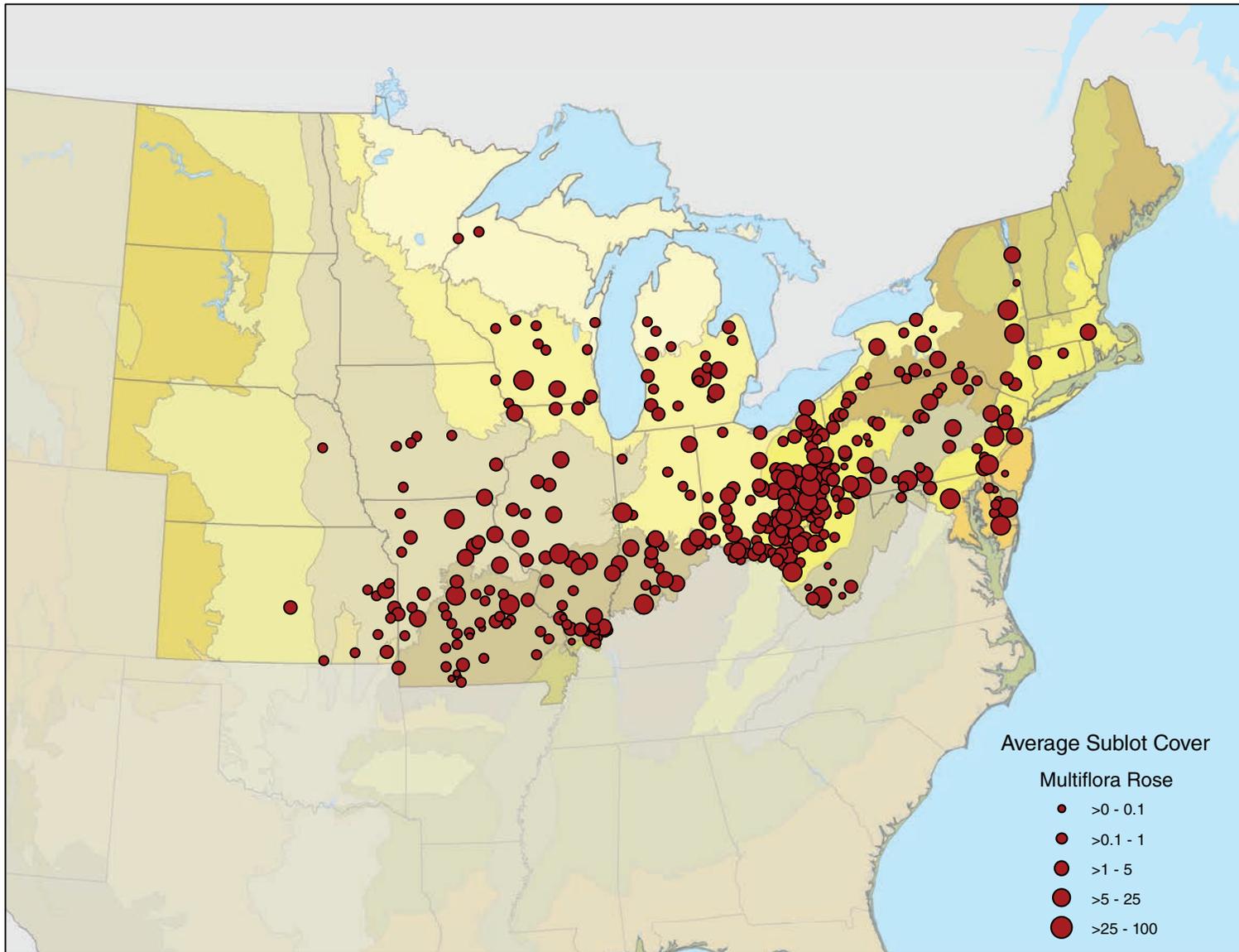


Figure 7.9—Distribution and average subplot cover of multiflora rose, the most commonly reported introduced species in the Region. Plot locations are approximate.

