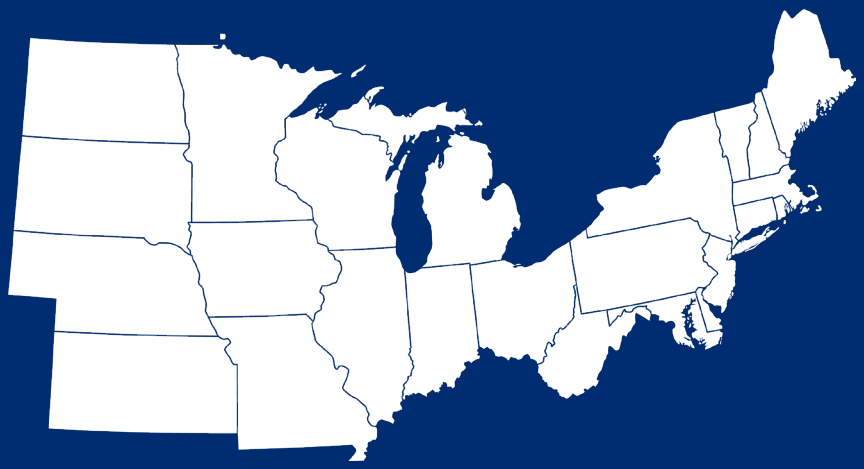
USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Research Station | General Technical Report NRS-239 | May 2026

Invasive Plant Species Monitored by the Northern Research Station Forest Inventory and Analysis Program: Comparing the 2009, 2014, and 2019 Inventories



Citation

Kurtz, Cassandra M. 2026. **Invasive plant species monitored by the Northern Research Station Forest Inventory and Analysis Program: Comparing the 2009, 2014, and 2019 inventories**. Gen. Tech. Rep. NRS–239. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 127 p. https://doi.org/10.2737/NRS-GTR-239.

Abstract

Invasive plant species (IPS) are causing vast changes across the landscape. They have widespread impacts from aesthetics to agricultural and ecological damage, costing billions of dollars to mitigate. Despite their negative impacts, many are planted for erosion control and site reclamation due to their quick colonization and ability to withstand harsh environments. Additionally, these species are utilized for herbal, medicinal, and aesthetic qualities. The U.S. Department of Agriculture, Forest Service, Forest Inventory Analysis (FIA) program collects invasive plant data on both public and private forest ownerships. This report focuses on the 44 IPS species monitored in the 24 Midwestern and Northeastern states that comprise the region monitored by the Northern Research Station (NRS).

Keywords: alien plants, exotic plants, exotic weeds, introduced plants, invasion, invasive plants, invasive species, invasive weeds, noxious plants

About the Author

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Acknowledgments

I would like to thank the field crew, trainers, database programmers, and state partners for their roles in data collection and processing. I am grateful for Scott Pugh who has provided superior assistance obtaining the invasive plant data and answering database questions. Additionally, I am thankful for Cassandra Olson and Donald Brown for their review of this document and the Communications and Science Delivery staff for their work in editing and putting the finishing touches on this publication.

Cover photos: Top row: Amur peppervine fruits, map of Northern Research Station area of responsibility. Middle row: Tatarian honeysuckle, princesstree, silktree. Bottom row: chinaberrytree, creeping jenny, Norway maple. See text for photo credits.

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Published by:
USDA Forest Service
One Gifford Pinchot Drive
Madison, WI 53726
May 2026

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Preface

This publication was written to update the 2013 publication: An Assessment of Invasive Plant Species Monitored by the Northern Research Station Forest Inventory and Analysis Program, 2005 through 2010 (Kurtz 2013), which included Forest Inventory and Analysis plots measured across the 24 states covered by the Northern Research Station over a 5-year period. This edition includes new bands of analysis with comparisons for inventories from 2009, 2014, and 2019. The sequential analysis offers insight into changes in invasive cover and spread, important facets in monitoring, and dealing with these aggressive invasive plant species.

Introduction

Invasive plants species (IPS) consist of native and nonnative species that can spread aggressively and outcompete surrounding vegetation, causing deleterious impacts. They can impact both nutrient and carbon cycles, and many yield a proliferation of seeds and are capable of rooting from tiny fragments. Stein and Flack (1996) highlight an important point, "Of the approximately 4,000 exotic plant species and 2,300 non-native animal species in the United States, most cause few problems."

Despite their beneficial uses for ecological site remediation, and culinary and medicinal use, some IPS cause huge agricultural impacts. Common barberry (*Berberis vulgaris*) is an alternate host for wheat stem rust which can cause the complete loss of grain fields. Another problematic plant is common buckthorn (*Rhamnus cathartica*) which is an alternate host for the soybean aphid (*Aphis glycines*; Kurtz 2013).

Monitoring these IPS is important, as these aggressive plants present a worldwide concern that is costly to manage and impacts forest productivity, habitats, and recreation quality. Across the United States, IPS affect millions of acres and cost society billions of dollars annually. From 1985 to 1995, IPS more than quadrupled their impacted region in the western United States and are annually increasing at 14.0 percent, spreading across western federal lands at 4,600 acres per day (Czarapata 2005, Kaufman and Kaufman 2007, Westbrooks 1998).

IPS have been monitored on a subset of Phase 2 (P2) FIA plots in the Midwest since 2005 and in the Northeast since 2007. Data collection was year-round in 2005 and 2006 occurring on 100 percent of the P2 plots. In 2007, sampling changed to the summer window, May through September. With the change in the sampling window, sampling intensity also changed. From 2007 through 2011, IPS data were collected on 20 percent of plots whereas, from 2012 through present, 12.5 percent of Phase 2 plots have invasive plants monitored on them. This subset of plots is called the Phase 2 Plus (P2+) sample. To reduce confusion, in this report, all inventory plots are referred to as P2 invasive plots as the name of these plots has changed over time. This report offers an update to the 2013 IPS report (Kurtz 2013) where the inventory data from 2005 through 2010 were analyzed.

NRS FIA field crews monitored 5,309 forested plots for invasive plants during the 2009 inventory, 6,361 in the 2014 inventory, and 4,244 in the 2019 inventory. The inventory years represent the end year in the range and offer 5-year comparisons. There is some plot overlap where plot information is used in two of the analysis periods. For example, the 2009 inventory represents plots measured from 2007 through 2009. The 2014 inventory represents some plots measured in 2009 and those measured from 2010 through 2014. The 2019 inventory represents some plots in 2013, and those inventoried 2014 through 2019. This overlap is because FIA traditionally reports on a 5-year interval. For the period

of analysis in this report, the amount of time for complete mensuration of an NRS state changed. For 2007 through 2013, states were (re)measured on a 5-year interval. In 2014, the cycle length was changed to seven years with some states offering support to continue the 5-year sampling interval. Due to the lengthened measurement interval, there is some overlap with 5-year reporting.

Along with the standard forest variables collected during P2 measurement (e.g., tree diameter, height, crown information), P2 invasive plots have various other attributes collected, including the occurrence and coverage of IPS, vegetation structure, and down woody debris. Each Forest Service FIA region has a specific list of invasive plants they monitor based on stakeholder interest. This report focuses on the 44 IPS monitored in the NRS region. I will refer to the invasives as 44 monitored, as there are 43 collected at the species level plus one undifferentiated genus (nonnative bush honeysuckle, *Lonicera* spp.). In the previous publication (Kurtz 2013), all species level nonnative bush honeysuckle data were lumped with the genus level observations. In this publication, I noted the species reported by the field crew and did not combine species level data for nonnative bush honeysuckle. Observations shown as nonnative bush honeysuckle in this report are from incidences where field crew did not differentiate the genus to species level. Additionally, this publication does not include the seven species that were only monitored from 2005 to 2006 in the Midwestern region (Amur peppervine (*Ampelopsis brevipedunculata*), Asiatic tearthumb (*Polugonum* x*bohemicum*), Chinese yam (*Dioscorea oppositifolia*), kudzu (*Pueraria montana*), lesser burdock (*Arctium minus*), marsh thistle (*Cirsium palustre*), and winter creeper (*Euonymus fortunei*)).

Overall, 46.1 percent of forested plots had one or more of the monitored invasives present in 2009, 51.7 percent in 2014, and 55.0 percent in 2019. FIA data shows an increase in the number of plots with invasive plants present over time, as well as an increase in the number of different IPS on each plot (Table 1). These changes are also apparent in Tables 2, 3, and 4, to a lesser extent, as individual species deviation is more difficult to notice versus overall trends (Table 1). Monitoring will clarify our understanding of regional distribution and abundance and will help educate individuals about potential risk species across the NRS region.

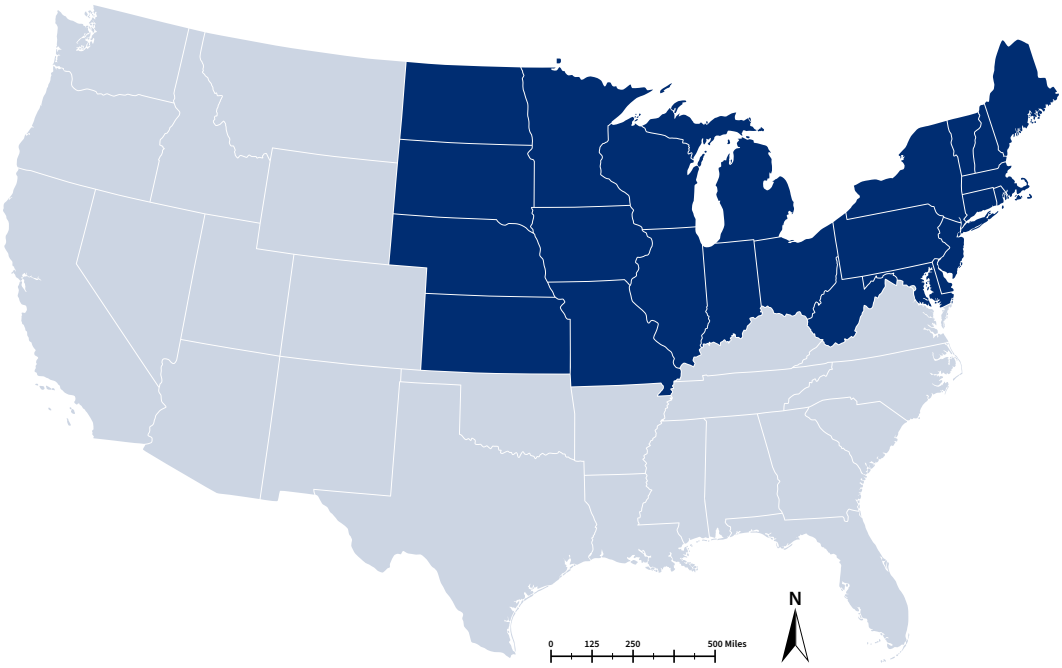
To provide a better understanding of the data, a brief overview of the FIA survey plots follows (see Westfall et al. 2022 for more details). Sample plots are randomly located throughout the NRS region. A plot consists of four subplots which total approximately 1/6 acre. The inventory is only conducted on plots that are at least 10.0 percent canopy cover by trees which comprise an area 120.0 feet wide or larger for at least 363 feet (total area of one acre or more). Each P2 plot represents approximately 6,000 acres, except in some states and national forests where there is regional intensification of plots. Invasive plant species are measured on a subset of the P2 field plots (P2 invasive plots), where the IPS of interest are recorded. Some of the IPS measured on the invasive plots also show up on the P2 plots as tally trees, however, the herb, shrub, and graminoids measured are exclusive to the P2 invasive plots.

In addition to variation in the amount of forest across the region, it is also important to remember that there are differences in sampling intensity by state and ownership, such as national forests. When looking at the maps, these caveats affect the number of plots. Caution is warranted because observing a species in a state with a low number of samples causes the percentage of plots with the species to be large for that given state. The tables in this publication help illustrate some of the differences by showing the number of plots monitored by state and year.

This document provides a regional overview of IPS monitored on NRS FIA plots and presents the species alphabetically by common name. The objective is to inform citizens about the current status of the selected IPS on forest land across the NRS FIA region by highlighting all observances from 2007 to 2019. Data includes common and scientific name, PLANTS Database code (USDA NRCS 2023), country or countries of origin, when it was introduced, species characteristics, where the species is currently found, and the results from FIA P2 invasive monitoring.

Maps throughout this report were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

The term "constancy" is included with the P2 invasive plot results and refers to the proportion of plots where the species is recorded. When applicable, noxious weed designations (restricted, banned, prohibited, and noxious) are included (USDA NRCS 2023). The definition of these terms follows. Restricted species are commonly observed plants which have detrimental impact and are controlled by prohibiting buying or selling, except by special permit. Banned species are plants which are illegal to buy or sell. Prohibited species are not present or present in low numbers, cannot be bought or sold, and require removal. Noxious species are those which are considered damaging to property, health, or the environment, and can be further categorized by classes ranging from A to C. Those plants classified as Class A noxious weeds are not present or found in limited numbers in a state, Class B are found in moderate numbers, while Class C weeds are commonly found throughout the state. The control of these species' ranges from high priority with the Class A weeds to reduced management of Class C weeds, however, control of Class C noxious weeds can be highly enforced depending on the local threat.



Map showing the 24 states that comprise the Northern Research Station (NRS) area of focus. All studies and surveys associated with this report were performed within this region.

Amur honeysuckle

(*Lonicera maackii*)

LOMA6

Background and characteristics: Amur honeysuckle, a member of the honeysuckle family (Caprifoliaceae), is native to central and northeastern China, Korea, and Japan and was introduced to the United States in 1898 (Luken and Thieret 1996). Often grown as an ornamental hedge, this aggressive wood shrub features abundant white flowers (Fig. 1) and attractive small red fruit. Amur honeysuckle creates a dense cover which displaces forest understory and inhibits regeneration, modifying forest composition and structure. This long-lived shrub resprouts readily with dispersion facilitated by birds who distribute the fruit across the landscape (Bartuszevige et al. 2007, Luken and Thieret 1996).

Figure 1.—Amur honeysuckle in flower. Licensed photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Amur honeysuckle grows in varying light levels but will not grow in deep shade. In forests, carbon gain is minimal and reduces its vigor (Luken and Thieret 1996). This noxious shrub is fire tolerant, can survive to -33.0 °F, 25.0 to 60.0 inches annual precipitation, 100 or more frost free days, pH levels of 5.5 to 8.0, and a minimum rooting depth of 16.0 inches. Additional limitations are its intolerance of drought, salinity, and anaerobic and calcareous soils (USDA NRCS 2023).

Current distribution: Despite having the preceding site limitations, Amur honeysuckle has spread across the eastern United States, creating nearly impenetrable shrub layers. It is now found in 27 states, obtaining invasive, prohibited status in Connecticut, Tier 1 invasive/noxious in Massachusetts, and prohibited in New York (USDA NRCS 2023).

Plot presence: Amur honeysuckle is the 11th most observed IPS, occurring on 246 of 4,244 NRS FIA plots in 2019 (5.8 percent; Table 5). In 2014, 4.0 percent of plots had this species (Table 6) and in 2009, 2.9 percent of plots had Amur honeysuckle (Table 7). This shows a gradual increase in the percentage of plots of Amur honeysuckle over time. Figures 2, 3, and 4 show how this species has changed in cover and spread in the region over time on FIA plots. At a glance, the change seems fairly minimal based on the three time points. However, it is somewhat difficult to see from the figures because the number of plots monitored varied by inventory year with 5,309 measured in 2009, 6,361 measured in 2014, and 4,244 measured in 2019.

Of the 24 NRS FIA states, Illinois has the greatest percentage of plots with Amur honeysuckle for each inventory. In 2019, 55.3 percent of plots in Illinois had this aggressive IPS, 39.4 percent in 2014, and 18.8 percent in 2009. This suggests the abundance of the species may be increasing throughout the state. Across the NRS region, Amur honeysuckle is present in 14 of the 24 states in 2019.

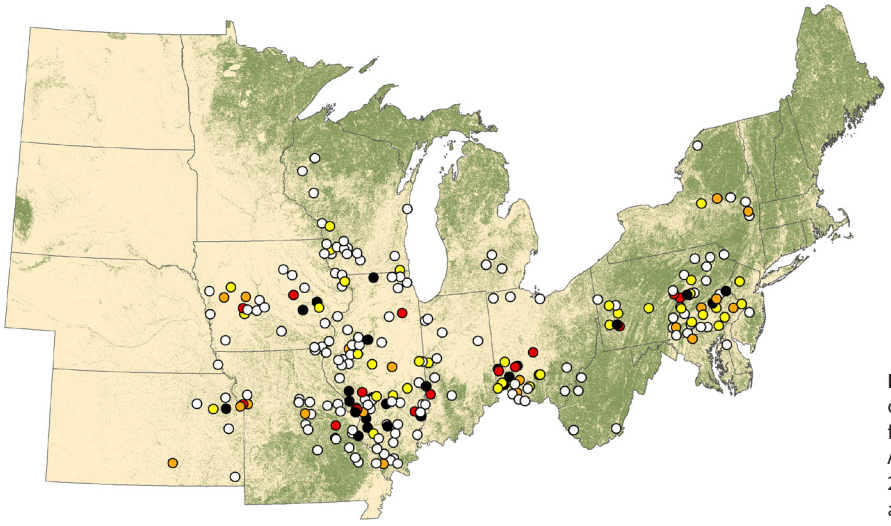


Figure 2.—Average cover of Amur honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

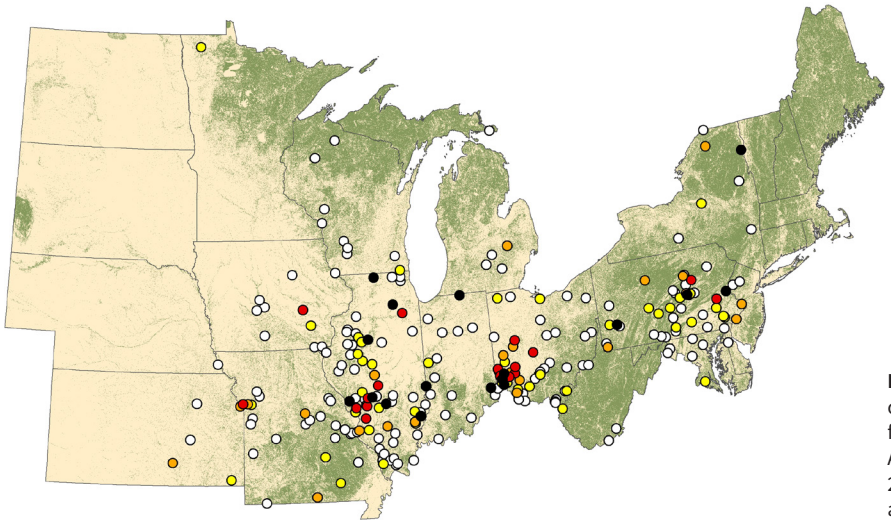


Figure 3.—Average cover of Amur honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

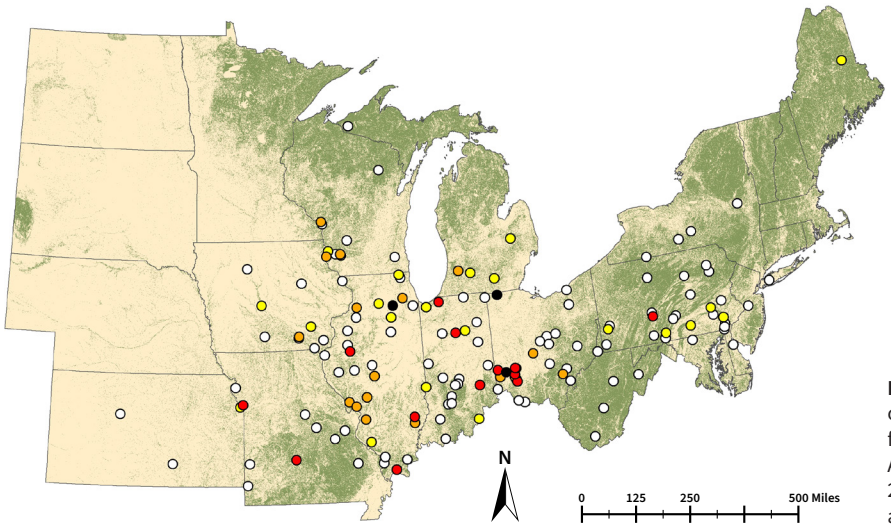


Figure 4.—Average cover of Amur honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Amur peppervine

(*Ampelopsis brevipedunculata*)

AMBR7

Background and characteristics: Amur peppervine, also known as porcelain berry, is a woody vine of the grape family (Vitaceae) that is native to Russia, China, Korea, and Japan and was introduced to North America as an ornamental near the end of the 19th century (Kaufman and Kaufman 2007). This invasive vine is primarily sold in variegated form and offers attractive grape-like foliage and colorful fruits (Fig. 5). Birds and small animals disperse the fruits, facilitating its spread (Kaufman and Kaufman 2007).

