

An Assessment of Invasive Plant Species in Northern U.S. Forests

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This publication is part of a series that provides an overview of the presence of invasive plant species monitored on an extensive systematic network of plots measured by the Forest Inventory and Analysis (FIA) program of the USDA Forest Service, Northern Research Station (NRS). Previous research notes in this series have featured one of the invasive plants monitored on forested plots by NRS FIA in the 24 states of the midwestern and northeastern United States. This report shifts to an overview of all the monitored invasive plants and suggests that most of these plants have spread within the region.

Introduction

Invasive plant species (IPS)¹ have been monitored on select Phase 2 (P2) FIA plots since 2005 in the Midwest and since 2007 in the northeastern part of the NRS region. In 2005 and 2006, IPS data were collected year-round on 100 percent of the plots. Starting in 2007, the sampling intensity changed to collecting IPS data on 20 percent of plots with the monitoring window running from May through September. Since 2012, IPS data are collected on the Phase 2 Plus (P2+) sample. These plots are a 12.5 percent subsample of the Phase 2 plots, measured from May through September, and only occur on forest land.²

In this report, the 2014 and 2019 inventory data are presented to examine how IPS have changed over time. NRS FIA crews monitored 6,361 forested plots for invasive plants during the 2014 inventory and 4,244 in the 2019 inventory. Along with the standard forest variables collected during P2 measurement (e.g., tree diameter, height), these plots have various other attributes collected including the occurrence and coverage of IPS, vegetation structure, and down woody debris.

In past research notes, all species level nonnative bush honeysuckle data were lumped with the genus level observations. For this report, these data are not combined. This results in reporting on 43 species plus one undifferentiated genus (nonnative bush honeysuckle³), hereafter referred to as the 44 monitored IPS.

Overall, 52 percent of forested plots had one or more of the monitored invasives present in 2014. This number increased to 55 percent in 2019.



Native eastern white pine (*Pinus strobus*) mixed in among nonnative Scotch pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*). USDA Forest Service photo by Cassandra M. Kurtz.



Dried oriental bittersweet (*Celastrus orbiculatus*) for sale. Courtesy photo by Leslie J. Mehrhoff/ Bugwood.org.

Number of Invasive Plant Species on Phase 2 Plus Plots, 2019

Invasive plant presence varies across the NRS region. Spatial analysis, examining the presence of each species, and monitoring the number of IPS per plot are all key pieces of information which offer insight to regional patterns and trends. Overall, the plots with the greatest number of monitored IPS occur in the southeastern part of the NRS region (Fig. 1). Plots are only measured on forest land, so less forested areas have fewer plots. For example, Ohio appears to have fewer plots with IPS than neighboring West Virginia and Pennsylvania, however it actually has the highest percent of plots with IPS in the 24 state NRS region.

In the NRS region, 23 of the 24 states have at least one plot with three or more IPS observed. South Dakota is the exception with no plot having more than two invasive plants present. The number of IPS per plot varies from 0 to 13. For those plots with more than 10 IPS, only one state (Illinois) has 11 species on a plot, zero states have 12 species, and one (Pennsylvania) has 13 species.

Continual monitoring is necessary to determine spread and abundance. These data help managers understand the local and regional propagule pressure of the species monitored by the FIA program. For management, control, and eradication, accurate identification is important. In the following tables, the presence of each IPS and state level analyses are shown. This offers an understanding of IPS in relation to the number of plots monitored as well as regional variation in abundance at the species and statewide levels.