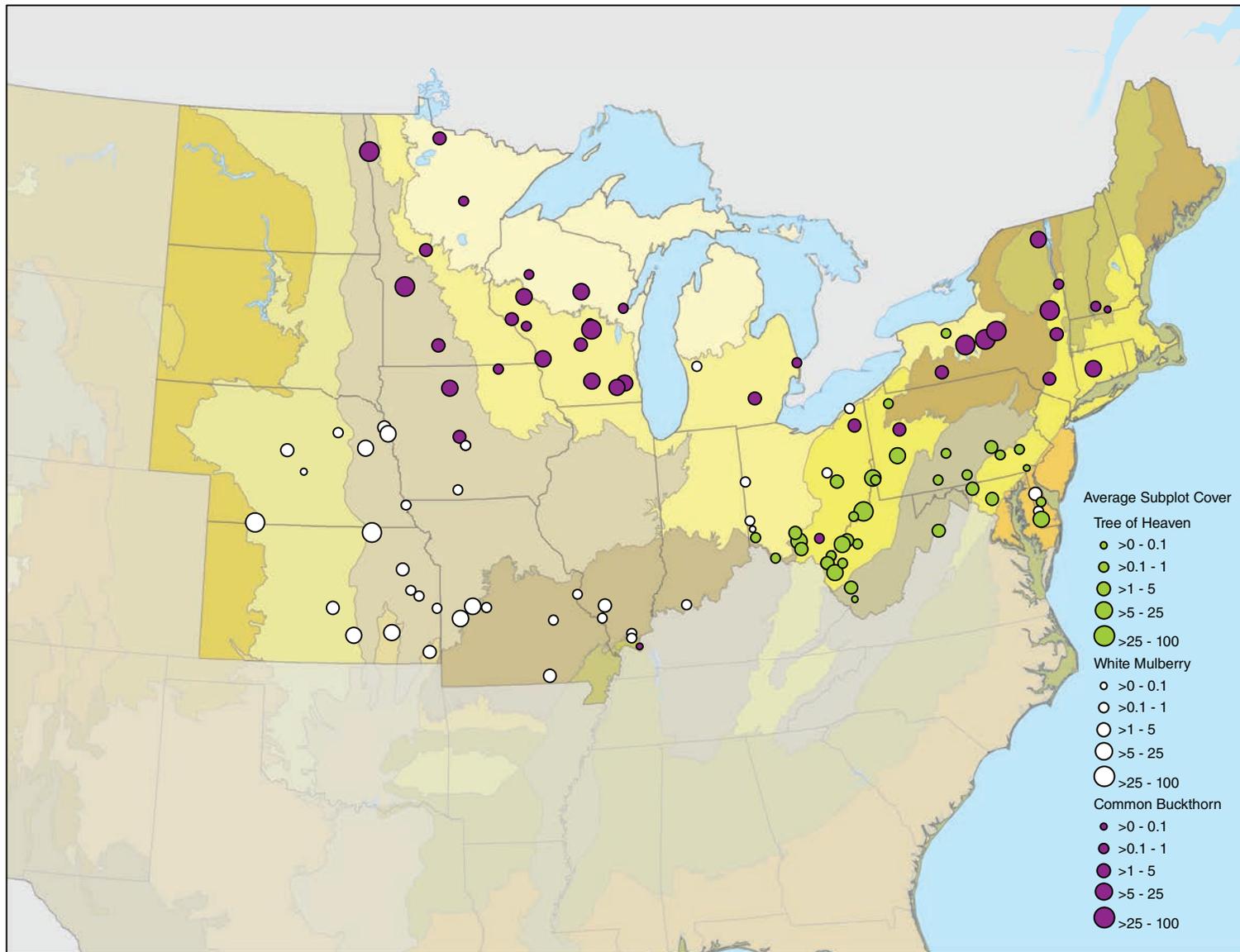


Figure 7.10—Distribution and average subplot cover of three selected introduced tree species: tree of heaven, white mulberry, and common buckthorn. In some areas buckthorn is more of a shrub than a small tree. Plot locations are approximate.

Table 7.4—Constancy of selected introduced species for the region and by ecological province

Common name	Region (1302)	Ecological province codes (number of plots)								
		211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	232 (65)	251 (83)
<i>Percentage of plots where species was recorded</i>										
Forbs										
Garlic mustard	7.3	6.35	0.00	0.00	17.86	12.68	24.11	2.62	0.00	7.23
Lesser burdock	3.3	5.56	0.00	0.62	3.57	0.00	8.51	1.57	0.00	9.64
Queen Anne’s lace	6.1	3.17	0.00	1.24	11.31	5.63	12.06	10.99	0.00	10.84
Broadleaf helleborine	2.1	10.32	12.36	0.31	0.60	0.00	0.71	0.00	0.00	0.00
Ground ivy	4.99	3.17	0.00	0.62	16.67	2.82	15.60	0.52	1.54	4.82
Orange hawkweed	4.5	3.97	3.37	10.84	1.19	0.00	7.09	1.57	0.00	0.00
St. Johnswort	3.15	3.17	2.25	3.10	4.76	1.41	4.26	2.62	4.62	1.20
Oxeye daisy	4.6	4.76	5.62	3.10	11.31	4.23	5.67	1.57	1.54	3.61
Climbing nightshade	3.38	7.14	1.12	4.33	1.19	0.00	11.35	0.52	0.00	0.00
Black bindweed	4.22	0.79	0.00	4.33	4.76	5.63	4.96	2.62	0.00	16.87
Grasses										
Sweet vernalgrass	2.23	10.32	0.00	0.00	7.14	2.82	0.71	0.00	1.54	0.00
Orchardgrass	4.15	3.17	0.00	0.62	11.90	5.63	7.09	2.09	0.00	9.64
Nepalese browntop	3.0	3.17	0.00	0.00	5.36	15.49	0.71	3.14	4.62	1.20
Reed canarygrass	4.99	5.56	1.12	3.41	4.17	0.00	13.48	1.57	0.00	15.66
Timothy	4.9	6.35	6.74	3.72	8.33	0.00	12.06	0.00	0.00	8.43
Shrubs										
Japanese barberry	4.38	3.97	2.25	0.31	19.05	12.68	3.55	0.52	1.54	1.20
Autumn olive	3.5	1.59	0.00	0.62	5.95	15.49	4.26	5.76	1.54	1.20
Amur honeysuckle	3.0	0.79	0.00	0.00	2.38	1.41	9.22	5.24	3.08	8.43
Vines										
Japanese honeysuckle	10.29	0.00	0.00	0.00	23.21	7.04	9.93	19.90	47.69	1.20
Multiflora rose	27.65	11.90	0.00	2.17	70.24	29.58	45.39	41.36	15.38	46.99
Trees										
Tree of heaven	2.76	0.00	0.00	0.00	12.50	11.27	2.13	0.52	3.08	0.00
White mulberry	3.3	0.00	0.00	0.00	2.98	0.00	3.55	4.71	3.08	15.66
Common buckthorn	3.23	2.38	3.37	1.55	5.36	0.00	10.64	0.00	0.00	7.23

DISCUSSION

Estimates of occupancy by introduced species by condition type, a coarse measure of forest fragmentation, suggest that introduced species are more abundant on forest edges. An examination of the adjacent non-forest conditions in this data set revealed that the vast majority of non-forest lands on forest edge plots are either developed, agricultural, or range, indicating a close proximity to human activities. This trend was followed at the ecoregion province level; provinces with a higher percentage of forest edge plots had higher occupancy of introduced species. At finer scales, other predictors for introduced species may prove to be more useful. Fortunately, because data are collected and stored at the subplot level, it will be possible to do further analyses.