Figure 5.—Amur peppervine fruit. Licensed photo by Randy Westbrooks, Invasive Plant Control, Inc./ Bugwood.org

Growth of Amur peppervine is generally on moist soils in areas of moderate to high light (Boos et al. 2010, Kaufman and Kaufman 2007). Where it establishes, this invasive vine impedes growth by shading out neighboring species, girdling vegetation, and reducing photosynthesis. Amur peppervine can climb up to 20.0 feet (Kaufman and Kaufman 2007). By growing up and over forest vegetation, Amur peppervine creates fuel continuity from the forest floor into the canopy, increasing the fuel load and likelihood of a crown fire (Zouhar et al. 2008).

Current distribution: Amur peppervine is found in 18 eastern states with Connecticut listing it as invasive and New York listing it as prohibited (USDA NRCS 2023).

Plot presence: Amur peppervine is not currently found on NRS FIA P2 invasive plots in the NRS region. In a previous report of FIA plots, which dates back to the 2005 inventory, Kurtz (2013) found this IPS present in two states in the NRS FIA region, Ohio and Pennsylvania.

Asiatic tearthumb

(*Polygonum perfoliatum* syn. *Persicaria perfoliata*)

POPE10

Background and characteristics: Asiatic tearthumb, also known as mile-a-minute vine, Devil's tail, tearthumb, Gangbangui, and Devil shield, is an annual vine of the buckwheat family (Polygonaceae). This invader is native to east Asia, China, India, and Japan and was brought to Portland, Oregon by ship ballast in 1890, but it was not until the late 1930s, when seeds came into a Pennsylvania nursery shipment of rhododendrons, that this IPS began to escape and establish naturalized populations (Kaufman and Kaufman 2007).

Figure 6.—Asiatic tearthumb infestation, smothering forest vegetation. Licensed photo by Richard Gardner/Bugwood.org.

Frequently found growing in moist areas, such as along streams, water is an important vector. Animals are another vector of the fruit and contribute to the spread of this invasive vine (Kaufman and Kaufman 2007). Asiatic tearthumb is found mainly in the mid-Atlantic and northeastern United States in sun to part shade, grows at a rate of up to 6.0 inches per day, and can reach up to 15.0 feet long (Kaufman and Kaufman 2007). Seeds of Asiatic tearthumb require about 2 months of temperatures below 46.0 °F to germinate (Kaufman and Kaufman 2007). The specific growth requirements of this vine restrict its presence. Asiatic tearthumb (Fig. 6) is detrimental to the forest as it grows up vegetation and across the forest floor, impeding photosynthesis of other plant species.

Current distribution: Asiatic tearthumb is recorded in 12 states and is listed as noxious, invasive, prohibited, or on the watch list in the following 5 states: Alabama, Connecticut, Michigan, North Carolina, and New York (USDA NRCS 2023).

Plot presence: Asiatic tearthumb is not currently found on NRS FIA P2 invasive plots in the NRS region. In a previous report of FIA plots which dates back to the 2005 inventory, Kurtz (2013) found this IPS present on 5 plots. It was found in Maryland, Pennsylvania, and West Virginia.

Autumn olive

(*Elaeagnus umbellata*)

ELUM

Background and characteristics: Autumn olive, a shrub of the oleaster family (Elaeagnaceae), is native to China, Japan, and Korea and was introduced to the United States in 1830 (Czarapata 2005, Kaufman and Kaufman 2007, Smith 1997). It has many characteristics of a successful invader. Autumn olive tolerates poor quality sites, is valuable as a visual screen for hedging and windrows, produces an abundance of fruit (Fig. 7), and has desirable wildlife characteristics, traits that encourage the planting of this species. Federal agencies also helped to further spread this species by promoting the planting of autumn olive (Zouhar et al. 2008). In areas where it is planted, birds and animals contribute to its spread by readily dispersing the fruit.

Figure 7.—Autumn olive fruit. Licensed photo by Richard Gardner/Bugwood.org.

Autumn olive is somewhat shade tolerant but is very rarely found in the deep shade of dense forests or on wet sites (Czarapata 2005, Smith 1997). Since autumn olive is tolerant of poor-quality sites and full sun, it is used for mine reclamation (Czarapata 2005). Where it does establish, the dense shrub impedes the growth of understory plants and can alter the forest community. Autumn olive can also impact the plant community by adding nitrogen to the soil, altering the nutrient cycle (Czarapata 2005, Kaufman and Kaufman 2007). These characteristics are a concern to land managers and can be problematic for restoration.

According to the PLANTS Database (USDA NRCS 2023), several site characteristics restrict the presence of autumn olive. This noxious shrub has high drought tolerance, requires 28.0 to 45.0 inches of precipitation annually, can survive to -23.0 °F, and needs 150 or more frost free days, pH levels between 5.0 and 7.5, and a minimum rooting depth of 18.0 inches. Additional limits to its presence are its intolerance of anaerobic soils and cold stratification requirement.

Current distribution: Autumn olive is now found in 36 states with Connecticut listing it as invasive and prohibited, Michigan as invasive and restricted, and New York as prohibited (USDA NRCS 2023).

Plot presence: Autumn olive is the 5th most commonly observed IPS, occurring on 370 of the 4,244 NRS FIA plots in 2019 (8.7 percent; Table 5). Looking at 2014, 6.7 percent of plots had this species (Table 6) and in 2009, 4.9 percent of plots had autumn olive (Table 7). Figures 8, 9, and 10 show how this species has changed in cover and spread in the region over time on FIA plots. Aside from the data showing a general increase in the percentage of plots this IPS occurs, the abundance of autumn olive per plot also increased overall. With the variation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), the subtle changes can be harder to see from a quick glance.

Of the 24 NRS FIA states, Illinois has the greatest percentage of plots with autumn olive in 2019 with 26.8 percent of plots having this aggressive IPS, 16.0 percent in 2014, and 17.5 percent in 2009. In 2014 and 2009, the state with the highest percentage of plots with autumn olive was West Virginia. Across the NRS region, autumn olive is present in 18 of the 24 states in 2019. The six states it is not present are: Delaware, Minnesota, Nebraska, North Dakota, Rhode Island, and South Dakota.

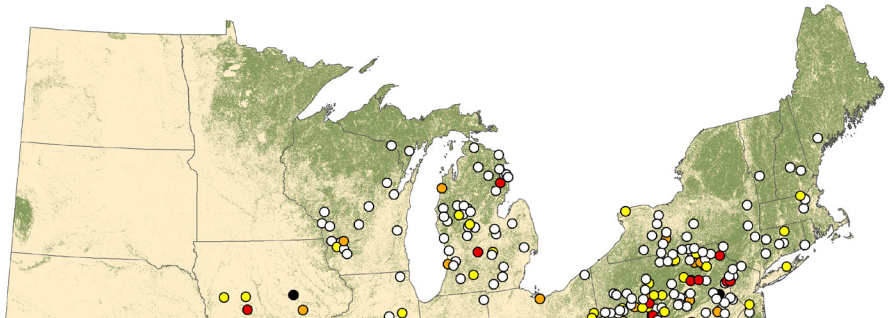


Figure 8.—Average cover of autumn olive on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

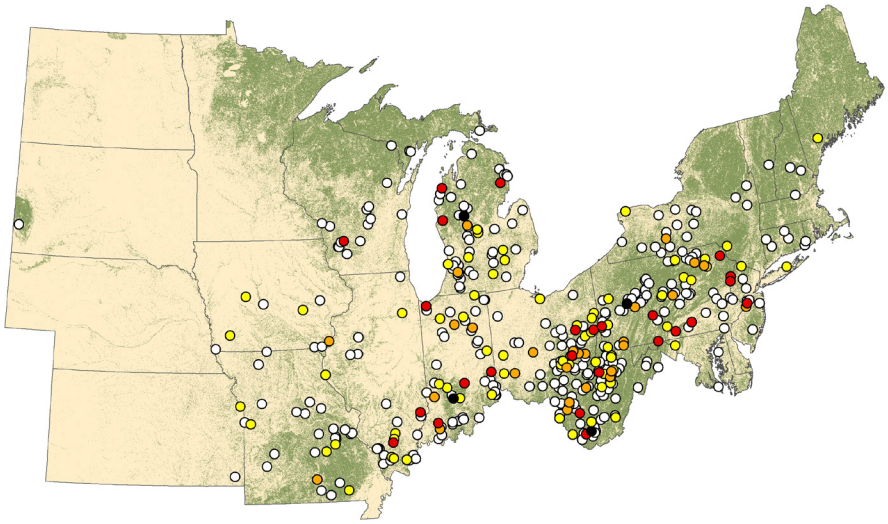


Figure 9.—Average cover of autumn olive on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

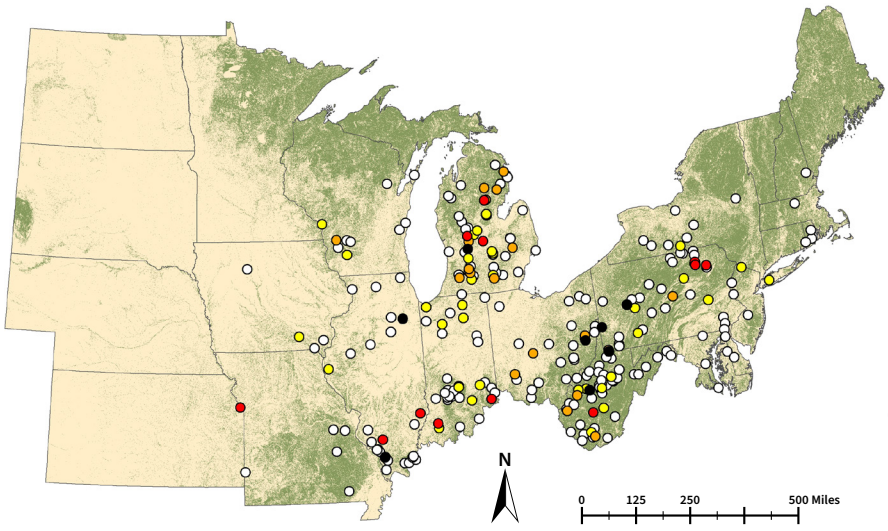


Figure 10.—Average cover of autumn olive on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Black locust

(*Robinia pseudoacacia*)

ROPS

Background and characteristics: Black locust, a fast-growing invasive tree of the legume family (Fabaceae), is native to the Appalachian Mountains and Ozark Plateau but has spread from its native range (Czarapata 2005, Kaufman and Kaufman 2007). A leguminous species, black locust can replenish the soil nitrogen level and alter species composition. It can tolerate dry, nutrient poor soils and is shade intolerant, characteristics that have contributed to its use for mine reclamation (Kaufman and Kaufman 2007). The spread of this species is also facilitated by people planting this tree for its proliferation of beautiful white flowers (Fig. 11). Its rapid growth coupled with aggressive suckering, sprouting, and seed production have helped this IPS succeed in the forest community where it shades competing vegetation. This short-lived invader is considered to have the most durable wood of any species in North America (Smith 1997).

Figure 11.—Black locust in flower. Licensed photo by Jan Samanek, Phytosanitary Administration, Bugwood.org.

Aside from the invasive tendencies of this species, black locust is medicinally important. American Indians chewed the root bark to induce vomiting and held the bark in the mouth to relieve toothaches (Foster and Duke 2000). It is also reported the flowers are used for fritters (Peterson 1977), and the species is used as a diuretic and for rheumatism, however all parts are potentially toxic, and the flower odor can cause nausea and headaches (Foster and Duke 2000).

According to the PLANTS Database (USDA NRCS 2023), it is suggested -37.0 °F is the northern limit of cold tolerance for black locust and it requires 16.0 to 65.0 inches of precipitation annually, a minimum of 140 frost free days, a pH of 4.6 to 8.2, and a rooting depth of at least 36.0 inches.

Current distribution: This IPS is present in the entire conterminous United States, with Connecticut and Michigan classifying it as an invasive and New York as a regulated species (USDA NRCS 2023).

Plot presence: Black locust is the 10th most commonly observed IPS, occurring on 262 of the 4,244 NRS FIA plots in 2019 (6.2 percent; Table 5). Looking at 2014, 6.4 percent of plots had this species (Table 6) and in 2009, 5.0 percent of plots had black locust (Table 7). Figures 12, 13, and 14 show how this species has changed in cover and spread in the region over time on FIA plots. Overall, no distinct patterns were noted. With the variation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, West Virginia has the greatest percentage of plots with black locust. In 2019, 33.3 percent of plots in West Virginia had this aggressive IPS, 38.6 percent did in 2014, and 36.3 percent in 2009. Across the NRS region, black locust is present in 17 of the 24 states in 2019. The seven states it is not present are Delaware, Kansas, Maine, New Hampshire, North Dakota, Rhode Island, and South Dakota.

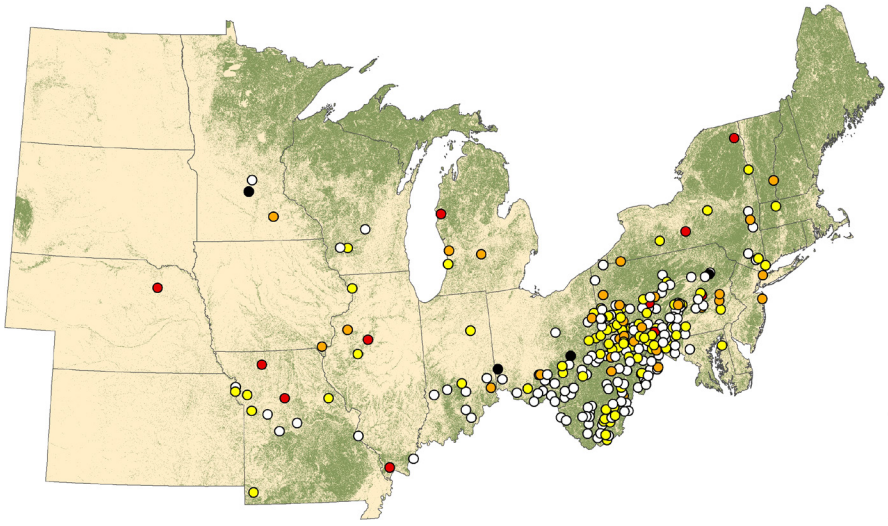


Figure 12.—Average cover of black locust on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

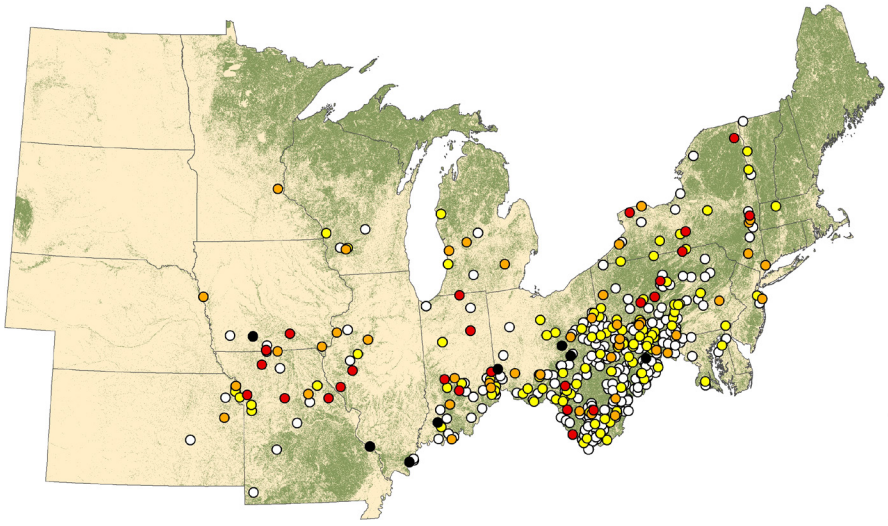


Figure 13.—Average cover of black locust on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

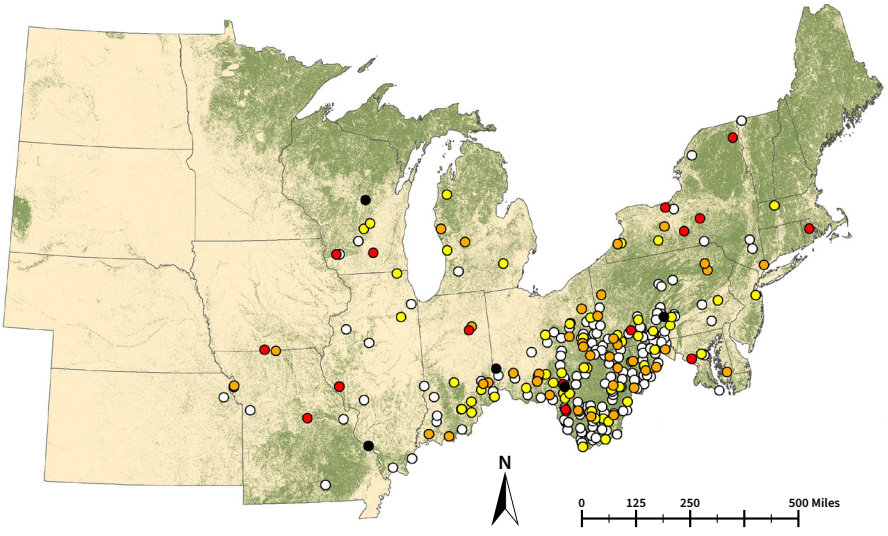


Figure 14.—Average cover of black locust on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Bohemian knotweed

(*Polygonum x bohemica* syn. *P. x bohemicum; Fallopia x bohemica; F. x bohemicum; Reynoutria x bohemica; R. x bohemicum*)

POBO10

Background and characteristics: Bohemian knotweed is an herbaceous perennial of the buckwheat family (Polygonaceae). It is a hybrid between Japanese knotweed and giant knotweed which are native to northeastern Asia and were introduced as ornamentals to Europe in the second half of the 19th century and to North America as ornamentals and fodder in the late 19th century (Murrell et al. 2011, Urgenson et al. 2009). Bohemian knotweed grows best in full sun (Fig. 15) but can tolerate some shade.