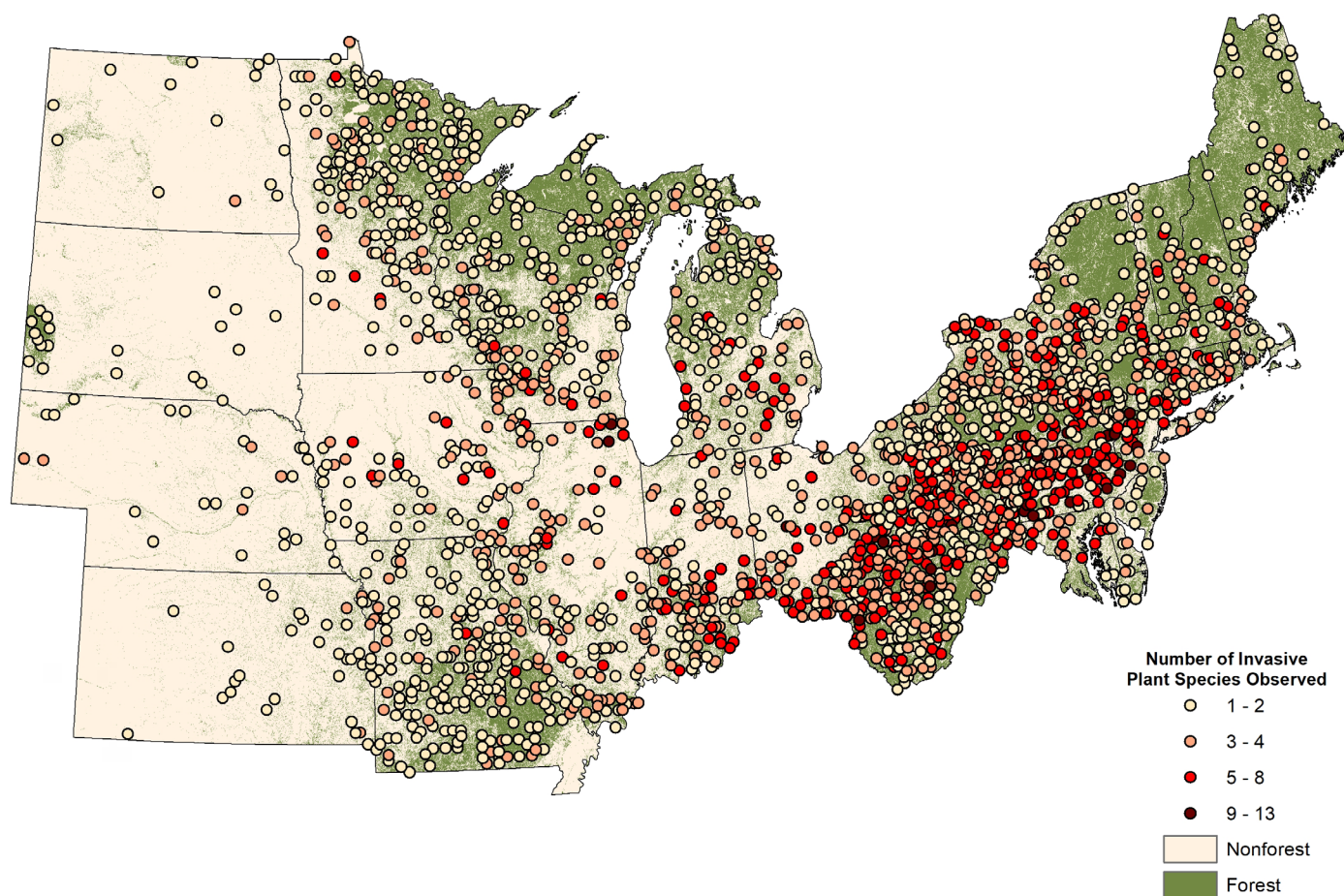


Figure 1. —Number of invasive plant species (IPS) per Phase 2 Plus plots, 2019. Percentages are rounded to the nearest whole number. Approximate plot locations depicted.

Changes in Invasive Plant Species over Time

The number of IPS per plot by state for 2014 and 2019 is shown in Table 1. In 2019, four states have greater than 90 percent of plots with one or more IPS present. Ohio is the highest at 98 percent, closely followed by Indiana at 97 percent, North Dakota at 93 percent, and Iowa at 92 percent of plots with IPS (2019). It is important to note the sample size when considering the percentage increase or decrease. For example, it appears the percentage of plots with IPS increased by 34 percent in North Dakota between 2014 and 2019. However, the number of plots monitored is

relatively small with 22 measured in 2014 and 15 measured in 2019. Several states have relatively small sample sizes. Despite having fewer plots, the data still provide valuable information, but with greater uncertainty.

Overall, the number of plots with IPS increased by about 3 percent between 2014 and 2019. Looking at each state individually, 18 of the 24 states show an increase in the percentage of plots with IPS. In general, there is an increase in the percentage of plots with IPS observed, as well as an increase in the number of invasive plants per plot. This will be important to watch in future inventories.