The ecoregion province summaries showed different rates of introduced species occupancy. Provinces M211, 212, and 223 had the lowest occupancy as measured by percentage of introduced species and relative cover (fig. 7.3); together, these provinces include about 48 percent of the plots in this study. Province 223 did have a high rate of PPWI, however (table 7.1).

The full census of vascular plants on each plot allowed us to examine trends of introduced species in terms of growth habits; surveys limited to short lists of species can only assess those species on the list, and are not likely to give a clear picture of overall trends. In an earlier analysis of invasive species in the upper Midwest

(Moser and others 2009), it was speculated that herbaceous plants are less likely to invade northern forests. Using the full species lists, we found that the proportion of introduced forbs is greater than the proportion of native forb species in ecoregion province 212, which encompasses the northern portions of Michigan, Wisconsin, and Minnesota.

Multiflora rose is by far the most common introduced species in the Region, with an overall constancy of 27.65 percent, and as high as 70 percent in province 221. However, it was not recorded in province M211 (table 7.4). Although it probably does occur within the province, multiflora rose was not recorded on any of the 89 forested plots, illustrating that it is much less prominent there. Originally introduced to the United States as root stock for ornamental roses, multiflora rose was widely promoted, starting in the 1930s, as a natural fence row to contain livestock, and then as a wildlife forage species and crash barrier in highway medians (Swearingen and others 2010). Today it is widespread.

We can look at the distribution of any individual species recorded in the inventory. Although it was not practical to examine every introduced species for this report, we examined the distribution of several species of high interest (figs. 7.5–7.10, table 7.4). The species highlighted in figures 7.6–7.10 show a variety of ranges. Orange hawkweed (*Hieracium aurantiacum*) was most concentrated in ecoregion province 212 where intact forest plots are more common than forest edge plots (fig. 7.6 and table 7.1). Timothy

(*Phleum pretense*), a grass so common it is often mistaken for a native species, was widespread, while Nepalese browntop (*Microstegium vimineum*), was limited to the southern portion of the Northern region.

Most of the selected species followed the trend of being recorded more often in forest edge or multiple forest condition plots but a few did not (fig. 7.5). Shade-tolerant species are troubling because they can survive in closed canopy forests, potentially far from traffic corridors where they may have originally been introduced.

Tree of heaven (*Ailanthus altissima*) is a short-lived, pollution tolerant tree. It grows fast, up to one to two meters per year in its first few years. Although it grows best in full sunlight, it is able to take advantage of gaps in the forest canopy and quickly fill them (Knapp and Canham 2000). It also produces an allelopathic chemical that inhibits most other nearby plant growth (Mergen 1959). One species that is not affected by this chemical is white ash (*Fraxinus americana*) (Mergen 1959). Indeed, white ash was present on 26 of the 39 plots where tree of heaven was recorded.

Nepalese browntop, also known as Japanese stiltgrass, is problematic in more southern climates, but has been found as far north as Massachusetts and New York. It reproduces vegetatively and by seed and is prevalent along river corridors. Seed dispersal is facilitated along waterways by flooding where spread of seeds increases (Swearingen and others

2010; Warren and others 2011). A recent investigation revealed that undisturbed leaf litter and understory canopy shade can limit the establishment of Nepalese browntop, but once disturbed by moving water or large animals (including humans), sites with normal amounts of leaf litter can become prone to invasion when seeds come in contact with mineral soil (Schramm and Ehrenfeld 2010). In addition, removal of understory by herbivory by deer or silvicultural thinning is likely to facilitate the establishment of this species. Kuhman and others (2010) found that in the Southern Appalachian Mountains, this grass was positively correlated with forest canopy cover, unlike the other species in their study. Twenty six of 39 plots with stiltgrass were intact forest, with 13 different forest types represented. However, nine of those plots were in the white oak/red oak/hickory type. As the floods of 2011 recede, we may see an increase of this invasive grass.

Broadleaf helleborine (*Epipactis helleborine*) was found slightly more often in intact forests than forest edges plots (fig. 7.5). It was relatively common (ranked 34 among 305 species), but concentrated in provinces 211 and M211 (table 7.4). Little information could be found on this particular species. However, Swearingen and others (2010) list it as a plant “to watch” in the mid-Atlantic States as it becomes more widespread in dry, gravelly soils in forests and woodland edges. Because VEG data collection included all vascular species, we were able to provide information on the distribution of up-and-coming species of concern.