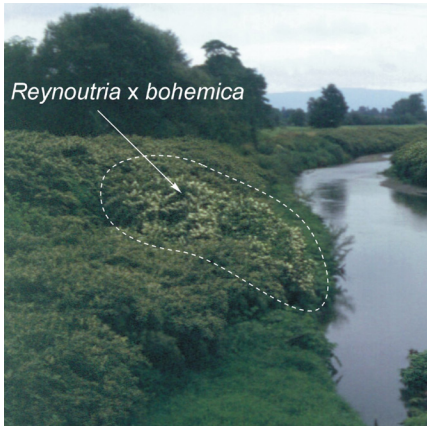


Figure 15.—Bohemian knotweed in flower. Licensed photo by Barbara Tokarska-Guzik, University of Silesia, Bugwood.org.

Bohemian knotweed is considered as one of the world's worst invasive species due to its aggressive nature, enabling it to destabilize banks along waterways and inflict structural damage to pavement and buildings (Murrell et al. 2011). Murrell et al. (2011) suggest the success of this species is not only from its ability to outcompete surrounding vegetation but may also be from allelopathic effects.

Current distribution: The extent of Bohemian knotweed presence is controversial. Urgenson (2006) suggests it is the most successful (and difficult to control) species of the *Polygonum* congeners in terms of regeneration and new shoot establishment and is thought to be more common in the United States than either of the parent species, whereas the PLANTS Database (USDA NRCS 2023) does not show any occurrences of this species in the United States. Nevertheless, New York lists Bohemian knotweed as prohibited and many states list this invader as a concern.

Plot presence: Bohemian knotweed is not a commonly observed IPS in the NRS region. The only inventory it was present was 2009, occurring on 2 of the 5,309 NRS FIA plots (6.2 percent; Table 7). Figure 16 shows the cover and spread of this species on FIA plots in 2009. Across the NRS region, Bohemian knotweed only occurred in two of the 24 states, Maryland and Pennsylvania. Throughout the period of measurement, there has been variation in the number of plots monitored each inventory: 4,244 in 2019, 6,361 in 2014, and 5,309 in 2009.

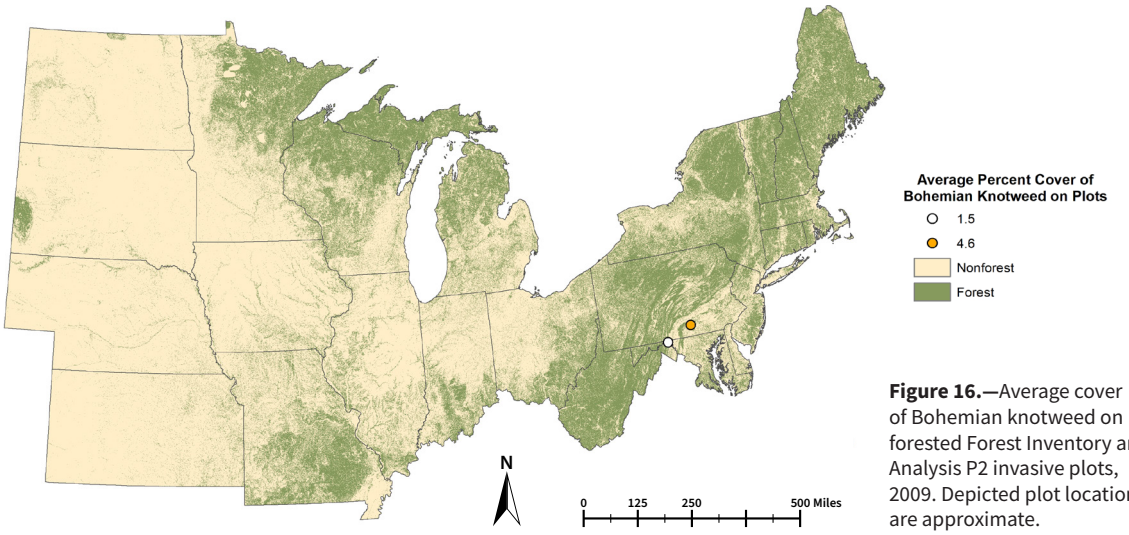


Figure 16.—Average cover of Bohemian knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Bull thistle

(*Cirsium vulgare*)

CIVU

Background and characteristics: Bull thistle, also known as spear thistle, is a biennial of the aster family (Asteraceae) that is native to Europe and Asia and was likely introduced during colonial times (Randall and Rejmánek 1993). It is most commonly observed on mesic soils but can be found on xeric and hydric soils. Germination ranges between 60.0 and 90.0 percent and is reduced when the temperature is below 50.0 °F or greater than 86.0 °F. In the shade, growth is restricted to south facing slopes, with 55.0 percent of full daylight causing rosette growth, the number of seeds per plant, and the percent viable seeds to be greatest (Klinkhamer and De Jong 1993). Where bull thistle establishes, it can form dense vegetation masses. A study by Randall and Rejmánek (1993) showed high densities of bull thistle reduced the growth rate of pines 25.0 to 33.0 percent and suggested this plant may have allelopathic effects that interfere with seedling growth.

Figure 17.—Bull thistle spines up close. Licensed photo by Rob Routledge, Sault College/Bugwood.org.

This species is a concern in agricultural and forested regions as well as along roadways and in disturbed areas. Sharp spines on the stems, leaves, and flowers make handling undesirable (Fig. 17), and the effects of infestations from this noxious weed are substantial. Agriculturally, it is unpalatable to most livestock. In addition, sheep grazing contributes to the spread of this IPS by reducing competition from other plants and increasing the growth, flowering, and seed production of the thistle plants (Klinkhamer and De Jong 1993). Aside from the negative impacts, some individuals eat the young leaves, stems, and roots (Peterson 1977).

Current distribution: Bull thistle is found in all 50 states (USDA NRCS 2023) with uniquely discerned distribution patterns in other countries. In Europe, its presence closely follows that of cultivated land, and in Canada this herbaceous invader is found in agricultural areas but is absent from the prairie region (Klinkhamer and De Jong 1993).

Plot presence: Bull thistle is the 18th most commonly observed IPS, occurring on 98 of the 4,244 NRS FIA plots in 2019 (2.3 percent; Table 5). In 2014, 2.1 percent of plots had this species (Table 6) and in 2009, 2.7 percent of plots had bull thistle (Table 7). Figures 18, 19, and 20 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of bull thistle. Cover was also variable over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, South Dakota has the greatest percentage of plots with bull thistle. In 2019, 14.0 percent of plots in South Dakota had this aggressive IPS, 13.1 percent did in 2014, and 14.7 percent in 2009. Across the NRS region, bull thistle is present in 16 of the 24 states in 2019. The eight states it is not present are: Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, North Dakota, Rhode Island, and Vermont.

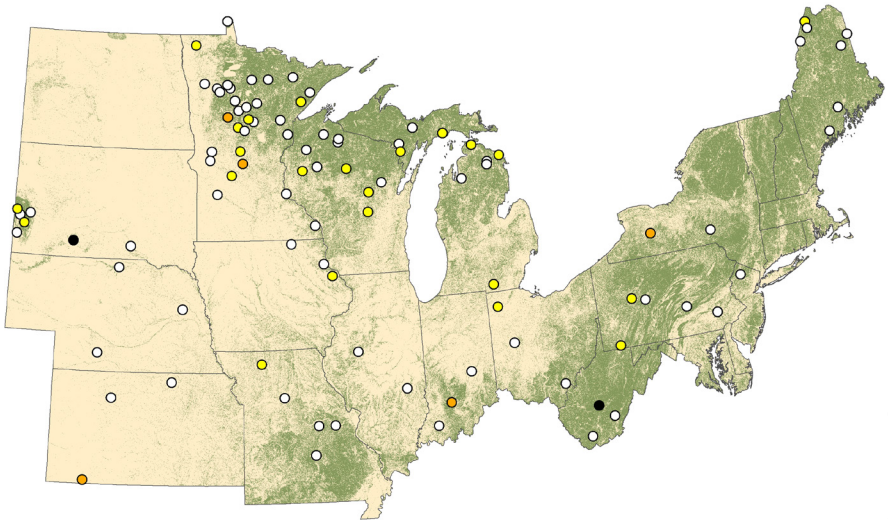


Figure 18.—Average cover of bull thistle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

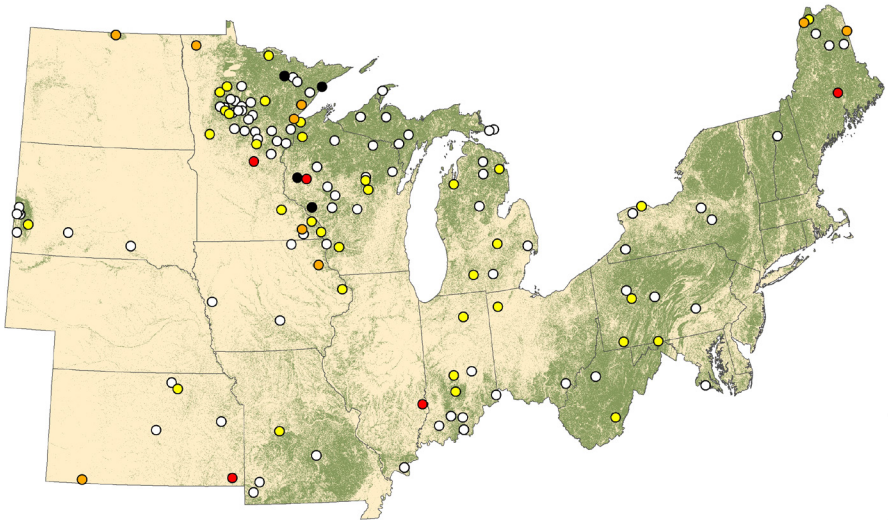


Figure 19.— Average cover of bull thistle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

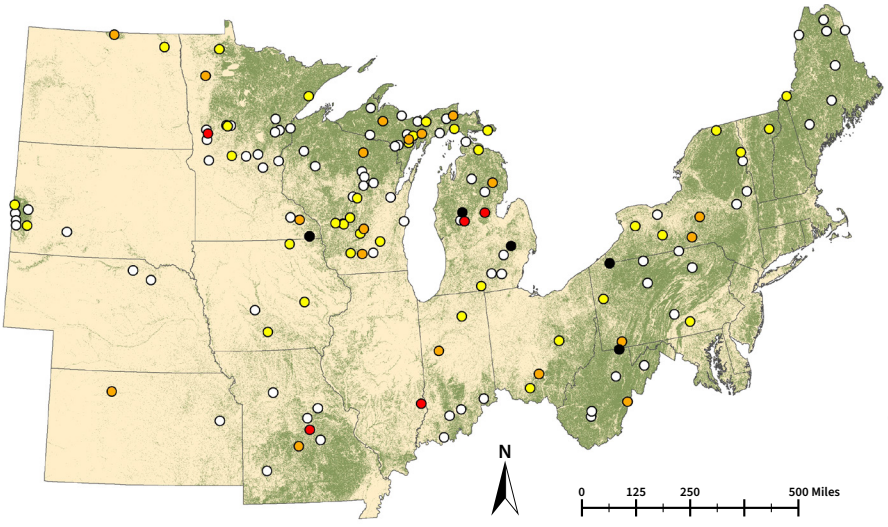


Figure 20.—Average cover of bull thistle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Canada thistle

(*Cirsium arvense*)

CIAR4

Background and characteristics: Canada thistle, an aggressive herbaceous perennial of the aster family (Asteraceae), arrived in North America during the early 1600s in contaminated crop seed from Europe, and has displaced native flora and fauna as well as reduced crop and pasture productivity (Czarapata 2005, Kaufman and Kaufman 2007). It is able to reduce crop yields 100 percent (Royer and Dickinson 1999), costing tens of millions of dollars in annual crop loss (Fig. 21) and millions more for its control (Czarapata 2005). A single Canada thistle plant produces from 1,500 to 5,000 seeds that remain viable up to 20 years (Czarapata 2005, Smith 1997). Due to the large number of seeds produced and the length of time the seeds remain viable, there are substantial restoration costs because of the need for continual removal over a long period.

Figure 21.—Canada thistle infestation. Licensed photo by Jan Samanek, Phytosanitary Administration/Bugwood.org.

Optimal growth of Canada thistle occurs in full sun. Where it does establish, this IPS sends out extensive running roots (Kaufman and Kaufman 2007). Along the stem of the plant are sharp spines that protect the plant from cattle browse. The disturbance caused by animals helps to facilitate the growth of this species since it is most successful in disturbed areas.

Aside from the negative impacts, this plant has medicinal qualities. It is reported to have value for skin eruptions and ulcers, poison ivy rash, and tuberculosis treatment (Foster and Duke 2000). The leaves have traditionally been used as a diuretic while the roots were used for dysentery, diarrhea, bowel tonic, and dewormer (Foster and Duke 2000). Despite being a plant of substantial medicinal value, this IPS is a problematic landscape weed and is considered noxious in much of the United States. A cold hardy plant, it is able to survive throughout North America with a northern limit corresponding to an average January temperature of -40.0 °F (Royer and Dickinson 1999).

Current distribution: Currently it is found in 42 states (not recorded in Hawaii and seven Southern/ Southeastern states), listed as invasive/prohibited in Connecticut, and prohibited in Alaska and New York (USDA NRCS 2023).

Plot presence: Canada thistle is the 13th most commonly observed IPS, occurring on 196 of the 4,244 NRS FIA plots in 2019 (4.6 percent; Table 5). Looking at 2014, 3.8 percent of plots had this species (Table 6) and in 2009, 3.3 percent of plots had Canada thistle (Table 7). Figures 22, 23, and 24 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of Canada thistle. Cover was also variable over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Minnesota has the greatest percentage of plots with Canada thistle. In 2019, 19.5 percent of plots in Minnesota had this aggressive IPS, 12.7 percent did in 2014, and 3.8 percent in 2009. Across the NRS region, Canada thistle is present in 14 states in 2019. The 10 NRS states it is not present are: Delaware, Kansas, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, Rhode Island, Vermont, and West Virginia.

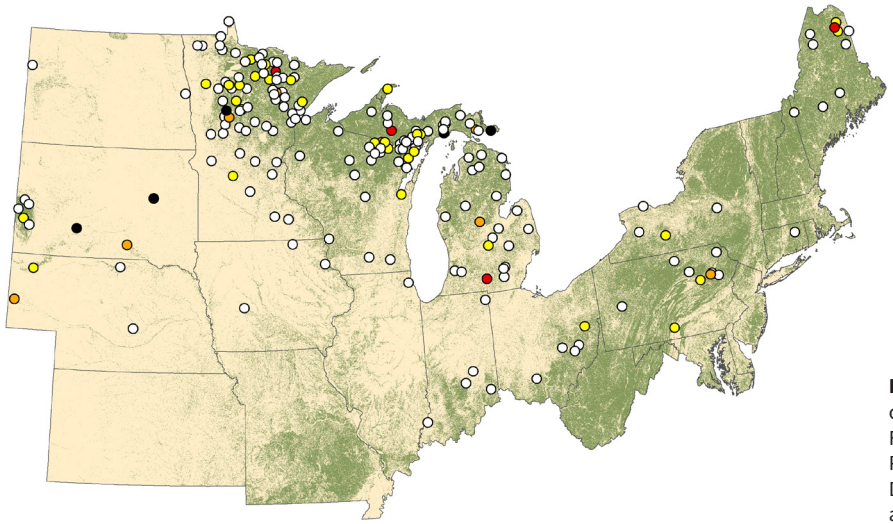


Figure 22.—Average cover of Canada thistle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

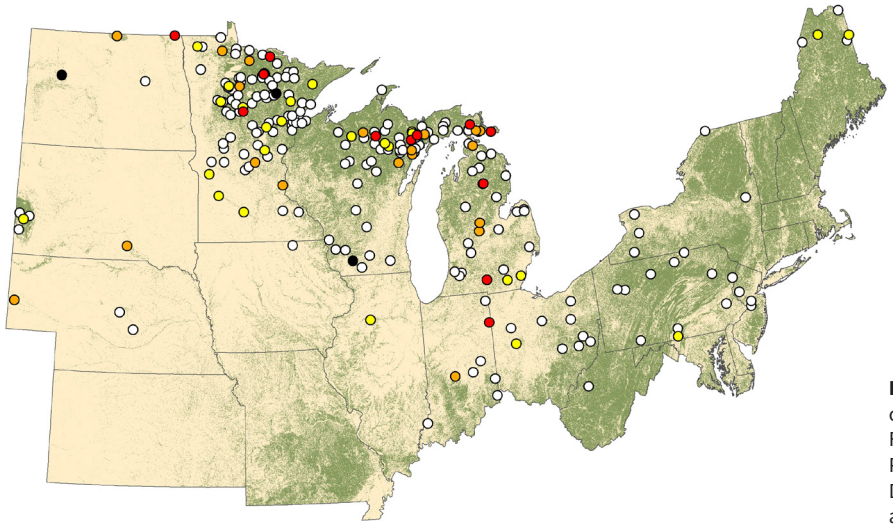


Figure 23.—Average cover of Canada thistle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

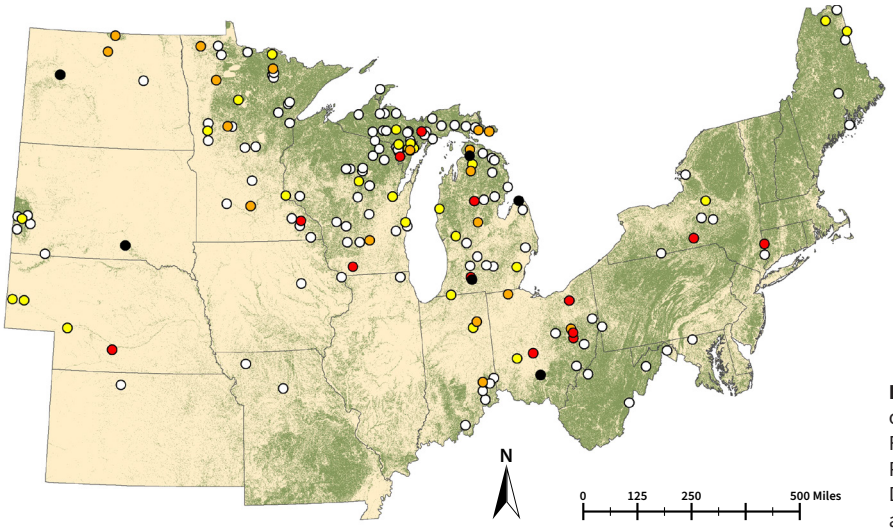


Figure 24.—Average cover of Canada thistle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Chinaberrytree

(*Melia azedarach*)

MEAZ

Background and characteristics: Chinaberrytree, also known as umbrella tree, Persian lilac, and bead tree, is a member of the mahogany (Meliaceae) family and can grow to 50.0 feet. It is native to Asia and northern Australia and was introduced as a shade tree in the southeast during the 1830s (Kaufman and Kaufman 2007). Grown for its ornamental value, this tree is aesthetically pleasing with stunning, fragrant flowers (Fig. 25), attractive berries, and majestic compound leaves.

Figure 25.—Chinaberrytree, flowering. Licensed photo by Rob Routledge, Sault College/Bugwood.org.

Chinaberrytree can grow in relatively undisturbed areas and tolerate high temperatures, poor soils, and periods of drought (Kaufman and Kaufman 2007). According to the PLANTS Database (USDA NRCS 2023), it is suggested 17.0 °F is the minimum temperature for Chinaberrytree and it requires 20.0 to 60.0 inches of precipitation annually, pH of 4.0 to 8.0, and rooting depth of at least 60.0 inches. Additionally, it is not anaerobic or fire tolerant.

On the landscape, Chinaberrytree can become problematic. The foliage of this invader is capable of changing soil properties. When the leaves decay, they increase the soil nitrogen and decrease the pH (Kaufman and Kaufman 2007). These ecosystem modifications can impact the vegetation and change the plant community.