Table 1.—Number of monitored Invasive Plant Species (IPS) per plot in 2014 and 2019, for each of the states monitored by the Northern Research Station Forest Inventory and Analysis. Percentages are rounded to the nearest hundredth.

Number of Invasive Plant Species Per Plot																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Plots Monitored	Percent of Plots with IPS	
Connecticut 2014	18	11	8	7	8	4	2	1	2	0	0	0	0	0	61	70.49	
Connecticut 2019	10	3	6	7	5	5	4	3	0	0	1	0	0	0	44	77.27	
Delaware 2014	5	7	2	3	1	1	0	0	1	1	0	0	0	0	21	76.19	
Delaware 2019	7	2	3	1	2	0	0	0	0	0	0	0	0	0	15	53.33	
Illinois 2014	26	32	50	35	20	8	1	1	1	0	1	0	0	0	175	85.14	
Illinois 2019	14	14	28	33	21	7	3	1	0	0	1	1	0	0	123	88.62	
Indiana 2014	22	53	71	50	43	17	8	9	3	0	1	0	0	0	277	92.06	
Indiana 2019	4	14	23	35	14	11	8	4	2	0	0	0	0	0	115	96.52	
Iowa 2014	6	35	32	15	13	2	1	0	0	0	0	0	0	0	104	94.23	
Iowa 2019	6	24	14	18	7	6	1	0	0	0	0	0	0	0	76	92.11	
Kansas 2014	67	32	12	5	0	0	0	0	0	0	0	0	0	0	116	42.24	
Kansas 2019	40	24	5	3	0	0	0	0	0	0	0	0	0	0	72	44.44	
Maine 2014	438	46	3	5	1	0	0	0	0	0	0	0	0	0	493	11.16	
Maine 2019	340	34	5	4	1	1	0	0	0	0	0	0	0	0	385	11.69	
Maryland 2014	30	6	7	8	8	4	6	3	3	0	0	0	0	0	75	60.00	
Maryland 2019	20	7	3	1	7	3	5	1	2	0	0	0	0	0	49	59.18	
Massachusetts 2014	50	12	5	11	7	3	0	4	0	0	0	0	0	0	92	45.65	
Massachusetts 2019	38	9	6	4	4	1	1	1	0	0	0	0	0	0	64	40.63	
Michigan 2014	416	108	48	19	12	7	7	4	1	1	0	0	0	0	623	33.23	
Michigan 2019	247	73	38	20	13	11	3	1	0	0	0	0	0	0	406	39.16	
Minnesota 2014	374	209	92	35	11	5	0	0	0	0	0	0	0	0	726	48.48	
Minnesota 2019	152	99	67	29	13	4	0	0	0	0	0	0	0	0	364	58.24	
Missouri 2014	197	206	61	27	5	2	0	0	0	0	0	0	0	0	498	60.44	
Missouri 2019	131	123	50	33	7	3	0	0	0	0	0	0	0	0	347	62.25	
Nebraska 2014	37	13	4	1	1	0	0	0	0	0	0	0	0	0	56	33.93	
Nebraska 2019	27	16	5	2	3	0	0	0	0	0	0	0	0	0	53	49.06	
New Hampshire 2014	125	7	2	3	1	0	1	0	0	0	0	0	0	0	139	10.07	
New Hampshire 2019	78	6	4	2	2	0	1	0	0	0	0	0	0	0	93	16.13	
New Jersey 2014	35	5	2	9	2	3	4	3	2	1	1	0	0	0	67	47.76	
New Jersey 2019	23	6	4	2	5	3	1	2	3	3	0	0	0	0	52	55.77	
New York 2014	258	79	69	51	33	25	14	7	1	1	1	0	0	0	539	52.13	
New York 2019	177	50	55	45	22	20	7	6	2	0	0	0	0	0	384	53.91	
North Dakota 2014	9	9	2	2	0	0	0	0	0	0	0	0	0	0	22	59.09	
North Dakota 2019	1	5	8	1	0	0	0	0	0	0	0	0	0	0	15	93.33	
Ohio 2014	15	36	50	57	50	36	14	10	3	1	0	0	0	0	272	94.49	
Ohio 2019	3	20	30	39	40	25	12	7	1	3	1	0	0	0	181	98.34	
Pennsylvania 2014	267	98	69	82	57	44	25	22	12	4	6	2	0	0	688	61.19	
Pennsylvania 2019	246	89	81	72	59	50	32	25	17	11	5	0	0	1	688	64.24	
Rhode Island 2014	11	3	1	4	0	0	0	0	0	0	0	0	0	0	19	42.11	
Rhode Island 2019	2	0	1	3	0	0	0	0	0	0	0	0	0	0	6	66.67	
South Dakota 2014	45	14	2	0	0	0	0	0	0	0	0	0	0	0	61	26.23	
South Dakota 2019	31	18	1	0	0	0	0	0	0	0	0	0	0	0	50	38.00	
Vermont 2014	91	14	5	6	3	1	0	0	0	0	0	0	0	0	120	24.17	
Vermont 2019	76	9	3	6	1	1	1	0	0	0	0	0	0	0	97	21.65	
West Virginia 2014	63	52	61	35	44	23	15	9	4	0	0	0	0	0	306	79.41	
West Virginia 2019	46	37	35	30	25	15	11	9	2	2	1	0	0	0	213	78.40	
Wisconsin 2014	468	177	79	47	24	11	3	0	2	0	0	0	0	0	811	42.29	
Wisconsin 2019	191	77	42	22	13	2	2	3	0	0	0	0	0	0	352	45.74	
Grand Total 2014	3,073	1,264	737	517	344	196	101	73	35	9	10	2	0	0	6,361	51.69	
Grand Total 2019	1,910	759	517	412	264	168	92	63	29	19	9	1	0	1	4,244	55.00	
Percentage of Plots																	
with IPS 2014	48.31	19.87	11.59	8.13	5.41	3.08	1.59	1.15	0.55	0.14	0.16	0.03	0.00	0.00	--	--	
Percentage of Plots																	
with IPS 2019	45.00	17.88	12.18	9.71	6.22	3.96	2.17	1.48	0.68	0.45	0.21	0.02	0.00	0.02	--	--	
Change in Percentage of Plots with IPS																	
Since 2014	-3.31	-1.99	0.60	1.58	0.81	0.88	0.58	0.34	0.13	0.31	0.05	-0.01	0.00	0.02	--	--	