Common buckthorn and Japanese barberry (*Berberis thunbergii*) are found nearly as often in intact forests as in forest edge or multiple condition plots (fig. 7.5). Buckthorn is a good example of a cultivated plant that survived for many years and then became naturalized and spread into natural areas. While best growth is in full light, it produces an abundance of seed that can germinate in partial light conditions and are borne in berries that are spread by birds (Swearingen and others 2010). Japanese barberry was promoted as an ornamental plant in the late 1800s; it rapidly spread into abandoned agricultural fields and open areas. DeGasperis and Motzkin (2007) studied the current distribution of this species and found it occurred more often in forests that re-established after agriculture abandonment in the early 20th century, after barberry had been introduced. More modern disturbances did not result in additional spread if seed sources were not immediately available and although barberry may be present in areas that were wooded in the early 20th century, it occurs in a smaller proportion of these stands.

One species we expected to see more often on intact plots was garlic mustard (*Alliaria petiolata*), known for its shade tolerance. Although it was wide spread in the southeastern portion of the region (fig. 7.6), it was recorded most often on forest edge plots (fig. 7.5).

It is often preferable to summarize data by ecoregion province and forest type in reports focused on FIA data. In this data set, there are 212 ecoregion province/forest type pairs, 89 of

which are represented by 1 plot, and a total of 166 have 5 or fewer plots. There are 27 pairs with at least 10 plots, and 13 of these ecoregion province/forest type pairs were designated as either multiple conditions or forest edge condition types. This data set is only about 60 percent of the total phase 3 grid for the region; more thorough analyses should be conducted with a complete set of FIA phase 3 plots.

CONCLUSION

The FIA phase 3 VEG data allow for estimation of the occupancy of introduced species in terms of percent number of introduced species and relative cover. Results indicate a strong influence of forest fragmentation on the regional distribution of introduced species. Occupancy of introduced species varied across ecoregion provinces; ecoregion provinces with a higher proportion of forest edge plots had the highest occupancy by introduced species.

Although the proportion of introduced species by growth habits was different from the proportion of native species in each growth habit for more than half of the provinces, forb species dominated both native and introduced growth habits in all ecoregion provinces. The two provinces with the lowest occupancy of introduced species (M211 and 212) had higher proportions of introduced forb species compared to their proportion of native forb species.

The distribution of individual species varied across ecoregion provinces and by condition type. Multiflora rose was by far the most

common introduced species, but varied in constancy from 0 percent (M211) to 70 percent (221). Of the selected species, most were recorded in forest edge or multiple condition plots, but a few were found more often in intact forest stands. One of the more commonly recorded forb species, broadleaf helleborine, was found more often on intact forest plots, and has only recently become a species to watch for invasive tendencies. We are able to report on the distribution of this species because of the full vascular plant species inventories available from plots where VEG data has been recorded.

Our findings highlight the importance of efforts to manage roadside and trailhead vegetation to minimize the spread of introduced and potentially invasive plant species into intact forests. This region-wide analysis of the distribution of introduced species established in the forests of the Northeastern United States is just a beginning. Further examination of distribution and abundance within each ecoregion province are possible with these data. However, with the additional plot data collected in 2009 and 2010, more ecoregion province/forest type pairs and some revisited plots will be available, providing for new ways to examine trends and report indications of changing species distributions.

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Appendix 7.1—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Multiflora rose	<i>Rosa multiflora</i> Thunb. ex Murr.	360
Japanese honeysuckle	<i>Lonicera japonica</i> Thunb.	134
Garlic mustard	<i>Alliaria petiolata</i> (Bieb.) Cavara & Grande	95
Queen Anne's lace	<i>Daucus carota</i> L.	80
Reed canarygrass	<i>Phalaris arundinacea</i> L.	65
Ground ivy	<i>Glechoma hederacea</i> L.	65
Timothy	<i>Phleum pratense</i> L.	64
Oxeye daisy	<i>Leucanthemum vulgare</i> Lam.	60
Orange hawkweed	<i>Hieracium aurantiacum</i> L.	59
Japanese barberry	<i>Berberis thunbergii</i> DC.	57
Black bindweed	<i>Polygonum convolvulus</i> L.	55
Orchardgrass	<i>Dactylis glomerata</i> L.	54
Spotted ladythumb	<i>Polygonum persicaria</i> L.	54
Red clover	<i>Trifolium pratense</i> L.	51
White clover	<i>Trifolium repens</i> L.	49
Autumn olive	<i>Elaeagnus umbellata</i> Thunb.	46
Climbing nightshade	<i>Solanum dulcamara</i> L.	44
White mulberry	<i>Morus alba</i> L.	43
Lesser burdock	<i>Arctium minus</i> Bernh.	43
Common buckthorn	<i>Rhamnus cathartica</i> L.	42
Common St. Johnswort	<i>Hypericum perforatum</i> L.	41
Nepalese browntop	<i>Microstegium vimineum</i> (Trin.) A. Camus	39
Amur honeysuckle	<i>Lonicera maackii</i> (Rupr.) Herder	39
Tree of heaven	<i>Ailanthus altissima</i> (P. Mill.) Swingle	36
Common sheep sorrel	<i>Rumex acetosella</i> L.	36
Meadow ryegrass	<i>Lolium pratense</i> (Huds.) S.J. Darbyshire	33
Canada bluegrass	<i>Poa compressa</i> L.	32
Black medick	<i>Medicago lupulina</i> L.	30
Sweet vernalgrass	<i>Anthoxanthum odoratum</i> L.	29
Yellow sweetclover	<i>Melilotus officinalis</i> (L.) Lam.	29
Sulphur cinquefoil	<i>Potentilla recta</i> L.	29