Chinaberrytree has several notable characteristics. Its leaves are used in some countries for insecticides, and the seeds are used to stun freshwater fish (Kaufman and Kaufman 2007). Medicinal uses have also been reported, including the treatment of leprosy and eczema, relief from asthma attacks, and as an antiparasitic and antifungal agent (Ferreiro et al. 2010). Despite the beneficial properties of this tree, it can also be deadly. The most toxic part of the tree is the fruits, and poisoning has been reported in children, horses, cattle, sheep, goats, pigs, dogs, rabbits, rats, guinea pigs, and poultry (Ferreiro et al. 2010).

Current distribution: Chinaberrytree is found in 18 continental states, along with Hawaii, Puerto Rico, and the Virgin Islands (USDA NRCS 2023).

Plot presence: Chinaberrytree is not currently found on NRS FIA P2 invasive plots. In 2014, it was found on one plot in New York (Table 6). Figure 26 shows the presence and coverage of Chinaberrytree in 2014. Through the years of inventory, the number of plots monitored changed (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

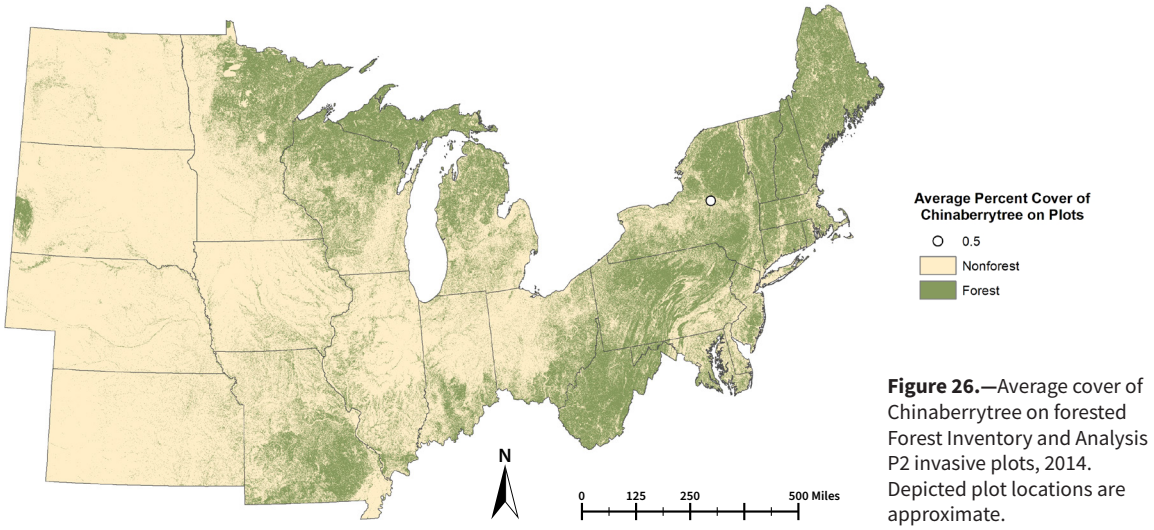


Figure 26.—Average cover of Chinaberrytree on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Chinese yam

(*Dioscorea oppositifolia* syn. *D. polystachya*)

DIOP

Background and characteristics: Chinese yam, also known as cinnamon vine, is an herbaceous vine of the yam family (Dioscoreaceae) that is native to China and India and was introduced to North America in the 1800s for food, medicinal, and ornamental purposes, but it was not until the 1980s when it was noticed in the wild. This herbaceous invader (Fig. 27) is most common in rich soil along streams or in floodplains and tolerates a wide range of light availability from full sun to shade (Kaufman and Kaufman 2007). Chinese yam can reach up to 15.0 feet long (Czarapata 2005).

Figure 27.—Chinese yam infestation. Licensed photo by Jack Ranney, University of Tennessee/ Bugwood.org.

A variety of uses have been discovered for Chinese yam (Kaufman and Kaufman 2007). The tuberous roots and above-ground tubers are eaten and taste similar to a sweet potato. Medicinally, Chinese yam is reported to be valuable for snakebites and scorpion stings, as a contraceptive, and an herbal tonic.

Current distribution: Chinese yam is found in 26 states and is on the watch list in Michigan (USDA NRCS 2023).

Plot presence: Chinese yam is not currently found on NRS FIA P2 invasive plots in the NRS region. In a previous report of FIA plots, dating back to the 2005 inventory, Kurtz (2013) found this IPS present in three states in the NRS FIA region, Illinois, Indiana, and Missouri. Based on that datum, Indiana had the highest percentage of plots with this species (6 plots; 1.3 percent).

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Common barberry

(*Berberis vulgaris*)

BEVU

Background and characteristics: Common barberry is a shrub of the barberry family (Berberidaceae) and was likely introduced in the 1600s for use in sauces and as a medicinal plant (Mack 2003, Royer and Dickinson 1999). Common barberry develops clusters of yellow flowers (Fig. 28) and produces seeds that are vectored by birds, increasing the likelihood of long-distance dispersal. The plants can bear fruit (Fig. 29) in as few as 4 years, and the seeds remain viable for at least 7 years (Peterson et al. 2005).

Figure 28.—Common barberry in flower. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Common barberry is an alternate host for wheat stem rust (*Puccinia graminis*) which reduces the crop yield of wheat, oats, barley, and other grasses (Royer and Dickinson 1999). Early descriptions of its infection on wheat are described in New England in the 1660s (Mack 2003). In the early 1700s, legislation began to be passed to control barberry, beginning with Connecticut in 1726 and followed by Massachusetts (1755) and Rhode Island (1772). By the time control efforts were implemented, common barberry was widespread in 13 states (Mack 2003). The early 1900s commonly had severe stem rust epidemics which reduced yields 50.0 to 70.0 percent with some fields completely lost (Peterson et al. 2005). From 1918 until the 1980s, state eradication campaigns ran which destroyed over 500 million bushes (Peterson et al. 2005). The senescence of this program may have been premature since there are still inoculums, as shown in Figure 30.

Aside from its invasive characteristics, common barberry has been used for several important medicinal purposes (Foster and Duke 2000). The berberine from this IPS is reported to be valuable for promoting appetite and sweating, as a diuretic, expectorant, laxative, astringent, antiseptic, blood purifier, and antibacterial. It has traditionally been used for itch relief and to treat jaundice, hepatitis, fevers, hemorrhage, diarrhea, coughs, arthritis, rheumatism, sciatica, and to increase white blood cell and platelet counts (from berbamine). Other uses for this plant include: jellies, cold drinks, and cooked fruit (Peterson 1977).

Figure 29.—Common barberry fruit. Licensed photo by Kirk Fisher/Adobe Stock images.

Current distribution: Common barberry is found in 31 states, with Connecticut listing it as invasive, prohibited (USDA NRCS 2023).

Plot presence: Common barberry is the 22nd most commonly observed IPS, occurring on 36 of the 4,244 NRS FIA plots in 2019 (0.8 percent; Table 5). In 2014, 0.6 percent of plots had this species (Table 6) and in 2009, 0.5 percent of plots had common barberry (Table 7). Figures 30 and 31 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence. Additionally, cover may have increased over time according to the data. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019 and 6,361 in 2014), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Vermont has the greatest percentage of plots with common barberry. In 2019, 4.6 percent of plots in Vermont had this aggressive IPS, however it is important to note the small sample size in Vermont with this species occurring on 5 of the 109 plots. Across the NRS region, common barberry is present in 9 of the 24 states in 2019. The nine states it is present are: Indiana, Maryland, Massachusetts, Michigan, New York, Ohio, Pennsylvania, Vermont, and West Virginia.

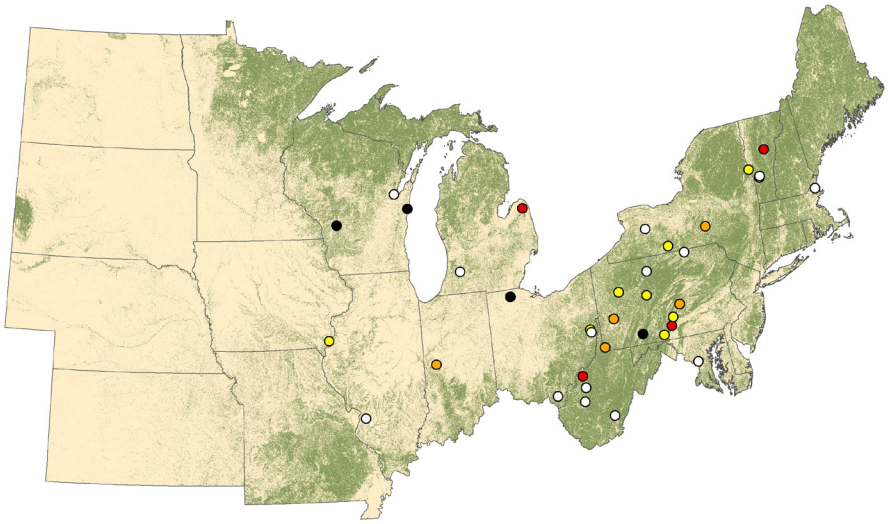

Figure 30.—Average cover of common barberry on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

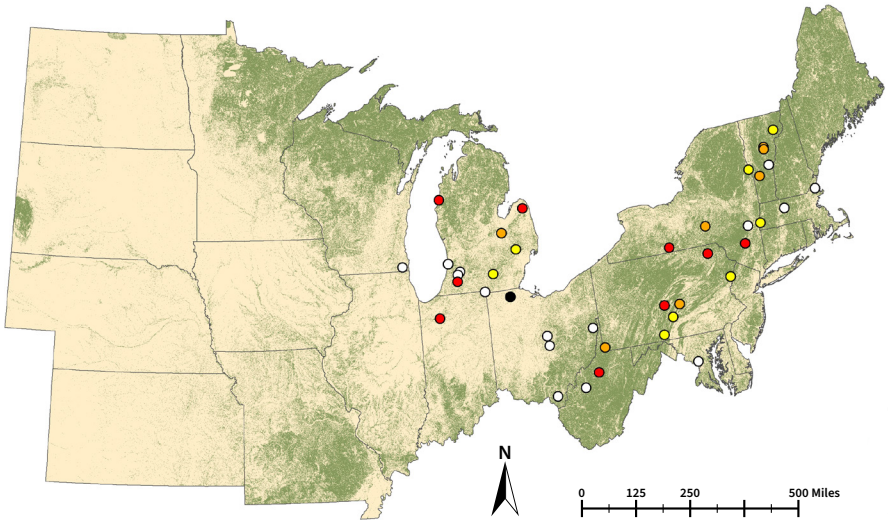

Figure 31.—Average cover of common barberry on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Common buckthorn

(*Rhamnus cathartica*)

RHCA3

Background and characteristics: Common buckthorn, also known as European buckthorn, is a woody shrub of the buckthorn family (Rhamnaceae) that is native to Eurasia and was brought to North America from Europe around the 1800s as an ornamental (Knight et al. 2007). In North America, the introduced buckthorns can easily be confused with native look-alikes such as Carolina buckthorn (*Rhamnus caroliniana*) and alder buckthorn (*Rhamnus alnifolia*). As with all species, accurate identification is important.

Figure 32.—Common buckthorn fruit. Licensed photo by Chis Evans, University of Illinois/ Bugwood.org.

Common buckthorn produces an abundance of fruit (Fig. 32). Its seeds are dispersed by birds and mammals. This spread creates dense thickets that hinder the growth of other species due to leafing out early and shading of the forest floor. In Wisconsin, Delanoy and Archibold (2007) note that this aggressive invader gains as much as 35.0 percent of its annual carbon before leaf emergence of native species, and its leaves are retained an average of 58 days longer than comparable native shrubs. These traits give buckthorn a competitive advantage.

Common buckthorn's ability to survive in the understory is also important to its success. Though shade tolerant, optimal growth occurs in areas with more light, and vigor is reduced in deep shade (Knight et al. 2007). Where common buckthorn establishes, its success may be facilitated by its high foliar nitrogen concentration, which stimulates earthworm invasion and litter decomposition (Kaufman and Kaufman 2007, Knight et al. 2007).

The spread of common buckthorn occurs from a few sources. From a horticultural standpoint, people have interest in this species as a hedge. When left naturally, nonnative buckthorns can reach up to 25.0 feet tall (Czarapata 2005, Kaufman and Kaufman 2007). The planting of common buckthorn was also promoted by federal agencies (Zouhar et al. 2008), and its aggressive nature has enabled it to become naturalized throughout the United States.

The presence of common buckthorn is a concern. Common buckthorn may be allelopathic (Delanoy and Archibold 2007, Knight et al. 2007) and affect the survival of other species. Agriculturally, common buckthorn is troublesome as it is an alternate host of oat crown rust (*Puccinia coronata*) and the primary overwintering host of the Asian soybean aphid (*Aphis glycines*). Aside from the negative impacts caused by this species, some have found this invader useful for making dyes and as a medicinal plant (Gould and Stuckey 1992).

In North America, the range of common buckthorn is climatically restricted. To germinate, a chilling period is necessary, and seedling survival is reduced by hot summers, cold winters, thick litter layers, and acidic/dry/water-logged soils (Knight et al. 2007, Kurtz 2010, Kurylo et al. 2007). Spring and fall frost damage further restricts its distribution with establishment occurring where it utilizes the entire growing season by maximizing carbon fixation and proper hardening/dehardening (Knight et al. 2007, Kurylo et al. 2007). Moser et al. (2009) note a reduction in the presence of this IPS south of 42.0 °N latitude which can also be seen in Figures 33 through 35. It is thought this species may be restricted from northward establishment due to global warming because of the substrate (Kurylo et al. 2007).

Current distribution: Common buckthorn is found in 34 states with Connecticut listing it as invasive, prohibited, Michigan as invasive, and New York as prohibited (USDA NRCS 2023).

Plot presence: Common buckthorn is the 8th most commonly observed IPS, occurring on 295 of the 4,244 NRS FIA plots in 2019 (7.0 percent; Table 5). Looking at 2014, 6.6 percent of plots had this species (Table 6) and in 2009, 5.5 percent of plots had common buckthorn (Table 7). Figures 33, 34, and 35 show how this species has changed in cover and spread in the region on FIA plots over time. There is some noticeable increased presence in the region (e.g., New York). Additionally, the average percent cover has varied over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, New York has the greatest percentage of plots with common buckthorn. In 2019, 20.1 percent of plots in New York had this aggressive IPS, increasing in the percentage of plots where it was found through the inventories. Across the NRS region, common buckthorn is present in 20 of the 24 states in 2019. The four states it is not present are Delaware, Kansas, Maryland, and West Virginia.

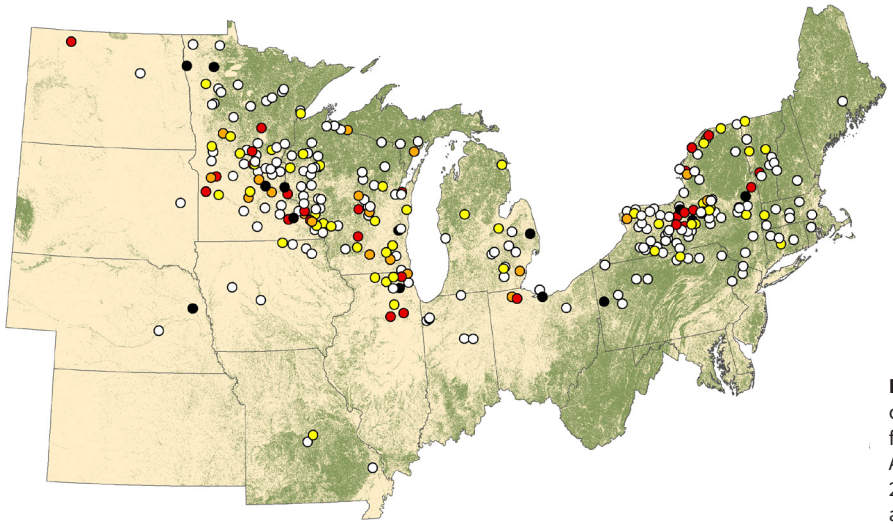

Figure 33.—Average cover of common buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

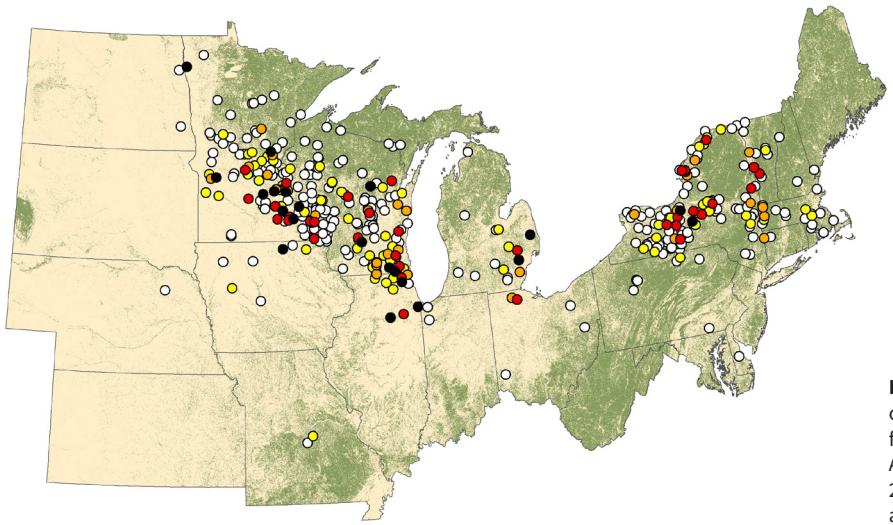

Figure 34.—Average cover of common buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

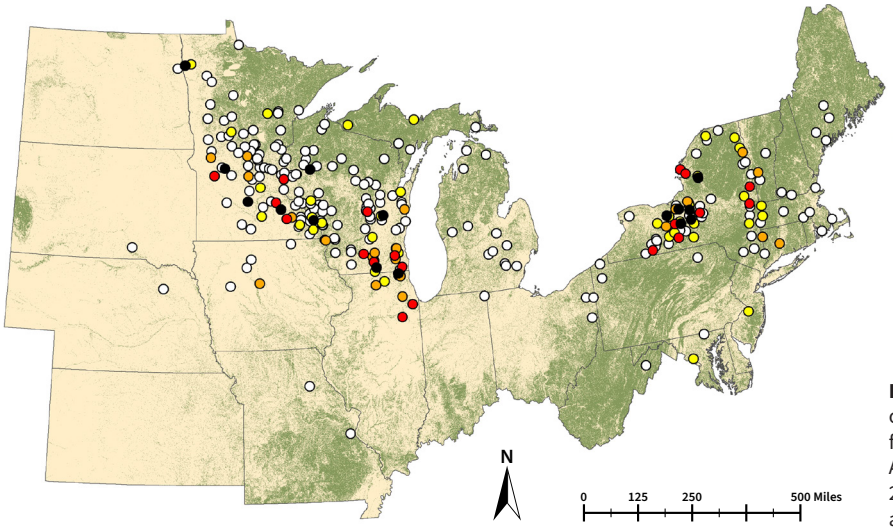

Figure 35.—Average cover of common buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Common reed

(*Phragmites australis*)

PHAU7

Background and characteristics: Common reed, also known as phragmites, is a member of the grass family (Poaceae). It has over 20 genetic strains or lineages with 11 considered native, rare, and worth special efforts to preserve by some researchers (Kaufman and Kaufman 2007). A 10.0-foot-tall strain has taken over thousands of acres of marshes in New England, where it displaces rare native species like the lady's slipper (*Cypripedium* spp.) and spotted turtles (*Clemmys guttata*) (Westbrooks 1998).