Invasive Plant Species on Phase 2 Plus Plots

In addition to monitoring the statewide trends, it is also important to watch species level changes. Most of the 44 invasive species monitored by the NRS show an increase in the percentage of plots they were observed on between 2014 and 2019 (Table 2). However, there were 12 species that showed a decrease. These species all had declines of less than 1 percent and are highlighted in gray. For the species that increased in the percentage of plots they were observed on since 2014, Amur honeysuckle had the largest increase at 5.38 percent. This was closely followed by garlic mustard (3.21 percent), Japanese stiltgrass (2.95 percent),

and nonnative bush honeysuckle (2.77 percent). Both the proportion of forest land with IPS and the percentage of plots with IPS showed a general increase between 2014 and 2019 with relatively few exceptions. Each are key aspects to watch as they both indicate different facets. One relates to how much of an area the IPS cover and the other relates to the presence of the species across the region, not factoring in the abundance on plots. As shown in Table 2, one can increase while the other decreases and vice versa. Because IPS data are collected on a small subset of forested plots, it is important to note that the differences may not be statistically significant.

Table 2.—Proportion of forest land and percent of plots with select Invasive Plant Species (IPS) for each of the states monitored by the Northern Research Station, 2014 and 2019. Rows shaded gray are species that decreased in the percentage of plots between 2014 and 2019. Percentages are rounded to the nearest hundredth.