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Redtop	<i>Agrostis gigantea</i> Roth	28
Morrow's honeysuckle	<i>Lonicera morrowii</i> Gray	28
Broad-leaved helleborine	<i>Epipactis helleborine</i> (L.) Crantz	27
Glossy buckthorn	<i>Frangula alnus</i> P. Mill.	26
Quackgrass	<i>Elymus repens</i> (L.) Gould	25
Asian bittersweet	<i>Celastrus orbiculata</i> Thunb.	25
Narrowleaf plantain	<i>Plantago lanceolata</i> L.	25
Creeping jenny	<i>Lysimachia nummularia</i> L.	25
Curly dock	<i>Rumex crispus</i> L.	25
Common mullein	<i>Verbascum thapsus</i> L.	25
Tatarian honeysuckle	<i>Lonicera tatarica</i> L.	24
Canada thistle	<i>Cirsium arvense</i> (L.) Scop.	23
Bull thistle	<i>Cirsium vulgare</i> (Savi) Ten.	23
Rough bluegrass	<i>Poa trivialis</i> L.	22
Tall fescue	<i>Lolium arundinaceum</i> (Schreb.) S.J. Darbyshire	21
European privet	<i>Ligustrum vulgare</i> L.	20
Sweet cherry	<i>Prunus avium</i> (L.) L.	20
Spreading hedgeparsley	<i>Torilis arvensis</i> (Huds.) Link	19
Deptford pink	<i>Dianthus armeria</i> L.	18
Bird vetch	<i>Vicia cracca</i> L.	18
Scotch pine	<i>Pinus sylvestris</i> L.	17
Prickly lettuce	<i>Lactuca serriola</i> L.	17
Meadow hawkweed	<i>Hieracium caespitosum</i> Dumort.	17
Coltsfoot	<i>Tussilago farfara</i> L.	17
Yellow salsify	<i>Tragopogon dubius</i> Scop.	16
Asiatic dayflower	<i>Commelina communis</i> L.	15
Common velvetgrass	<i>Holcus lanatus</i> L.	14
Catnip	<i>Nepeta cataria</i> L.	14
Common hawkweed	<i>Hieracium lachenalii</i> K.C. Gmel.	14
Bitter dock	<i>Rumex obtusifolius</i> L.	14
Golden clover	<i>Trifolium aureum</i> Pollich	14

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Wine raspberry	<i>Rubus phoenicolasius</i> Maxim.	13
Japanese brome	<i>Bromus japonicus</i> Thunb. ex Murr.	11
Annual bluegrass	<i>Poa annua</i> L.	11
Big chickweed	<i>Cerastium fontanum</i> ssp. <i>vulgare</i> Baumg.	11
Marshpepper knotweed	<i>Polygonum hydropiper</i> L.	11
Dames rocket	<i>Hesperis matronalis</i> L.	11
Common motherwort	<i>Leonurus cardiaca</i> L.	11
Chinese lespedeza	<i>Lespedeza cuneata</i> (Dum.-Cours.) G. Don	11
Tall morning-glory	<i>Ipomoea purpurea</i> (L.) Roth	11
Common chickweed	<i>Stellaria media</i> (L.) Vill.	11
Common sowthistle	<i>Sonchus oleraceus</i> L.	11
Purple crownvetch	<i>Coronilla varia</i> L.	10
Indian strawberry	<i>Duchesnea indica</i> (Andr.) Focke	10
Russian olive	<i>Elaeagnus angustifolia</i> L.	10
Spotted knapweed	<i>Centaurea biebersteinii</i> DC.	10
Fly honeysuckle	<i>Lonicera x xylosteoides</i> Tausch	10
Oriental ladythumb	<i>Polygonum cespitosum</i> Blume	10
Butter and eggs	<i>Linaria vulgaris</i> P. Mill.	10
Birdfoot deervetch	<i>Lotus corniculatus</i> L.	10
Garden yellowrocket	<i>Barbarea vulgaris</i> Ait. f.	10
Alsike clover	<i>Trifolium hybridum</i> L.	10
Common reed	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	9
Common mouse-ear Chickweed	<i>Cerastium fontanum</i> Baumg.	9
Norway spruce	<i>Picea abies</i> (L.) Karst.	9
False baby's breath	<i>Galium mollugo</i> L.	9
Spotted snapweed	<i>Impatiens balsamina</i> L.	9
Nodding plumeless thistle	<i>Carduus nutans</i> L.	8
Paradise apple	<i>Malus pumila</i> P. Mill.	8
Norway maple	<i>Acer platanoides</i> L.	8
Common tansy	<i>Tanacetum vulgare</i> L.	8