Figure 36.—Common reed infestation. USDA Forest Service photo by James H. Miller/ Bugwood.org.

Common reed is shade intolerant and generally found in wet areas. It is tolerant of brackish waters and spreads mainly through root fragments carried by water (Kaufman and Kaufman 2007). This aggressive invader can take over an area in just a few years. The dense colonies formed by common reed can be used to remove pollutants from the ground, the rhizomes are roasted, seeds are used for porridge, and blades are used for thatching roofs (Kaufman and Kaufman 2007). It also is used to stabilize shorelines, provide cover for wildlife, and for fishing rods (Czarapata 2005). Even though useful benefits have been derived from this IPS, the costs to ecosystems far outweigh the benefits. In an ecosystem, this graminoid can form dense colonies (Fig. 36) which supplant native species and alter water flow.

The PLANTS Database (USDA NRCS 2023) suggests this noxious weed can reach 13.0 feet, survive to -38.0 °F and requires 12.0 to 60.0 inches of precipitation annually, 110 or more frost free days, pH levels between 4.5 and 8.7, and a minimum rooting depth of 20.0 inches. Additional qualities that enable common reed to invade a wide variety of locations are its adaptability to fine, medium, and coarse textured soils and its high anaerobic tolerance, though it does have low drought tolerance.

Current distribution: Common reed is found in 49 states (not in Alaska) and is native to Puerto Rico. Four states designate this invader as noxious, prohibited, restricted, or invasive (USDA NRCS 2023).

Plot presence: Common reed is the 24th most commonly observed IPS, occurring on 19 of the 4,244 NRS FIA plots in 2019 (0.4 percent; Table 5). Looking at 2014, 23 plots had this IPS (0.4 percent; Table 6) and in 2009, 29 plots (0.5 percent) had common reed (Table 7). Figures 37, 38, and 39 show how this species has changed in cover and spread in the region on FIA plots over time. Overall, the change in cover and distribution is fairly minimal and not very apparent. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

By state, common reed is relatively rare on FIA plots. In 2019, Connecticut and Michigan have the most plots with this aggressive species (4 plots). Common reed is present on plots in 8 of the 24 states in 2019.

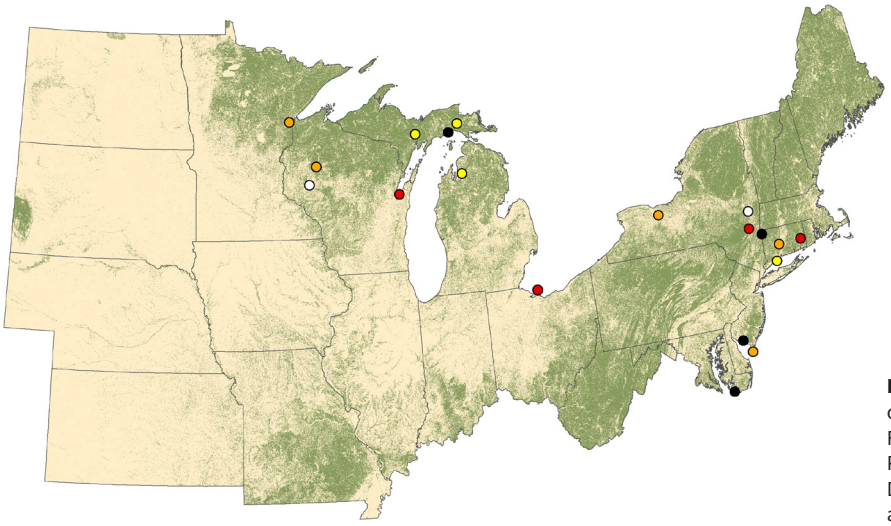

Figure 37.—Average cover of common reed on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

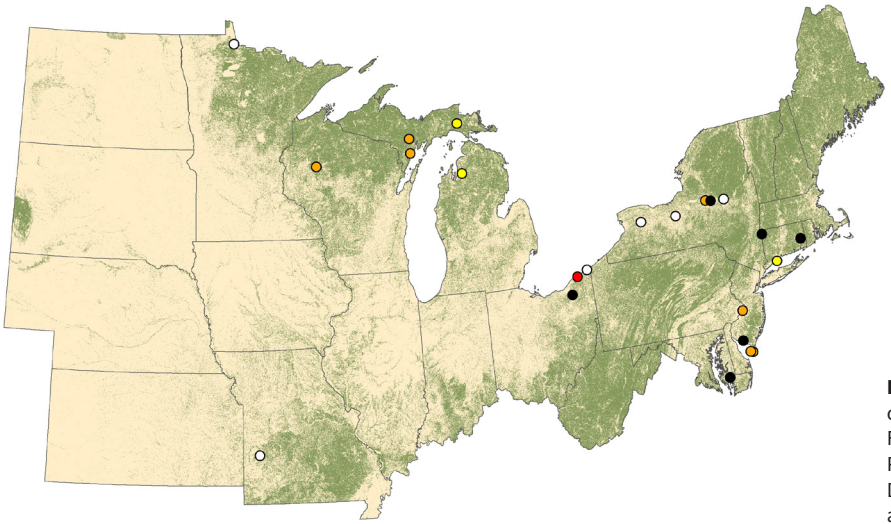

Figure 38.—Average cover of common reed on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

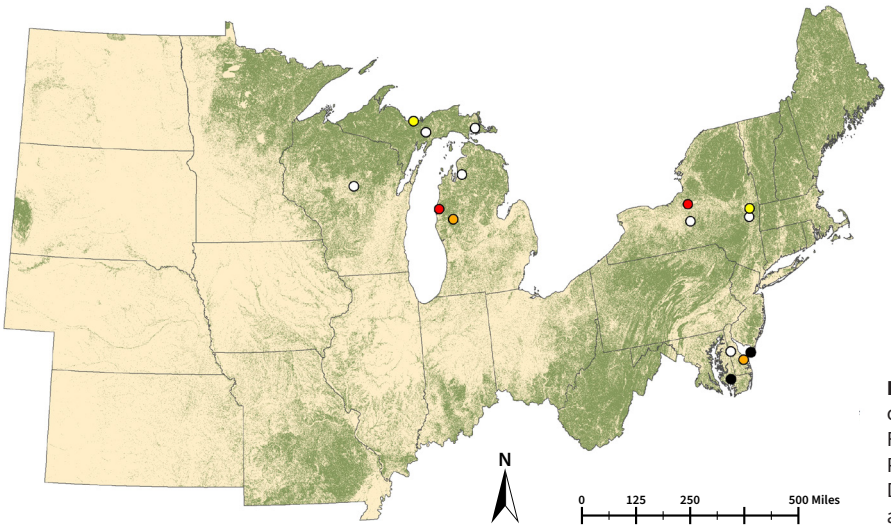

Figure 39.—Average cover of common reed on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Creeping jenny

(*Lysimachia nummularia*)

LYNU

Background and characteristics: Creeping jenny, also known as moneywort and wandering sailor, is an herbaceous plant of the primrose family (Primulaceae) that was introduced from Europe and southwest Asia as an ornamental groundcover (USFS FHS 2005). It is a popular groundcover since it spreads very rapidly and has shiny rounded leaves and yellow flowers (Fig. 40). Cultivars of this species have been bred and are widely available as landscape plants.

Figure 40.—Creeping jenny, flowering. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Creeping jenny grows in sun to part shade and rapidly spreads to smother neighboring vegetation. Optimal growth occurs in moist areas such as along waterways where it can form dense mats and displace native vegetation. Spread is by both vegetative propagules and seed.

Current distribution: Creeping jenny is now found in 37 states with Connecticut listing it as potentially invasive (USDA NRCS 2023).

Plot presence: Creeping jenny is the 19th most commonly observed IPS, occurring on 74 of the 4,244 NRS FIA plots in 2019 (1.7 percent; Table 5). Looking at 2014, 1.9 percent of plots had this species (Table 6) and in 2009, 1.1 percent of plots had creeping jenny (Table 7). Figures 41, 42, and 43 show how this species has changed in cover and spread in the region on FIA plots over time. There is some noticeable increased cover and spread in the region (e.g., Missouri). With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Indiana has the greatest percentage of plots with creeping jenny. In 2019, 10.4 percent of plots in Indiana had this aggressive IPS, increasing from 6.5 percent in 2014, and 2.4 percent in 2009. Across the NRS region, creeping jenny is present in 11 of the 24 states in 2019.

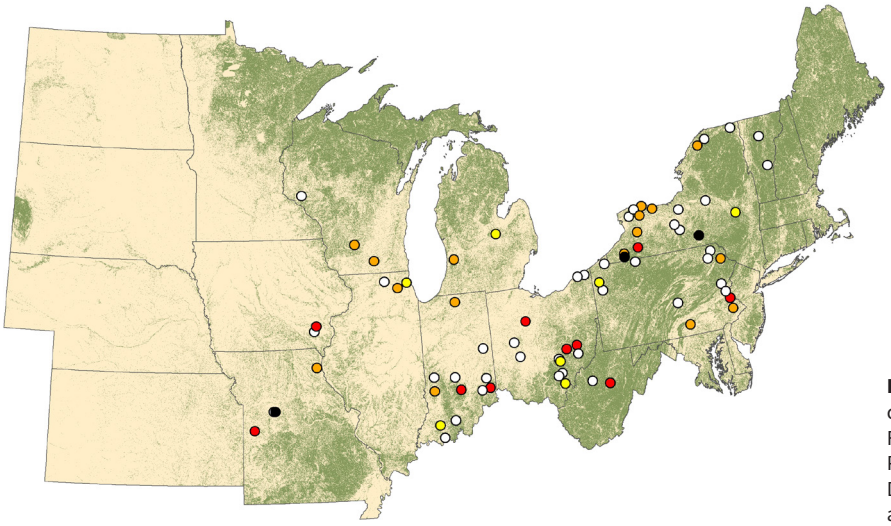

Figure 41.—Average cover of creeping jenny on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

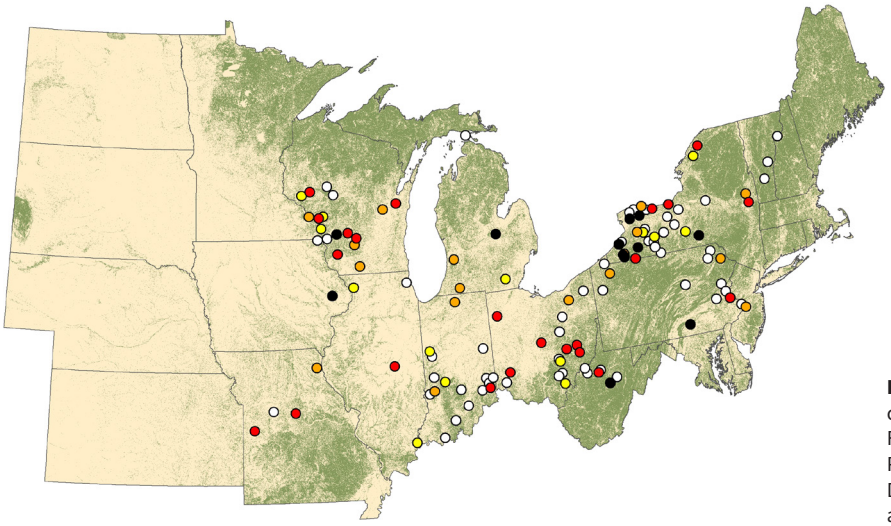

Figure 42.—Average cover of creeping jenny on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

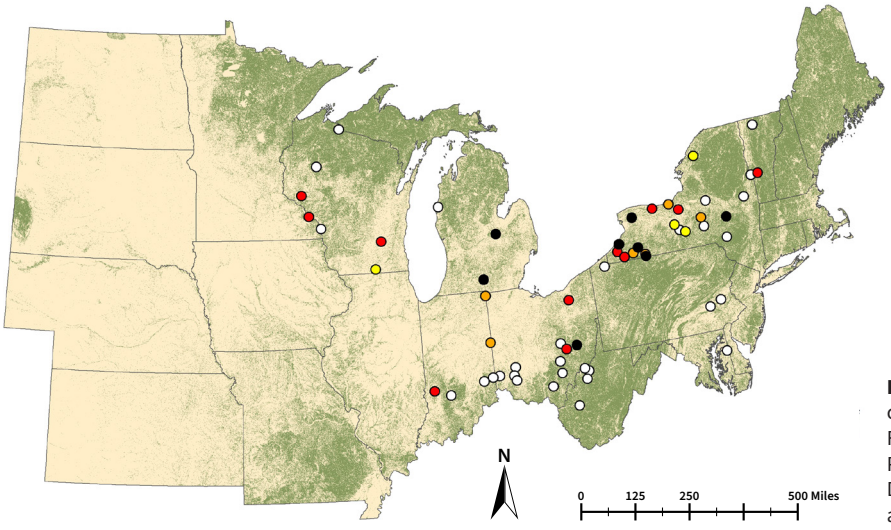

Figure 43.—Average cover of creeping jenny on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Dames rocket

(*Hesperis matronalis*)

HEMA3

Background and characteristics: Dames rocket, an herbaceous perennial of the mustard family (Brassicaceae), was introduced from Europe in the 1600s (Kaufman and Kaufman 2007, Susko and Hussein 2008). It is often found in disturbed areas such as along roadsides and near residences. Humans facilitate the spread of this species through transport and by planting this flower because it is colorful, easy to grow, and relatively low maintenance. Dames rocket seeds are a common component of wildflower mixes. The fragrant flowers are predominantly purple though some are pink or white (Fig. 44). Dames rocket plants are distinguishable from phlox (*Phlox* spp.) as the flowers have four petals versus phlox which has five. Each plant produces an abundance of flowers which mature into wiry seed pods filled with seeds. A plant can produce up to 20,000 seeds (Royer and Dickinson 1999) that can remain viable for several years. The seeds are often transported in storms and via humans by sticking to their shoes and vehicle tires, and by attaching to the feet and fur of animals.

Figure 44.—Dames rocket infestation in flower. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Animals also spread dames rocket by creating disturbances. The disturbance exposes mineral soil and increases light availability. Deer may contribute to germination by browsing other plant species instead of dames rocket and by creating soil disturbances that facilitate growth (Rawinski 2008). This noxious weed can grow in full sun or shade but does best in sun conditions (Kamm 2004). Recently there has been some interest in this plant as a potential biofuel energy crop. Kamm (2004) found this plant, as a crop, offers an impressive yield and may be an economical biomass alternative.

According to the PLANTS Database (USDA NRCS 2023), it is suggested dames rocket does not require cold stratification, and its growth is restricted by fertility (medium tolerance, not adapted to fine or coarse soils), precipitation (requires 32.0 to 60.0 inches annually), temperature (-23.0 °F minimum), frost free days (120 minimum), pH (tolerates a range from 5.0 to 7.0), rooting depth (12.0 inch minimum), CaCO3 (low tolerance), fire (low tolerance), and salinity (no tolerance).

Current distribution: Dames rocket occurs in 41 states (absent from 8 Southern states and Hawaii). It is classified as invasive, prohibited in Connecticut (USDA NRCS 2023). The distribution of this IPS has important agricultural implications as it is an alternate host of several crop mosaic viruses including ribgrass (RMV), cucumber (CMV), beet (BtMV), cauliflower (CaMV), radish (RaMV), squash (SqMV), and turnip (TuMV) mosaic viruses (Kaufman and Kaufman 2007, Royer and Dickinson 1999, Susko and Hussein 2008).

Plot presence: Dames rocket is the 21st most commonly observed IPS, occurring on 38 of the 4,244 NRS FIA plots in 2019 (0.9 percent; Table 5). Looking at 2014, 0.8 percent of plots had this species (Table 6) and in 2009, 0.8 percent of plots had dames rocket (Table 7). Figures 45, 46, and 47 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of dames rocket. Cover was also variable over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Nebraska has the greatest percentage of plots with dames rocket. In 2019, 5.7 percent of plots in Indiana had this aggressive IPS, 0.0 percent did in 2014, and 0.0 percent in 2009. It is important to note that Nebraska had under 60 plots sampled in each of the inventories so each observance represents a large percentage, with zero observances in 2009 and 2014 and three observances in 2019. Across the NRS region, dames rocket is present in 11 of the 24 states in 2019.

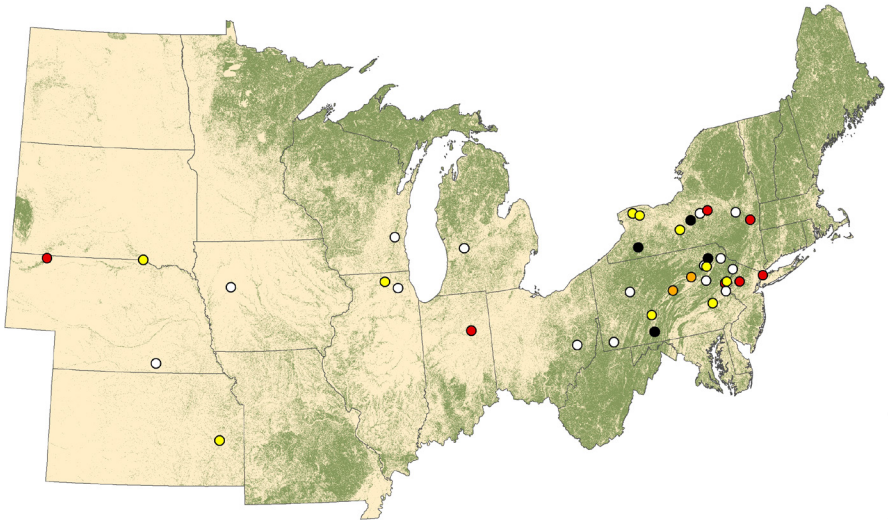

Figure 45.—Average cover of dames rocket on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

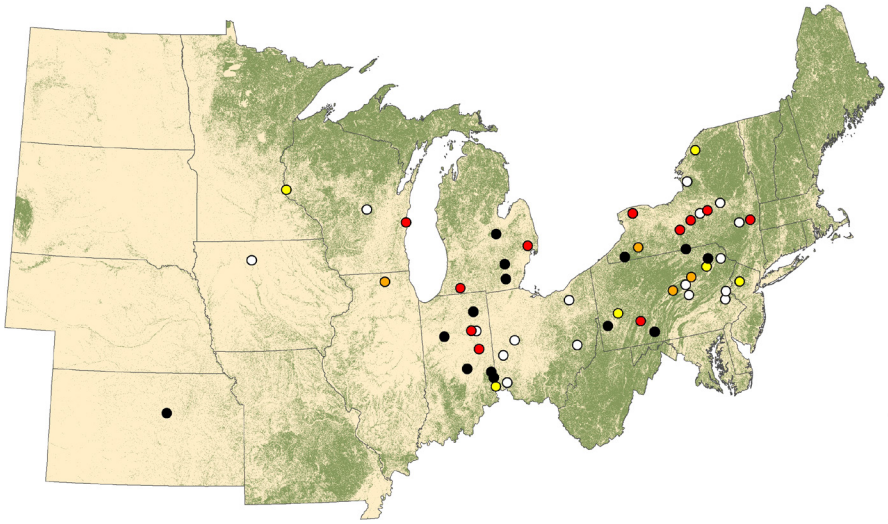

Figure 46.—Average cover of dames rocket on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

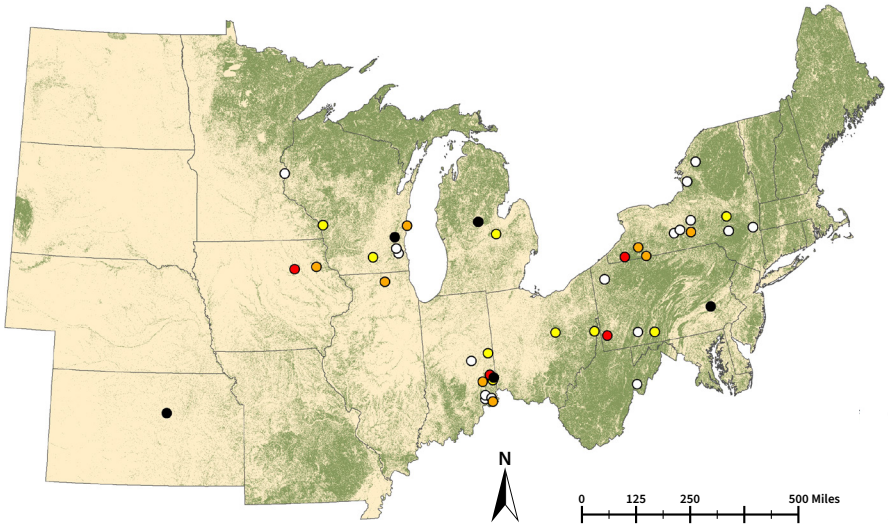

Figure 47.—Average cover of dames rocket on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

English ivy

(*Hedera helix*)

HEHE

Background and characteristics: English ivy is a woody vine of the ginseng family (Araliaceae). It is native to Europe, western Asia, and northern Africa and was brought to North America (first recorded in 1727), by European colonists as a decorative plant (Kaufman and Kaufman 2007). Due to the ease of growing this plant, English ivy is common both indoors and outdoors. The popularity of this vine has resulted in several variegated cultivars being bred for ornamental use.