Species	Proportion of forest land with IPS		Change in forest proportion with IPS	Number of plots IPS observed	Percent of plots with IPS		Change in percent of plots with IPS
	2014	2019	2014–2019	2019	2014	2019	2014–2019
Multiflora rose (<i>Rosa multiflora</i>)	1.47	1.63	0.15	1,328	28.77	31.29	2.52
Garlic mustard (<i>Alliaria petiolata</i>)	0.75	0.68	-0.07	554	9.84	13.05	3.21
Nonnative bush honeysuckle (<i>Lonicera spp.</i>)	0.45	0.64	0.19	483	8.61	11.38	2.77
Japanese stiltgrass (<i>Microstegium vimineum</i>)	1.12	1.74	0.61	404	6.57	9.52	2.95
Autumn olive (<i>Elaeagnus umbellata</i>)	0.38	0.51	0.13	370	6.74	8.72	1.97
Japanese honeysuckle (<i>Lonicera japonica</i>)	1.06	0.84	-0.22	339	7.45	7.99	0.54
Japanese barberry (<i>Berberis thunbergii</i>)	0.18	0.25	0.07	334	6.01	7.87	1.86
Common buckthorn (<i>Rhamnus cathartica</i>)	0.60	0.65	0.05	295	6.57	6.95	0.38
Reed canarygrass (<i>Phalaris arundinacea</i>)	0.70	0.78	0.08	291	7.39	6.86	-0.53
Black locust (<i>Robinia pseudoacacia</i>)	0.48	0.45	-0.03	262	6.35	6.17	-0.18
Amur honeysuckle (<i>Lonicera maackii</i>)	0.42	0.81	0.39	246	0.42	5.80	5.38
Oriental bittersweet (<i>Celastrus orbiculatus</i>)	0.26	0.37	0.11	243	3.96	5.73	1.76
Canada thistle (<i>Cirsium arvense</i>)	0.06	0.07	0.01	196	3.80	4.62	0.81
Morrow's honeysuckle (<i>Lonicera morrowii</i>)	0.42	0.42	0.00	191	5.28	4.50	-0.78
European privet (<i>Ligustrum vulgare</i>)	0.13	0.16	0.02	160	2.44	3.77	1.33
Tree of heaven (<i>Ailanthus altissima</i>)	0.20	0.25	0.05	129	2.23	3.04	0.81
Glossy buckthorn (<i>Frangula alnus</i>)	0.24	0.27	0.03	101	2.34	2.38	0.04
Bull thistle (<i>Cirsium vulgare</i>)	0.02	0.01	0.00	98	2.14	2.31	0.17
Creeping jenny (<i>Lysimachia nummularia</i>)	0.13	0.10	-0.03	74	1.92	1.74	-0.17
Norway maple (<i>Acer platanoides</i>)	0.11	0.09	-0.02	45	0.77	1.06	0.29
Dames rocket (<i>Hesperis matronalis</i>)	0.07	0.04	-0.03	38	0.82	0.90	0.08
Siberian elm (<i>Ulmus pumila</i>)	0.10	0.25	0.14	37	0.72	0.87	0.15
European cranberrybush (<i>Viburnum opulus</i>)	0.01	0.04	0.03	36	0.19	0.85	0.66
Common barberry (<i>Berberis vulgaris</i>)	0.01	0.02	0.00	36	0.63	0.85	0.22
Spotted knapweed (<i>Centaurea stoebe ssp. micranthos</i>)	0.07	0.11	0.04	34	0.85	0.80	-0.05
Common reed (<i>Phragmites australis</i>)	0.07	0.13	0.06	19	0.36	0.45	0.09
Tatarian honeysuckle (<i>Lonicera tatarica</i>)	0.03	0.03	0.00	15	0.72	0.35	-0.37
Japanese knotweed (<i>Polygonum cuspidatum</i>)	0.02	0.06	0.03	13	0.36	0.31	-0.06
Russian olive (<i>Elaeagnus angustifolia</i>)	0.03	0.12	0.09	11	0.27	0.26	-0.01
Japanese meadowsweet (<i>Spiraea japonica</i>)	0.05	0.03	-0.02	11	0.16	0.26	0.10
English ivy (<i>Hedera helix</i>)	0.01	0.04	0.03	10	0.06	0.24	0.17
Princesstree (<i>Paulownia tomentosa</i>)	0.07	0.02	-0.05	8	0.19	0.19	0.00
Leafy spurge (<i>Euphorbia esula</i>)	0.01	0.02	0.01	7	0.17	0.16	-0.01
Purple loosestrife (<i>Lythrum salicaria</i>)	0.01	0.01	0.00	5	0.11	0.12	0.01
Giant knotweed (<i>Polygonum sachalinense</i>)	0.01	0.04	0.03	3	0.09	0.07	-0.02
Showy fly honeysuckle (<i>Lonicera x bella</i>)	0.04	0.00	-0.03	3	0.68	0.07	-0.61
Silktree (<i>Albizia julibrissin</i>)	0.01	0.01	0.00	2	0.02	0.05	0.03
Louise's swallow-wort (<i>Cynanchum louiseae</i>)	0.00	0.00	0.00	2	0.05	0.05	0.00
Saltcedar (<i>Tamarix ramosissima</i>)	--	0.01	0.01	1	--	0.02	0.02
European swallow-wort (<i>Cynanchum rossicum</i>)	--	0.00	0.00	1	--	0.02	0.02
Chinaberry (<i>Melia azedarach</i>)	0.00	--	0.00	0	0.02	--	-0.02