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Narrowleaf cattail	<i>Typha angustifolia</i> L.	8
Field bindweed	<i>Convolvulus arvensis</i> L.	7
Brittlestem hempnettle	<i>Galeopsis tetrahit</i> L.	7
Alfalfa	<i>Medicago sativa</i> L.	7
Greater burdock	<i>Arctium lappa</i> L.	7
Mouseear hawkweed	<i>Hieracium pilosella</i> L.	7
Green brome	<i>Setaria viridis</i> (L.) Beauv.	7
Field clover	<i>Trifolium campestre</i> Schreb.	7
Cheatgrass	<i>Bromus tectorum</i> L.	6
Poison hemlock	<i>Conium maculatum</i> L.	6
Fuller's teasel	<i>Dipsacus fullonum</i> ssp. <i>sylvestris</i> L.	6
Marijuana	<i>Cannabis sativa</i> L.	6
Colonial bentgrass	<i>Agrostis capillaris</i> L.	6
Love-lies-bleeding	<i>Amaranthus caudatus</i> L.	6
Wild garlic	<i>Allium vineale</i> L.	6
White sweetclover	<i>Melilotus alba</i> Medikus	6
Corn speedwell	<i>Veronica arvensis</i> L.	6
Johnsongrass	<i>Sorghum halepense</i> (L.) Pers.	6
Jack-go-to-bed-at-noon	<i>Tragopogon pratensis</i> L.	6
Siberian elm	<i>Ulmus pumila</i> L.	6
Wild parsnip	<i>Pastinaca sativa</i> L.	5
Barnyardgrass	<i>Echinochloa crus-galli</i> (L.) Beauv.	5
Winged burning bush	<i>Euonymus alata</i> (Thunb.) Sieb.	5
Chicory	<i>Cichorium intybus</i> L.	5
Dwarf honeysuckle	<i>Lonicera xylosteum</i> L.	5
Common barberry	<i>Berberis vulgaris</i> L.	5
Japanese knotweed	<i>Polygonum cuspidatum</i> Sieb. & Zucc.	5
Celandine	<i>Chelidonium majus</i> L.	5
Purple loosestrife	<i>Lythrum salicaria</i> L.	5
Maidenstears	<i>Silene vulgaris</i> (Moench) Garcke	5
Field sowthistle	<i>Sonchus arvensis</i> L.	5
Princesstree	<i>Paulownia tomentosa</i> (Thunb.) Sieb. & Zucc. ex Steud.	4

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Creeping buttercup	<i>Ranunculus repens</i> L.	4
Burnweed	<i>Erechtites hieracifolia</i> (L.) Raf. ex DC.	4
Marsh thistle	<i>Cirsium palustre</i> (L.) Scop.	4
Absinthium	<i>Artemisia absinthium</i> L.	4
Ornamental jewelweed	<i>Impatiens glandulifera</i> Royle	4
Hairy catsear	<i>Hypochaeris radicata</i> L.	4
Henbit deadnettle	<i>Lamium amplexicaule</i> L.	4
Korean clover	<i>Kummerowia stipulacea</i> (Maxim.) Makino	4
Japanese clover	<i>Kummerowia striata</i> (Thunb.) Schindl.	4
Tall hawkweed	<i>Hieracium piloselloides</i> Vill.	4
Rugosa rose	<i>Rosa rugosa</i> Thunb.	4
Prickly Russian thistle	<i>Salsola tragus</i> L.	4
Black nightshade	<i>Solanum nigrum</i> L.	4
Grasslike starwort	<i>Stellaria graminea</i> L.	4
Corn gromwell	<i>Buglossoides arvensis</i> (L.) I.M. Johnston	3
Leafy spurge	<i>Euphorbia esula</i> L.	3
Winter creeper	<i>Euonymus fortunei</i> (Turcz.) Hand.-Maz.	3
Silver cinquefoil	<i>Potentilla argentea</i> L.	3
Hoary false madwort	<i>Berteroa incana</i> (L.) DC.	3
Austrian pine	<i>Pinus nigra</i> Arnold	3
Musk mallow	<i>Malva moschata</i> L.	3
Common mallow	<i>Malva neglecta</i> Wallr.	3
Dwarf snapdragon	<i>Chaenorhinum minus</i> (L.) Lange	3
Hedge false bindweed	<i>Calystegia sepium</i> ssp. <i>sepium</i> (L.) R. Br.	3
Oriental bittersweet	<i>Celastrus orbiculatus</i> Thunb.	3
Rampion bellflower	<i>Campanula rapunculoides</i> L.	3
Peppermint	<i>Mentha x piperita</i> L. (pro sp.)	3
True forget-me-not	<i>Myosotis scorpioides</i> L.	3
Purple deadnettle	<i>Lamium purpureum</i> L.	3
Redstar	<i>Ipomoea coccinea</i> L.	3
Corn	<i>Zea mays</i> L.	3

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Witch's moneybags	<i>Hylotelephium telephium</i> ssp. <i>telephium</i> (L.) H. Ohba.	3
Germander speedwell	<i>Veronica chamaedrys</i> L.	3
Common wheat	<i>Triticum aestivum</i> L.	3
Beefsteakplant	<i>Perilla frutescens</i> (L.) Britt.	2
Shepherd's purse	<i>Capsella bursa-pastoris</i> (L.) Medik.	2
Meadow brome	<i>Bromus commutatus</i> Schrad.	2
Lesser pond sedge	<i>Carex acutiformis</i> Ehrh.	2
India mustard	<i>Brassica juncea</i> (L.) Czern.	2
Field mustard	<i>Brassica rapa</i> L.	2
Smooth hawkbeard	<i>Crepis capillaris</i> (L.) Wallr.	2
Scarlet pimpernel	<i>Anagallis arvensis</i> L.	2
Chinese yam	<i>Dioscorea oppositifolia</i> L.	2
Codlins and cream	<i>Epilobium hirsutum</i> L.	2
Wormseed wallflower	<i>Erysimum cheiranthoides</i> L.	2
Stinkgrass	<i>Eragrostis ciliaris</i> (All.) Vign. ex Janchen	2
Smooth crabgrass	<i>Digitaria ischaemum</i> (Schreb.) Schreb. ex Muhl.	2
David's spurge	<i>Euphorbia davidii</i> Subils	2
Thymeleaf sandwort	<i>Arenaria serpyllifolia</i> L.	2
Spearmint	<i>Mentha spicata</i> L.	2
Meadow foxtail	<i>Alopecurus pratensis</i> L.	2
Redroot amaranth	<i>Amaranthus retroflexus</i> L.	2
Velvetleaf	<i>Abutilon theophrasti</i> Medik.	2
Yellow Spring bedstraw	<i>Galium verum</i> L.	2
Gallant-soldier	<i>Galinsoga parviflora</i> Cav.	2
Tall yellow sweetclover	<i>Melilotus altissimus</i> Thuill.	2
Field pepperweed	<i>Lepidium campestre</i> (L.) Ait. f.	2
Ivyleaf morning-glory	<i>Ipomoea hederacea</i> Jacq.	2
Wild oat	<i>Avena fatua</i> L.	2
Woolly burdock	<i>Arctium tomentosum</i> P. Mill.	2
Bermudagrass	<i>Cynodon dactylon</i> (L.) Pers.	2
Rose of Sharon	<i>Hibiscus syriacus</i> L.	2