Figure 48.—English ivy. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/ Bugwood.org.

English ivy is most abundant in the Pacific Northwest and on the East Coast of the United States where it is generally found on moist sites in shade to part shade, though it is drought tolerant. This invasive vine produces berries that are mildly toxic, so few bird species eat them (Kaufman and Kaufman 2007). It thrives in disturbed areas and can reach up to 90.0 feet long (Czarapata 2005, Kaufman and Kaufman 2007). The rapid growing vines climb up vegetation (Fig. 48) and can increase the surface area and windthrow potential, impede photosynthesis, and girdle vegetation. English ivy has important fire implications as it can potentially increase the fuel load and chance of a crown fire by creating fuel continuity (Zouhar et al. 2008).

Based on the literature and field observations (USDA NRCS 2023), it is suggested English ivy can survive to -23.0 °F and requires 28.0 to 65.0 inches of precipitation annually, 160 or more frost free days, pH levels between 5.2 and 7.8, a minimum rooting depth of 12.0 inches, and aerobic conditions.

Current distribution: Since its introduction in 1727, it has spread to 32 states, with North Carolina classifying this woody vine as invasive (USDA NRCS 2023).

Plot presence: English ivy is the 28th most commonly observed IPS, occurring on 10 of the 4,244 NRS FIA plots in 2019 (0.2 percent; Table 5). Looking at 2014, 0.1 percent of plots had this species (Table 6) and in 2009, 0.0 percent of plots had English ivy (Table 7). Figures 49, 50, and 51 show how this species has changed in cover and spread in the region over time on FIA plots. Based on the data, there is an increase in both cover and spread of English ivy over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Delaware has the highest percentage of plots with English ivy (6.7 percent), while Maryland and Pennsylvania have the greatest number of plots with this invader (2 plots, representing 4.1 percent and 0.3 percent respectively). Since there are only 10 plots with this species in 2019, its presence throughout the region is rather low, only occurring in eight states. The eight states it is found in are Delaware, Indiana, Maryland, Michigan, New Jersey, New York, Ohio, and Pennsylvania.

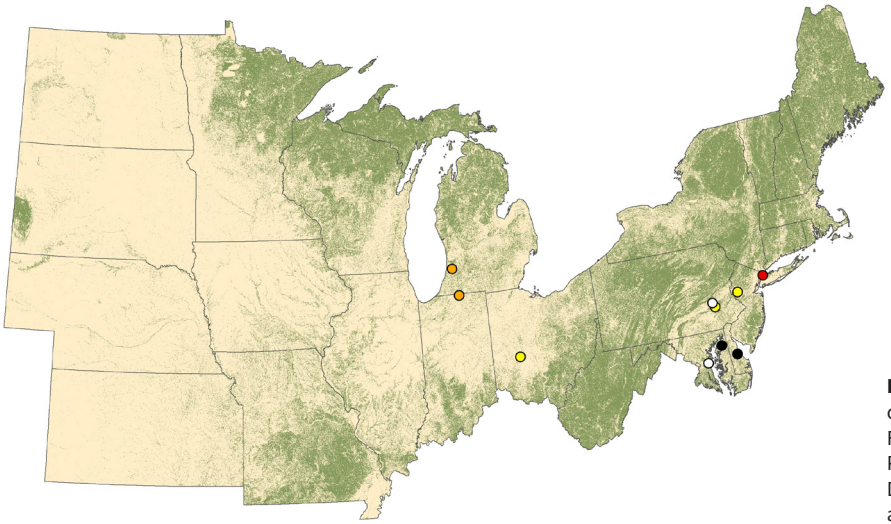

Figure 49.—Average cover of English ivy on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

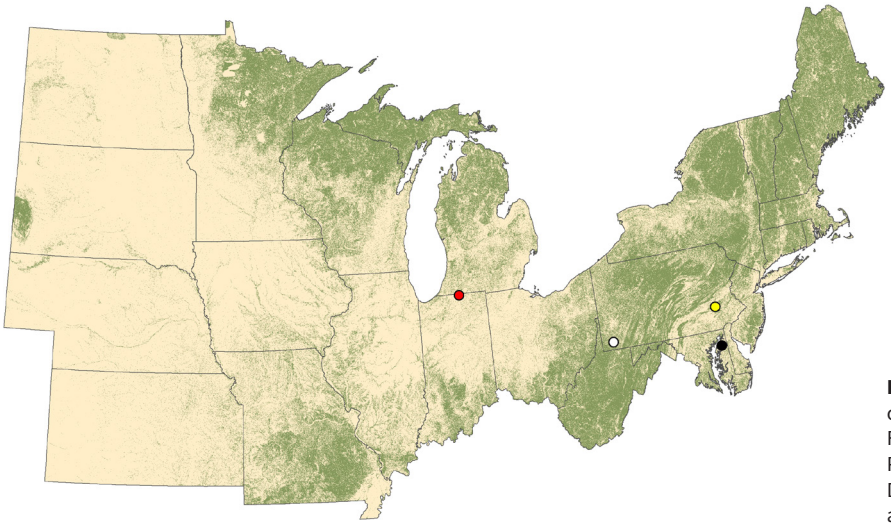

Figure 50.—Average cover of English ivy on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

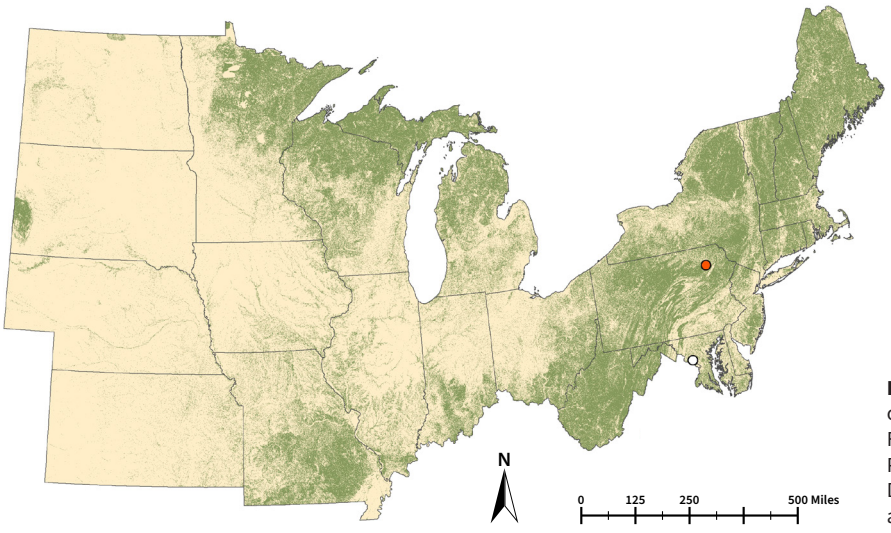

Figure 51.—Average cover of English ivy on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

European cranberrybush

(*Viburnum opulus*)

VIOP

Background and characteristics: European cranberrybush, also known as Guelder rose, rose elder, and snowball bush, is a woody shrub of the honeysuckle family (Caprifoliaceae) that is native to Europe and is spreading across north Asia, north Africa, and North America (Velioglu et al. 2006). Growth is best in the sun with flowering reduced in part shade. It is generally found on damp soils and is planted for its ornamental value, offering attractive foliage, white flower clusters (Fig. 52), and edible glossy red fruits. European cranberrybush is also medicinally important. The berries are used for alcohol, preserves, pastries, candy, high blood pressure, heart troubles, coughs, colds, tuberculosis, shortness of breath, kidney and bladder infections, stomach pain, duodenal ulcers, and bleeding (Velioglu et al. 2006). The bark is also used for various medicinal purposes.

Figure 52.—European cranberrybush. Licensed photo by Robert Vidéki, Doronicum Kft./ Bugwood.org.

The PLANTS Database (USDA NRCS 2023) suggests this invasive shrub grows to 12.0 feet tall, resprouts, can survive to -38.0 °F and requires cold stratification, 30.0 to 50.0 inches of precipitation annually, 110 or more frost free days, pH levels between 5.2 and 7.0, and a minimum rooting depth of 14.0 inches. Additional growth limitations are its intolerance of anaerobic and coarse textured soils.

Current distribution: European cranberrybush is found in 30 states (primarily the northern half of the United States) (USDA NRCS 2023).

Plot presence: European cranberrybush is the 22nd most commonly observed IPS, occurring on 36 of the 4,244 NRS FIA plots in 2019 (0.8 percent; Table 5). Looking at 2014 and 2009, 0.2 percent of plots had European cranberrybush (Tables 6 and 7). Figures 53, 54, and 55 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of European cranberrybush. Cover was also variable over time. However, it is apparent that there is a greater presence of European cranberrybush now than in past inventories. It is also important to note the increase in coverage. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Michigan has the greatest percentage of plots with European cranberrybush. In 2019, 3.9 percent of plots in Michigan had this aggressive IPS, 0.0 percent did in 2014, and 0.1 percent in 2009. Across the NRS region, European cranberrybush is present in 7 of the 24 states in 2019. The seven states it is present in are Illinois, Iowa, Michigan, Minnesota, New Jersey, West Virginia, and Wisconsin.

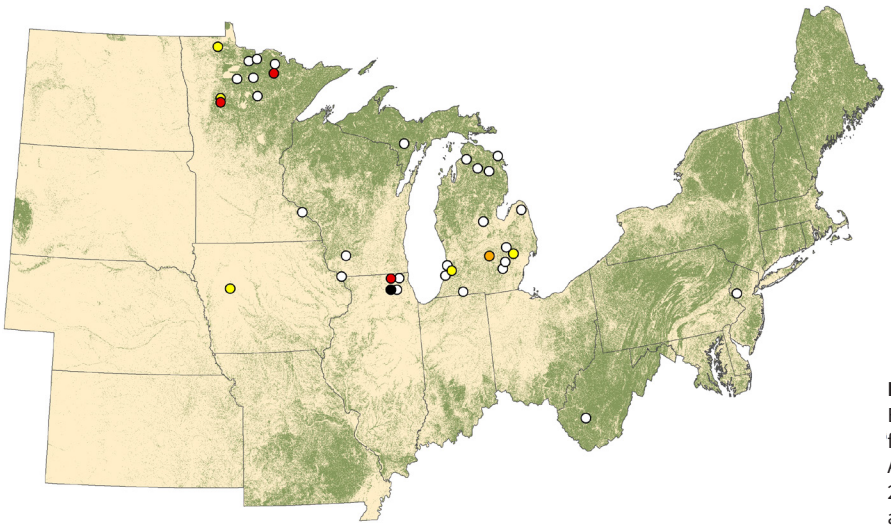

Figure 53.—Average cover of European cranberrybush on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

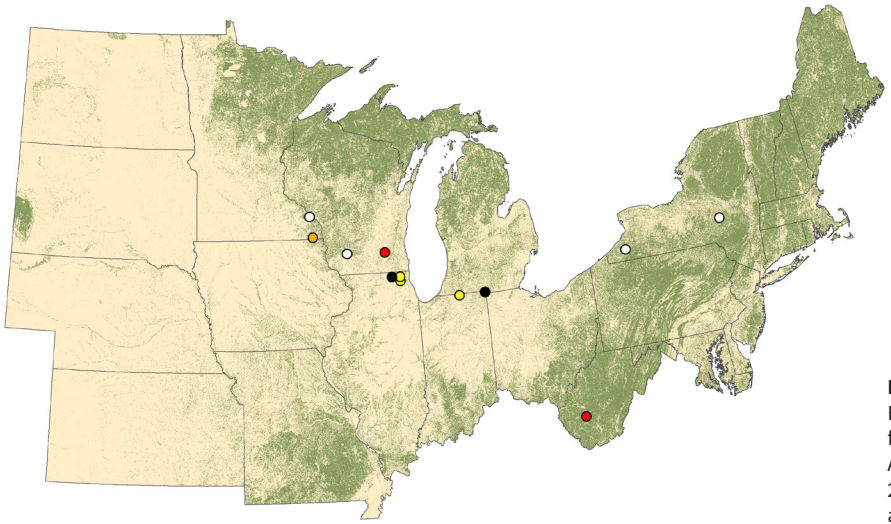

Figure 54.—Average cover of European cranberrybush on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

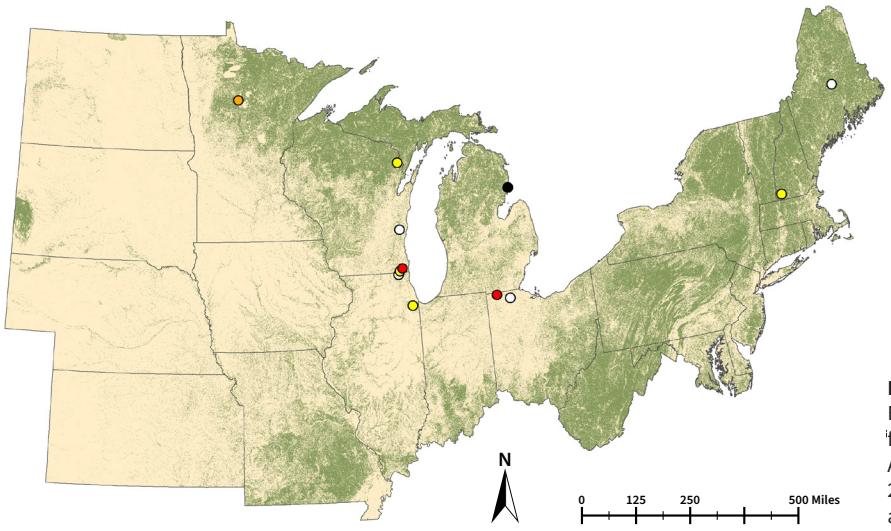

Figure 55.—Average cover of European cranberrybush on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

European privet

(*Ligustrum vulgare*)

LIVU

Background and characteristics: European privet, also known as common or wild privet, is a deciduous shrub of the olive family (Oleaceae) that was introduced from Europe in the mid-1800s (Miller et al. 2010). It is shade tolerant and commonly used for topiary. In addition, this shrub is widely planted for its beauty as a hedge, displaying attractive clusters of fragrant flowers (Fig. 56) and fruits. The fruit are readily dispersed by birds and other animals, such as deer (Kaufman and Kaufman 2007).

Figure 56.—European privet in flower. Licensed photo by Robert Vidéki, Doronicum Kft./ Bugwood.org.

The PLANTS Database (USDA NRCS 2023) suggests this noxious shrub can survive to -38.0 °F and requires cold stratification, 18.0 to 50.0 inches of precipitation annually, 130 or more frost free days, pH levels between 5.0 and 7.5, and a minimum rooting depth of 2.0 inches. Additional growth limitations include its intolerance of anaerobic conditions and coarse textured soils.

Current distribution: European privet is now found in 36 states, with heaviest presence in the eastern half of the United States, with Connecticut classifying this IPS as potentially invasive (USDA NRCS 2023). Due to the horticultural interest in this plant, many species of privet have been introduced, and distinguishing between them is difficult.

Plot presence: European privet is the 15th most commonly observed IPS, occurring on 160 of the 4,244 NRS FIA plots in 2019 (3.8 percent; Table 5). Looking at 2014, 2.4 percent of plots (Table 6) had European privet whereas in 2009, 1.7 percent of plots had this aggressive invader (Table 7). Figures 57, 58, and 59 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of European privet. Cover was also variable over time. Overall, both the occurrence and percent cover seem to have increased over time. With the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), it can be harder to see the changes from a quick glance.

Of the 24 NRS FIA states, Ohio has the greatest percentage of plots with European privet. In 2019, 19.3 percent of plots in Ohio had this aggressive IPS, 15.8 percent did in 2014, and 15.7 percent in 2009. Across the NRS region, European privet is present in 12 of the 24 states in 2019.