Of the 44 species monitored, multiflora rose was the most common. Forty-one species were observed on plots in the span of time covered by this report. The three species that were not found are Bohemian knotweed, punktree, and tallow tree. This does not mean they do not exist in the region, but that they were not found on the plots inventoried. Additionally, three of the species observed

did not occur in both inventories. Chinaberry was only found in 2014 whereas saltcedar and European swallow-wort were only found in 2019. Various mechanical and biological control methods are useful to keep the populations of IPS in check. The data may also be utilized to see the effects of widespread biological control or disease impacts on the monitored species.

Reference

USDA Forest Service. 2021. **Forest inventory and analysis national core field guide, vol. 1: field data collection procedures for phase 2 plots, ver. 9.1.** <https://www.usda.gov/library/field-guides-methods-proc/> (accessed March 24, 2022).

FIA Program Information

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Additional Invasive Plant Information

Invasive and Exotic Plants: <http://www.invasive.org/species/weeds.cfm>

Invasive Plant Atlas of New England: <http://www.eddmaps.org/ipane/>

Invasive Plant Atlas of the United States: <http://www.invasiveplantatlas.org/index.html>

Midwest Invasive Plant Network: <http://mipn.org/>

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Footnotes (from page 1)

¹ Hereafter IPS may also be referred to as "invasive species," "invasive plants," or "invasives."

² FIA defines forest land as land that is at least 10 percent stocked with trees of any size or land formerly having had such tree cover and not currently developed for nonforest use. Generally, the minimum area for classification as a forest is 1 acre in size and at least 120 feet in width. There are more specific criteria for defining forest land near streams, rights-of-way, and shelterbelt strips (USDA Forest Service 2021).

³ Amur honeysuckle (*Lonicera maackii*); autumn olive (*Elaeagnus umbellata*); black locust (*Robinia pseudoacacia*); Bohemian knotweed (*Polygonum xbohemicum*); bull thistle (*Cirsium vulgare*); Canada thistle (*Cirsium arvense*); Chinaberrytree (*Melia azedarach*); common barberry (*Berberis vulgaris*); common buckthorn (*Rhamnus cathartica*); common reed (*Phragmites australis*); creeping jenny (*Lysimachia nummularia*); dames rocket (*Hesperis matronalis*); English ivy (*Hedera helix*); European cranberrybush (*Viburnum opulus*); European privet (*Ligustrum vulgare*); European swallow-wort (*Cynanchum rossicum*); garlic mustard (*Alliaria petiolata*); giant knotweed (*Polygonum sachalinense*); glossy buckthorn (*Frangula alnus*); Japanese barberry (*Berberis thunbergii*); Japanese honeysuckle (*Lonicera japonica*); Japanese knotweed (*Polygonum cuspidatum*); Japanese meadowsweet (*Spiraea japonica*); Japanese stiltgrass (*Microstegium vimineum*); leafy spurge (*Euphorbia esula*); Louise's swallow-wort (*Cynanchum louiseae*); multiflora rose (*Rosa multiflora*); Morrow's honeysuckle (*Lonicera morrowii*); nonnative bush honeysuckle (*Lonicera* spp.); Norway maple (*Acer platanoides*); oriental bittersweet (*Celastrus orbiculatus*); princess tree (*Paulownia tomentosa*); punktree (*Melaleuca quinquenervia*); purple loosestrife (*Lythrum salicaria*); reed canarygrass (*Phalaris arundinacea*); Russian olive (*Elaeagnus angustifolia*); saltcedar (*Tamarix ramosissima*); showy fly honeysuckle (*Lonicera x bella*); Siberian elm (*Ulmus pumila*); silktree (*Albizia julibrissin*); spotted knapweed (*Centaurea stoebe* ssp. *micranthos*); tallow tree (*Triadica sebifera*); tatarian honeysuckle (*Lonicera tatarica*); tree of heaven (*Ailanthus altissima*).