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Fig buttercup	<i>Ranunculus ficaria</i> L.	2
Cereal rye	<i>Secale cereale</i> L.	2
White willow	<i>Salix alba</i> L.	2
Japanese bristlegrass	<i>Setaria faberi</i> Herrm.	2
Spiny sowthistle	<i>Sonchus asper</i> (L.) Hill	2
Yellow bristlegrass	<i>Setaria pumila</i> (Poir.) Roemer & J.A. Schultes	2
Hedgemustard	<i>Sisymbrium officinale</i> (L.) Scop.	2
Bladder campion	<i>Silene latifolia</i> ssp. <i>alba</i> Poir.	2
Suckling clover	<i>Trifolium dubium</i> Sibthorp	2
Garden vetch	<i>Vicia sativa</i> L.	2
Common comfrey	<i>Symphytum officinale</i> L.	2
Common periwinkle	<i>Vinca minor</i> L.	2
Garden valerian	<i>Valeriana officinalis</i> L.	2
Field pennycress	<i>Thlaspi arvense</i> L.	2
Rabbitfoot clover	<i>Trifolium arvense</i> L.	2
Erect hedgeparsley	<i>Torilis japonica</i> (Houtt.) DC.	2
Birdeye speedwell	<i>Veronica persica</i> Poir.	2
Stinging nettle	<i>Urtica dioica</i> ssp. <i>dioica</i> L.	2
Pearl millet	<i>Pennisetum glaucum</i> (L.) R. Br.	1
Japanese pachysandra	<i>Pachysandra terminalis</i> Sieb. & Zucc.	1
Erect brome	<i>Bromus erectus</i> Huds.	1
Wild radish	<i>Raphanus raphanistrum</i> L.	1
Black mustard	<i>Brassica nigra</i> (L.) W.D.J. Koch	1
Siberian peashrub	<i>Caragana arborescens</i> Lam.	1
Caucasian bluestem	<i>Bothriochloa bladhii</i> (Retz.) S.T. Blake	1
Smooth brome	<i>Bromus inermis</i> ssp. <i>inermis</i> var. <i>inermis</i> Leyss.	1
Whitetop	<i>Cardaria draba</i> (L.) Desv.	1
Caraway	<i>Carum carvi</i> L.	1
Bald brome	<i>Bromus racemosus</i> L.	1
Kenilworth ivy	<i>Cymbalaria muralis</i> P.G. Gaertn., B. Mey. & Scherb.	1

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Rye brome	<i>Bromus secalinus</i> L.	1
Corn brome	<i>Bromus squarrosus</i> L.	1
Tidalmarsh flatsedge	<i>Cyperus serotinus</i> Rottb.	1
Splitlip hempnettle	<i>Galeopsis bifida</i> Boenn.	1
Acacia	<i>Acacia sophorae</i> (Labill.) R.Br.	1
Indian teasel	<i>Dipsacus sativus</i> (L.) Honckeny	1
Tall oatgrass	<i>Arrhenatherum elatius</i> (L.) Beauv. ex J. & K. Presl	1
Birthwort	<i>Aristolochia clematitis</i> L.	1
Garden chervil	<i>Anthriscus cerefolium</i> (L.) Hoffmann	1
Corn chamomile	<i>Anthemis arvensis</i> L.	1
Annual vernalgrass	<i>Anthoxanthum aristatum</i> Boiss.	1
Annual wallrocket	<i>Diploaxis muralis</i> (L.) DC.	1
Violet crabgrass	<i>Digitaria violascens</i> Link	1
Blessed thistle	<i>Cnicus benedictus</i> L.	1
Weeping lovegrass	<i>Eragrostis curvula</i> (Schrud.) Nees	1
Hairy cupgrass	<i>Eriochloa villosa</i> (Thunb.) Kunth	1
Doubtful knight's-spur	<i>Consolida ajacis</i> (L.) Schur	1
Buckwheat	<i>Fagopyrum esculentum</i> Moench	1
Sweet autumn virginsbower	<i>Clematis terniflora</i> DC.	1
European spindle tree	<i>Euonymus europaea</i> L.	1
Blue flax	<i>Linum perenne</i> L.	1
Rose campion	<i>Lychnis coronaria</i> (L.) Desr.	1
Black bindweed	<i>Polygonum convolvulus</i> var. <i>convolvulus</i> L.	1
Border privet	<i>Ligustrum obtusifolium</i> Sieb. & Zucc.	1
European stoneseed	<i>Lithospermum officinale</i> L.	1
Chinese privet	<i>Ligustrum sinense</i> Lour.	1
White poplar	<i>Populus alba</i> L.	1
Oval-leaf knotweed	<i>Polygonum arenastrum</i> Jord. ex Boreau	1
Gold-of-pleasure	<i>Camelina sativa</i> (L.) Crantz	1
Oakleaf goosefoot	<i>Chenopodium glaucum</i> L.	1
Sticky chickweed	<i>Cerastium glomeratum</i> Thuill.	1