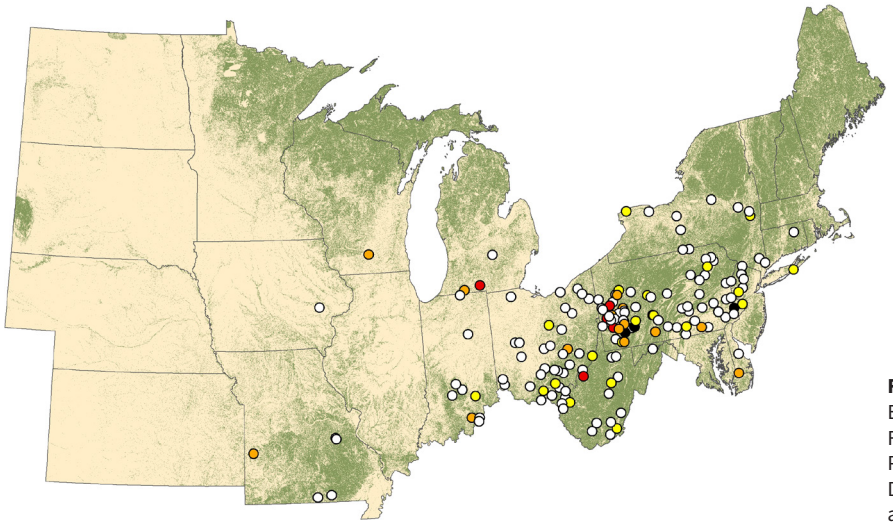

Figure 57.—Average cover of European privet on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

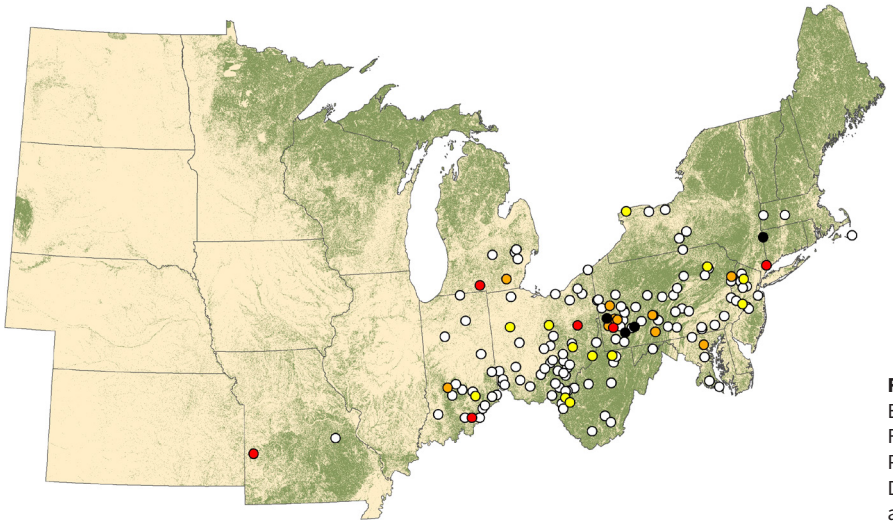

Figure 58.—Average cover of European privet on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

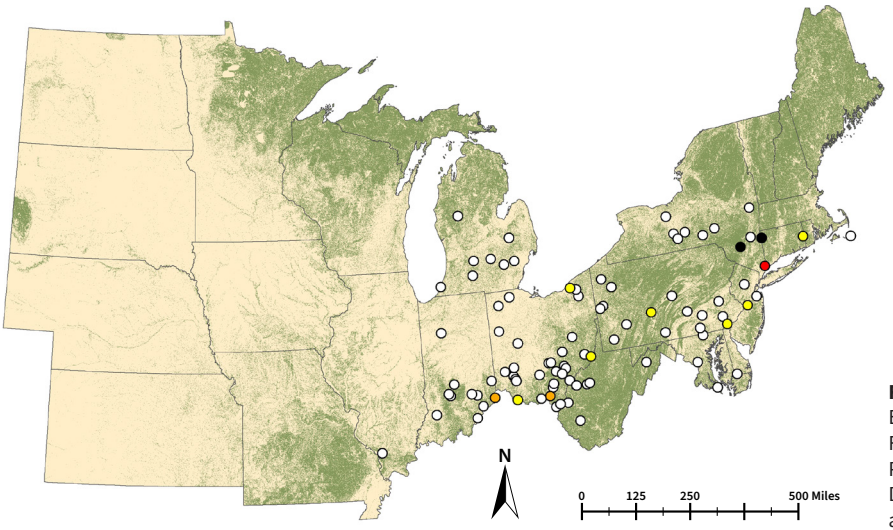

Figure 59.—Average cover of European privet on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

European swallow-wort

(*Cynanchum rossicum* syn. *C. medium, Vincetoxicum medium, and V. rossicum*)

CYRO8

Background and characteristics: European swallow-wort, also known as pale swallow-wort and dog-strangling vine, is a perennial herbaceous vine of the milkweed family (Asclepiadaceae) that was first collected in Monroe County, New York in 1897 (Sheeley and Raynal 1996). It has dainty light pink to reddish brown flowers (Fig. 60) and is planted as an ornamental. Vines of European swallow-wort can grow up to 6.0 feet long (Czarapata 2005, Kaufman and Kaufman 2007).

Figure 60.—European swallow-wort, flowering. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

The effects caused by this species are concerning. This IPS may threaten at least 54 species of rare plants, insects, birds, and land snails in the globally rare alvar (i.e., shallow limestone barrens) habitats of New York's Great Lakes Basin, along with causing variable effects on the monarch populations since it may outcompete host plants such as the native common milkweed (DiTommaso and Losey 2003). DiTommaso and Losey (2003) found European swallowwort is not a viable host species for monarch oviposition, though they mention another study that suggests it is a suitable host. Due to conflicting results, the value of European swallow-wort as a host plant for monarch oviposition is unclear.

Current distribution: European swallow-wort is a concern in many states of the NRS region. Currently it is found in eight states in the eastern half of the United States, with Connecticut listing it as invasive, prohibited, Michigan as invasive, and New York as a prohibited invasive species (USDA NRCS 2023).

Plot presence: European swallow-wort is the 34th most commonly observed IPS, occurring on 1 of the 4,244 NRS FIA plots in 2019 (0.0 percent; Table 5). In 2014 it was not present on plots (Table 6) whereas in 2009 this IPS was found on 1 plot (Table 7). Figures 61 and 62 show presence and cover of European swallow-wort over time, however, the number of occurrences is low. It is also important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009). New York is the only state where European swallow-wort occurs.

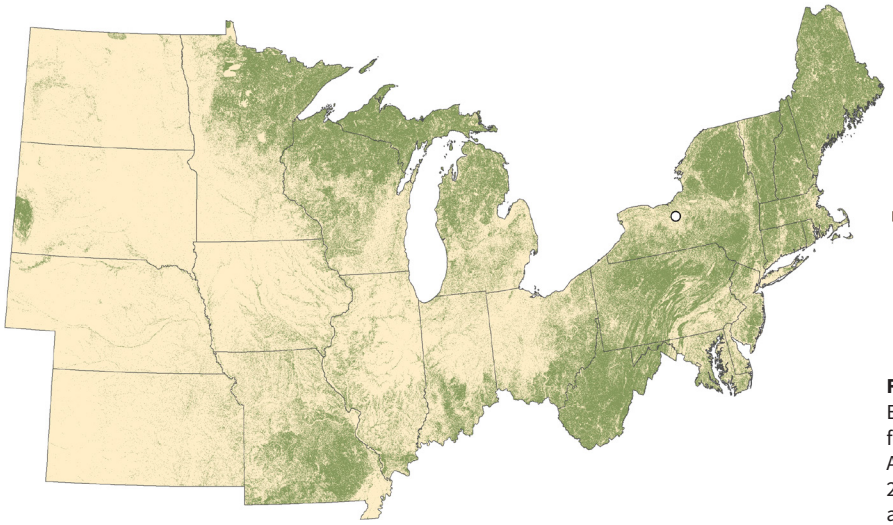

Figure 61.—Average cover of European swallow-wort on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

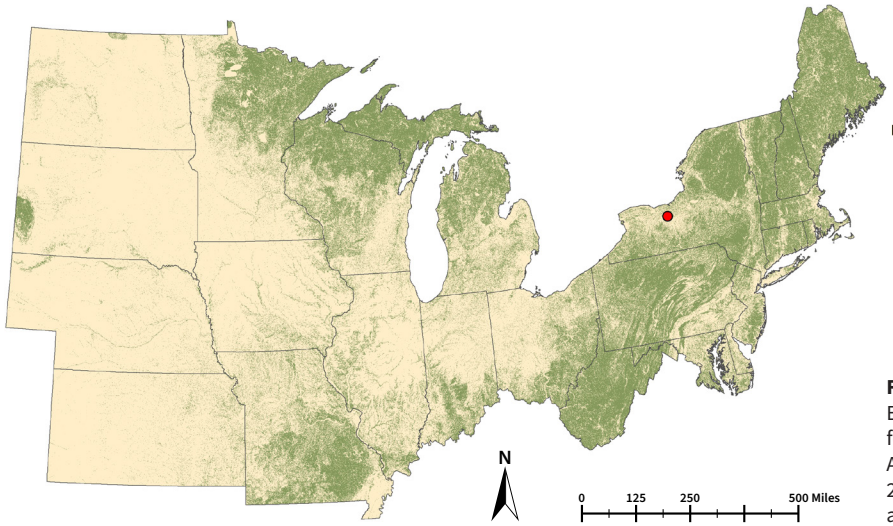

Figure 62.—Average cover of European swallow-wort on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Garlic mustard

(*Alliaria petiolata*)

ALPE4

Background and characteristics: Garlic mustard is an herbaceous biennial of the mustard family (Brassicaceae). It was introduced in the mid-1800s from Europe as a food and medicinal plant and has spread throughout much of North America and Canada at a rate of 2,500 square miles per year (Rodgers et al. 2008). This herbaceous invader commonly occurs on disturbed sites. It now dominates the understory of many forests in New England and the Midwest and has become one of the most rapidly expanding woodland IPS in eastern North America (Welk et al. 2002). After only 5 to 7 years, this species can dominate the forest floor (Czarapata 2005) where its dense growth can replace spring ephemerals (Cavers et al. 1979). Contributing to its success, garlic mustard produces an abundance of small seeds that are dispersed by humans, waterways, and animal fur, feet, and feathers. The seeds remain viable in the soil up to 5 years (Bartuszevige et al. 2007).

Figure 63.—Garlic mustard infestation, in flower. Licensed photo by Steven Katovich/ Bugwood.org.

Peculiar to this species is its ability to invade mature forests. It has a photosynthetic advantage at low irradiance (Dhillion and Anderson 1999) and outcompetes native vegetation by monopolizing the available light, nutrients, and moisture. Kurtz (2010) found the nonforest edge effect for garlic mustard was detectable much further into the forest (914.7 feet) than for the four other invasive species she studied (multiflora rose [*Rosa multiflora*], common buckthorn, nonnative bush honeysuckles, and reed canarygrass [*Phalaris arundinacea*]). However it is suggested these invasions generally occur following disturbance (Bartuszevige et al. 2007).

Garlic mustard generally establishes in deciduous woods with nonacidic, mesic soil (Welk et al. 2002) and is rarely found on xeric sites (Kurtz 2010). After establishing, garlic mustard often forms dense monocultures (Fig. 63), changing the habitat suitability for forest fauna and impacting the entire food chain. It also inhibits the growth of mycorrhizal fungi, threatening the nutrient uptake and competitive ability of native plants (Dhillion and Anderson 1999, Kaufman and Kaufman 2007, Weber and Gibson 2007).

The success of native plants is also put at risk by fauna that assist with the germination and dispersal of garlic mustard. White-tailed deer (*Odocoileus virginianus*) may contribute to the spread of garlic mustard by avoiding this aggressive invader and browsing other species, creating soil disturbances that facilitate germination (Rawinski 2008). This trend has been found in eastern hemlock (*Tsuga canadensis*) forests (Booth et al. 2010). Through changing the soil and litter layers and exposing mineral soil, the presence of nonnative earthworms may also facilitate germination. Garlic mustard plants can displace native mustard, threatening the rare native West Virginia white butterfly (*Pieris virginiensis*). This butterfly depends on the native mustard, and due to the differing chemistry of the leaves, the larvae fail to survive on the garlic mustard plants (Kaufman and Kaufman 2007).

Aside from the negative consequences caused by this plant, it is valued as a culinary and medicinal plant. The leaves have a high vitamin A and C content and can be used for garlic in salads, sandwiches, or cooking (Cavers et al. 1979, Kaufman and Kaufman 2007). Medicinally, garlic mustard is reported to be valuable as a sudorific, deobstruent, and to treat gangrene, ulcers, and dropsy (Cavers et al. 1979).

Due to the site requirements of garlic mustard, it is climatically restricted within the NRS region. Research suggests garlic mustard requires ≥19.7 inches of annual rainfall, warmth during the main development (the 48.2 °F May isotherm), adequate cold winters (the 42.8 °F January isotherm and mean December, January, and February temperatures < 41.0 °F), and sufficient time for plant development (the isoline of >120 frost free days) (Welk et al. 2002). Booth et al. (2010) also similarly suggest garlic mustard has a northern limit defined by sufficiently warm springs and summers and winters that are not too cold, as well as being restricted by soil type since garlic mustard occurs outside the acidic boreal soils. Research by Moser et al. (2009) further supports the influence of climate by noting a considerable reduction in the presence of garlic mustard north of 44.0 °N latitude, which is also suggested by Figures 64, 65, and 66.

In the future, garlic mustard may become an extremely troublesome weed. As the climate changes, garlic mustard may adapt more readily than most plant species since it does not require a specific morphological stage to respond to favorable conditions (Booth et al. 2010), and the flowers open earlier with increasing temperature (Welk et al. 2002).

Current distribution: Currently garlic mustard is found in 36 states and is listed as invasive, prohibited and/or noxious by Alabama, Connecticut, Michigan, Missouri, New York, and North Carolina (USDA NRCS 2023).

Plot presence: Garlic mustard is the 2nd most commonly observed IPS, occurring on 554 of the 4,244 NRS FIA plots in 2019 (13.1 percent; Table 5). Looking at 2014, 9.8 percent of plots (Table 6) had garlic mustard whereas in 2009, 7.4 percent of plots had this aggressive invader (Table 7). Figures 64, 65, and 66 show how this species has changed in cover and spread in the region over time on FIA plots. Some states had an increase in presence while others showed a reduction in the presence of garlic mustard. Cover was also variable over time. Graphically, it is hard to notice the increase in presence of garlic mustard in the region which is likely influenced by the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, Indiana and Ohio have the greatest percentage of plots with garlic mustard. In 2019, 34.8 percent of plots in these states had this aggressive IPS, however in 2014, Ohio had a much larger percentage of plots with garlic mustard than Indiana (29.0 percent versus 19.1 percent). Additionally in 2009, Ohio had a higher percentage of plots with this IPS (27.4 percent) than Indiana (18.2 percent). Across the NRS region, garlic mustard is present in 18 of the 24 states in 2019. It is absent from plots in Maine, New Hampshire, North Dakota, Rhode Island, South Dakota, and Vermont.

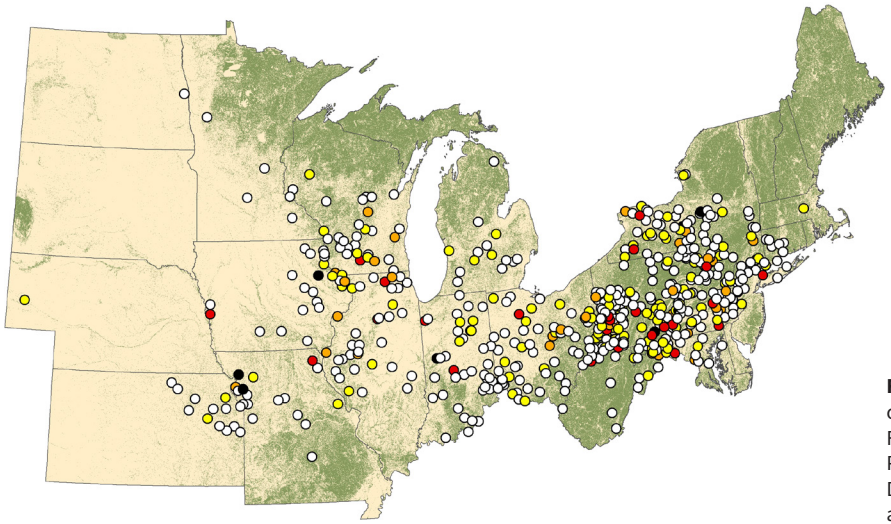

Figure 64.—Average cover of garlic mustard on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

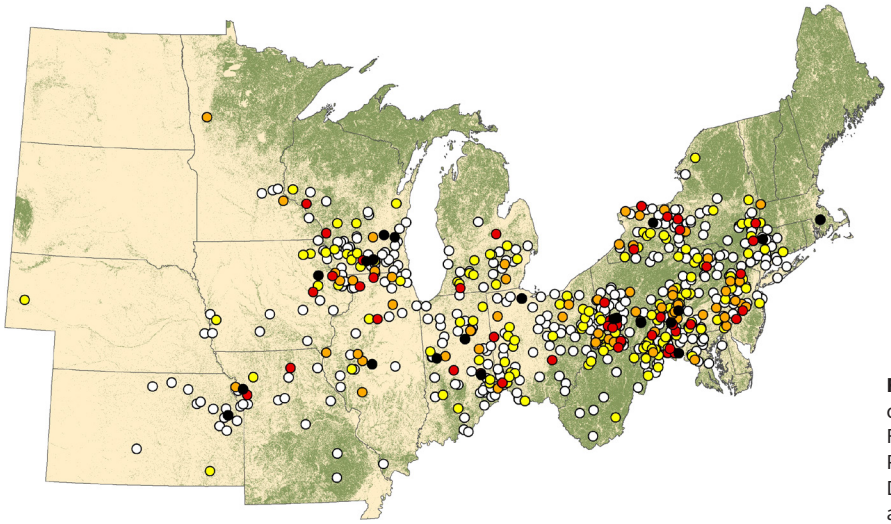

Figure 65.—Average cover of garlic mustard on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

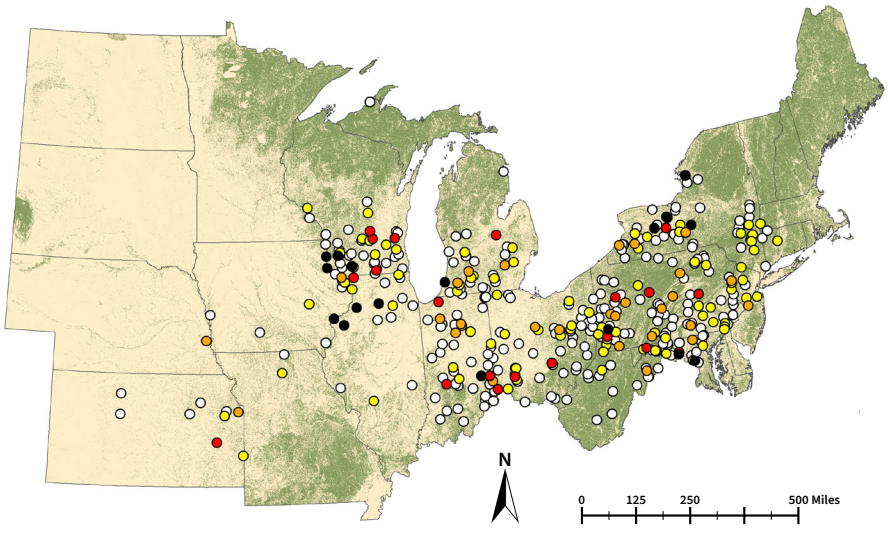

Figure 66.—Average cover of garlic mustard on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

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Giant knotweed

(*Polygonum sachalinense* syn. *Fallopia sachalinensis, Reynoutria sachalinensis*)

POSA4

Background and characteristics: Giant knotweed is an herbaceous perennial of the buckwheat family (Polygonaceae) that grows in sun to part shade. It was introduced in the second half of the 19th century to Europe from Japan and in the late 19th century to North America as an ornamental and for fodder (Urgenson et al. 2009). Floristic records in the northwestern United States suggest this IPS, along with Bohemian and Japanese knotweed, are among the most rapidly spreading plant invaders (Urgenson et al. 2009). People have facilitated the spread of this species by planting it in gardens where they enjoy the white flowers (Fig. 67). Another important spread mechanism is flood waters which transport rhizome fragments (Urgenson et al. 2009).

Figure 67.—Giant knotweed infestation, in flower. Licensed photo by Jan Samanek, Phytosanitary Administration/Bugwood.org.

Where this plant establishes, it creates dense mats that can outcompete neighboring plants and impede photosynthesis, making it difficult for other species to survive. Urgenson et al. (2009) found that this plant has the ability to alter the structure and function of riparian forests due to its high rate of resorption of foliar nitrogen which results in less nitrogen being added to the soil.

Current distribution: Giant knotweed is found in 27 states, with Michigan listing it as invasive, New York as prohibited, and Connecticut as potentially invasive, prohibited (USDA NRCS 2023).

Plot presence: Giant knotweed is the 32nd most commonly observed IPS, occurring on 3 of the 4,244 NRS FIA plots in 2019 (0.1 percent; Table 5). Looking at 2014, 0.1 percent of plots (Table 6) had giant knotweed whereas in 2009, 0.0 percent of plots had this aggressive invader (Table 7). Figures 68, 69, and 70 show how this species has changed in cover and spread in the region over time on FIA plots. With the limited number of occurrences in the region, in addition to the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), change can be hard to see.

Of the 24 NRS FIA states, Pennsylvania is the only state with giant knotweed in 2019. Michigan, Ohio, Pennsylvania, and West Virginia had this IPS in 2014. In 2009, it was only present in Michigan.