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Sneezeweed	<i>Achillea ptarmica</i> L.	1
Amur peppervine	<i>Ampelopsis brevipedunculata</i> (Maxim.) Trautv.	1
Crested wheatgrass	<i>Agropyron cristatum</i> (L.) Gaertn.	1
Wild chives	<i>Allium schoenoprasum</i> L.	1
Broadleaf wild leek	<i>Allium ampeloprasum</i> L.	1
Amur maple	<i>Acer ginnala</i> Maxim.	1
Common yarrow	<i>Achillea millefolium</i> var. <i>millefolium</i> L.	1
European columbine	<i>Aquilegia vulgaris</i> L.	1
Broadleaf Solomon's seal	<i>Polygonatum hirsutum</i> (Bosc ex Poir.) Pursh	1
Common corncockle	<i>Agrostemma githago</i> L.	1
Monkshoodvine	<i>Ampelopsis aconitifolia</i> Bunge	1
Common bugle	<i>Ajuga reptans</i> L.	1
Bishop's goutweed	<i>Aegopodium podagraria</i> L.	1
Orange daylily	<i>Hemerocallis fulva</i> (L.) L.	1
Weeping forsythia	<i>Forsythia suspensa</i> (Thunb.) Vahl	1
Dovefoot geranium	<i>Geranium molle</i> L.	1
Roundfruit rush	<i>Juncus compressus</i> Jacq.	1
Common barley	<i>Hordeum vulgare</i> L.	1
Plume poppy	<i>Macleaya cordata</i> (Willd.) R. Br.	1
Disc mayweed	<i>Matricaria discoidea</i> DC.	1
Spotted henbit	<i>Lamium maculatum</i> L.	1
Italian ryegrass	<i>Lolium perenne</i> ssp. <i>multiflorum</i> L.	1
Field cottonrose	<i>Logfia arvensis</i> (L.) Holub	1
European stickseed	<i>Lappula squarrosa</i> (Retz.) Dumort.	1
Bell's honeysuckle	<i>Lonicera x bella</i> Zabel	1
Chinese ginseng	<i>Panax ginseng</i> C. Meyer	1
Garden asparagus	<i>Asparagus officinalis</i> L.	1
Field scabiosa	<i>Knautia arvensis</i> (L.) Coult.	1
Hyssop	<i>Hyssopus officinalis</i> L.	1
White deadnettle	<i>Lamium album</i> L.	1
Jimsonweed	<i>Datura stramonium</i> L.	1

continued

Appendix 7.1 (continued)—Introduced species recorded on 1,302 plots in Northeastern United States, in order of number of plots where recorded

Common name	Scientific name	Number of plots
Hibiscus	<i>Hibiscus lunariifolius</i> Willd.	1
Dwarf iris	<i>Iris pumila</i> L.	1
Orchardgrass	<i>Dactylis glomerata</i> ssp. <i>glomerata</i> L.	1
European meadow rush	<i>Juncus inflexus</i> L.	1
Flower of an hour	<i>Hibiscus trionum</i> L.	1
Asiatic tearthumb	<i>Polygonum perfoliatum</i> L.	1
European gooseberry	<i>Ribes uva-crispa</i> var. <i>sativum</i> L.	1
Sweetbriar rose	<i>Rosa eglanteria</i> L.	1
European black currant	<i>Ribes nigrum</i> L.	1
St. Anthony's turnip	<i>Ranunculus bulbosus</i> L.	1
Cultivated currant	<i>Ribes rubrum</i> L.	1
Common pear	<i>Pyrus communis</i> L.	1
Laurel willow	<i>Salix pentandra</i> L.	1
Cutleaf blackberry	<i>Rubus laciniatus</i> Willd.	1
Bouncingbet	<i>Saponaria officinalis</i> L.	1
Old-man-in-the-Spring	<i>Senecio vulgaris</i> L.	1
Grain sorghum	<i>Sorghum bicolor</i> ssp. <i>bicolor</i> (L.) Moench	1
Yellow bristlegrass	<i>Setaria pumila</i> ssp. <i>pallidifusca</i> (Poir.) Roemer & J.A. Schultes	1
Japanese meadowsweet	<i>Spiraea japonica</i> L. f.	1
Bladder campion	<i>Silene latifolia</i> Poir.	1
Small tumbleweed mustard	<i>Sisymbrium loeselii</i> L.	1
Garden vetch	<i>Vicia sativa</i> ssp. <i>nigra</i> L.	1
Alexanders	<i>Smyrnium olusatrum</i> L.	1
Lewiston cornsalad	<i>Valerianella locusta</i> (L.) Lat.	1
Common lilac	<i>Syringa vulgaris</i> L.	1
Nightflowering silene	<i>Silene noctiflora</i> L.	1
Bigleaf periwinkle	<i>Vinca major</i> L.	1
Small-leaf spiderwort	<i>Tradescantia fluminensis</i> Vell.	1
European cranberrybush	<i>Viburnum opulus</i> var. <i>opulus</i> L.	1
Threadstalk speedwell	<i>Veronica filiformis</i> Sm.	1