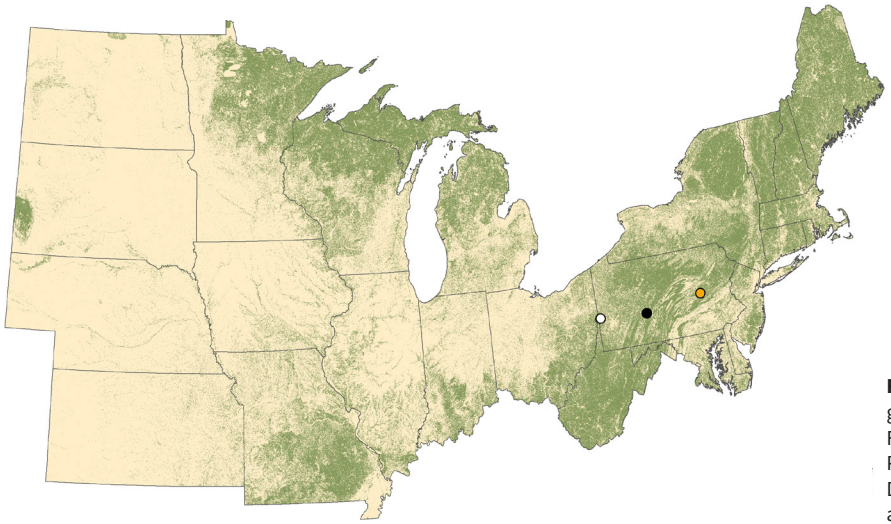

Figure 68.—Average cover of giant knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

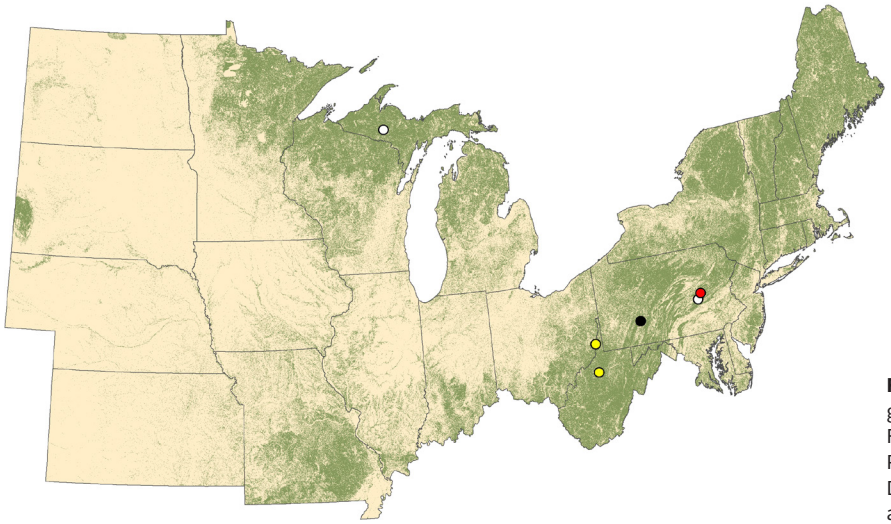

Figure 69.—Average cover of giant knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

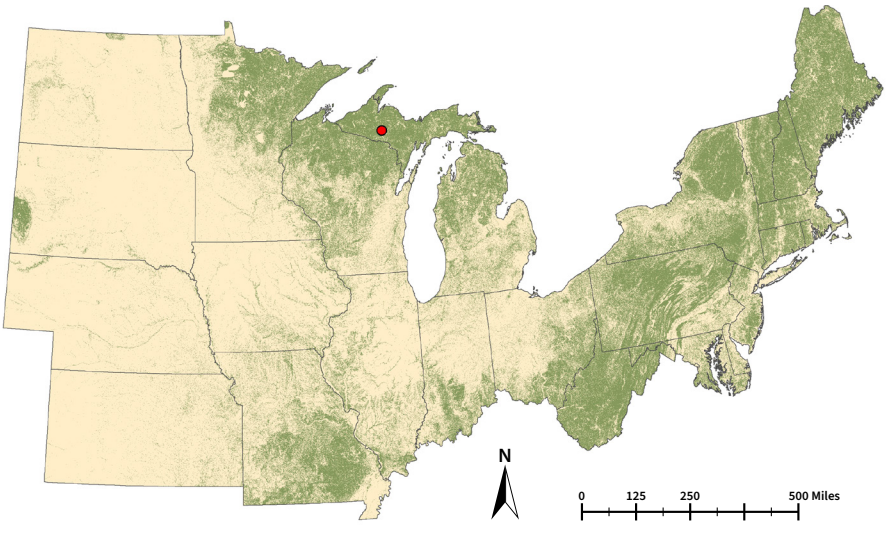

Figure 70.—Average cover of giant knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Glossy buckthorn

(*Frangula alnus*)

FRAL4

Figure 71.—Glossy buckthorn with fruit. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Background and characteristics: Glossy buckthorn, a woody shrub of the buckthorn family (Rhamnaceae), was introduced to the United States from Eurasia in the mid-1800s for ornamental use and is now naturalized in the northeastern United States and southeastern Canada (Gassmann et al. 2008). It is sometimes known by the common name of smooth buckthorn and alder buckthorn. A successful invader, glossy buckthorn is very adaptable and can grow in full sun or shade. It is problematic in wet areas but can also grow on upland sites (Czarapata 2005, Kaufman and Kaufman 2007). Interest in this plant for landscaping is primarily due to its form. Glossy buckthorn is sold as a hedge offering showy, glossy leaves and attractive berries (Fig. 71). The numerous berries are readily transported by small animals and birds. In birds, the berries have a laxative effect (Czarapata 2005). Deer may also contribute to the spread of glossy buckthorn since they do not browse this noxious shrub and instead browse other plant species, creating soil disturbances that facilitate germination (Rawinski 2008). Federal agencies promoted planting this IPS (Zouhar et al. 2008) which has also contributed to its spread. Some cultures have found this invader useful for making dyes and as a medicinal plant (Gould and Stuckey 1992).

Glossy buckthorn's presence (Fig. 72) is similar to that of common buckthorn (Fig. 33) with reduced presence south of 42 °N. According to the PLANTS Database (USDA NRCS 2023), it is suggested glossy buckthorn can survive to -38.0 °F and requires cold stratification, 35.0 to 60.0 inches of precipitation annually, 90 or more frost free days, pH levels between 5.0 and 6.5, and a minimum rooting depth of 14.0 inches. Additional growth limitations are its intolerance of anaerobic conditions and low tolerance of calcareous soils.

Current distribution: In the United States, glossy buckthorn is found in 25 states with Connecticut and Michigan listing it as invasive and New York as prohibited (USDA NRCS 2023).

Plot presence: Glossy buckthorn is the 17th most commonly observed IPS, occurring on 101 of the 4,244 NRS FIA plots in 2019 (2.4 percent; Table 5). Looking at 2014, 2.3 percent of plots (Table 6) had glossy buckthorn whereas in 2009, 2.2 percent of plots had this aggressive invader (Table 7). Figures 72, 73, and 74 show how this species has changed in cover and spread in the region over time on FIA plots. It does appear that there is an increase in coverage, spread, and presence over time. An important facet to note is the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), so change can be hard to see.

In 2019 Massachusetts has the highest percentage of plots with glossy buckthorn at 25.0 percent. In 2014, 19.6 percent of plots in Massachusetts had this aggressive shrub, and in 2009, 13.3 percent of plots did. Glossy buckthorn is present in 13 of the 24 states in 2019.

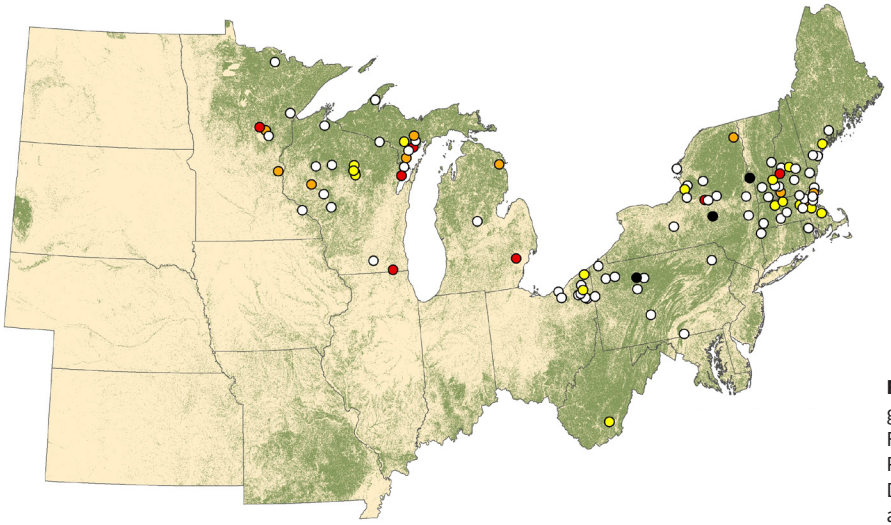

Figure 72.—Average cover of glossy buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

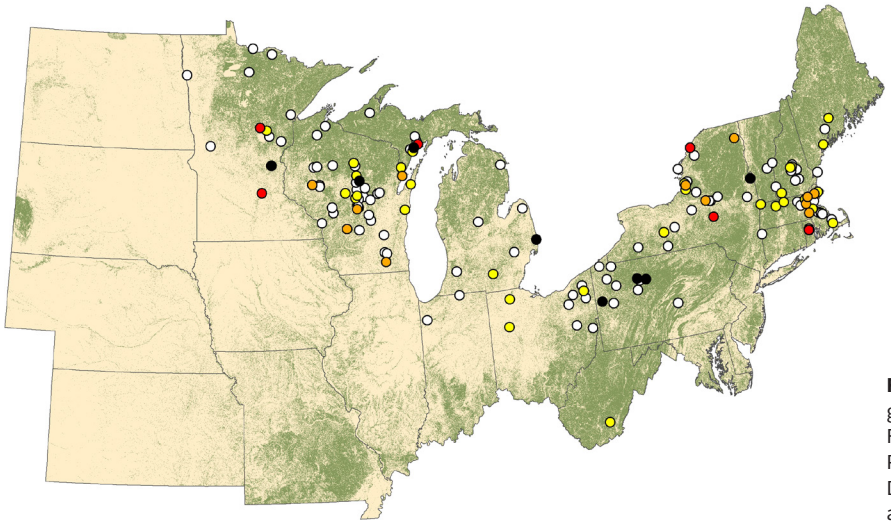

Figure 73.—Average cover of glossy buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

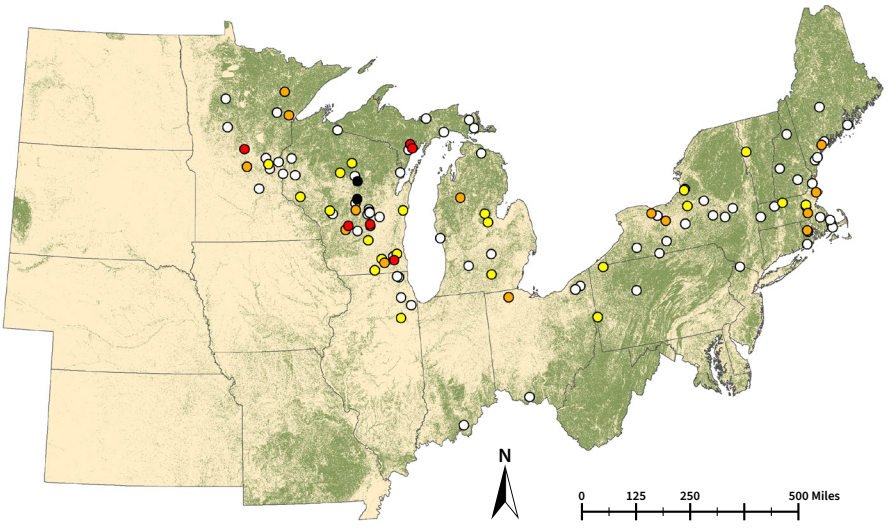

Figure 74.—Average cover of glossy buckthorn on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Japanese barberry

(Berberis thunbergii)

CIVU

Background and characteristics: Japanese barberry, a shrub of the barberry family (Berberidaceae), was sent from Russia to Boston in 1875 as a substitute for common barberry which harbors black stem rust (*Puccinia graminis*), affecting barley and wheat plants (Kaufman and Kaufman 2007). As a landscape plant, Japanese barberry is highly desired because of its drought resistance and attractive fruit and foliage (Fig. 75). Due to its horticultural value, several ornamental cultivars have been released. This species can survive across a broad range of light levels, but when grown in the shade, the color of its foliage is not as vibrant.

Figure 75.—Japanese barberry infestation. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

As an aggressive spreading shrub, Japanese barberry has several important spread mechanisms. Birds are an important vector of the seeds (Kaufman and Kaufman 2007). Deer may also promote the presence of Japanese barberry since they do not browse this plant but instead browse other species, creating soil disturbances which facilitate germination (Rawinski 2008). This trend was found in an eastern hemlock forest where deer accelerated invasion by Japanese barberry (Booth et al. 2010). Japanese barberry also spreads through vegetative propagules and from rooting where the branches contact the soil. By spreading vegetatively, this invasive can form a dense shrub layer that impedes the growth of other species and is a nuisance to humans and animals since the plants are covered with spines. An additional negative impact caused by these plants is the alteration of the soil chemistry. Research suggests this IPS can change soil pH and nitrate levels, favoring its growth over other plants (Boos et al. 2010).

Though tolerant of a wide variety of conditions, Japanese barberry does have some specific requirements. According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious shrub can survive to -28.0 °F and requires 30.0 to 60.0 inches of precipitation annually, 180 or more frost free days, pH levels between 5.5 and 7.2, and a minimum rooting depth of 18.0 inches. Additional limits to its presence are its intolerance of anaerobic and calcareous soils as well as its cold stratification requirement.

Current distribution: Federal agencies promoted planting this species (Zouhar et al. 2008), and its aggressive growth and spread have contributed to the presence of this IPS throughout the United States. Japanese barberry is now found in 32 states, primarily in the Northeast and Midwest, with Connecticut, Michigan, and North Carolina listing it as invasive and Maryland as a Tier 2 invasive plant, and New York as prohibited (USDA NRCS 2023).

Plot presence: Japanese barberry is the 7th most commonly observed IPS, occurring on 334 of the 4,244 NRS FIA plots in 2019 (7.9 percent; Table 5). Looking at 2014, 6.0 percent of plots (Table 6) had Japanese barberry whereas in 2009, 4.8 percent of plots had this aggressive invader (Table 7). Figures 76, 77, and 78 show how this species has changed in cover and spread in the region over time on FIA plots. Even though the percent of plots with Japanese barberry increased over the span of these inventories, it is hard to tell due to the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, Connecticut has the highest percentage of plots with Japanese barberry. In 2019, 56.8 percent of plots in these states had this aggressive IPS; there were 45.9 percent in 2014 and 30.2 percent in 2009. Across the NRS region, Japanese barberry is present in 18 of the 24 states in 2019. It is absent from plots in Delaware, Kansas, Missouri, Nebraska, North Dakota, and South Dakota.

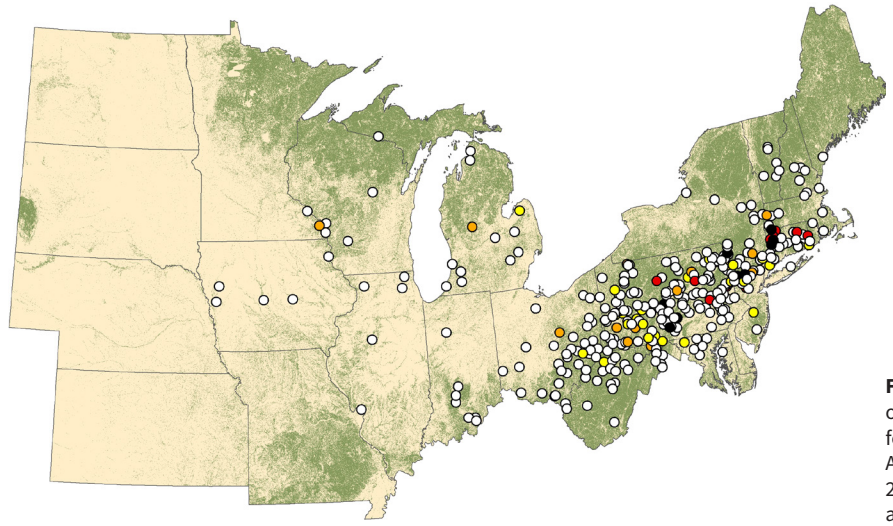

Figure 76.—Average cover of Japanese barberry on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

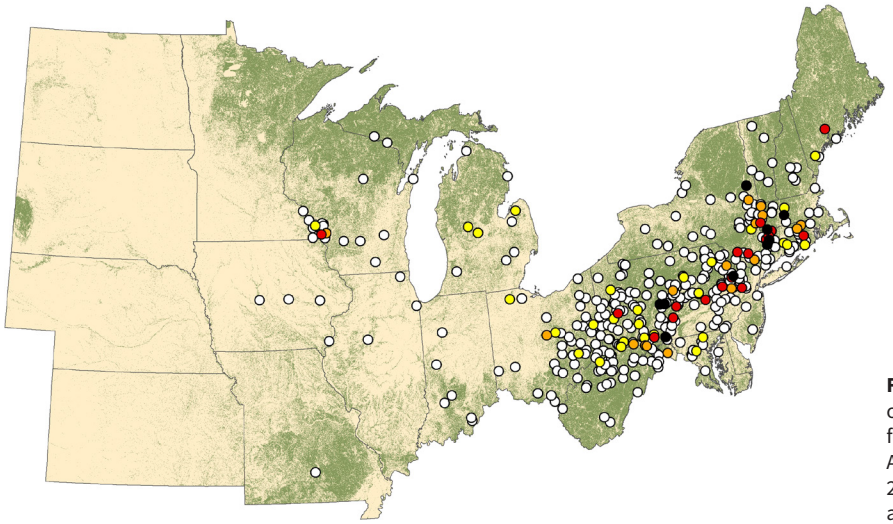

Figure 77.—Average cover of Japanese barberry on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

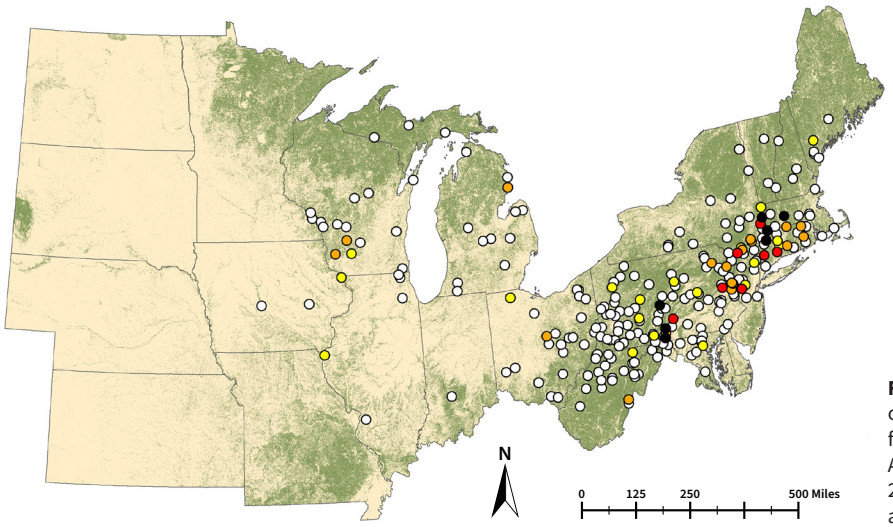

Figure 78.—Average cover of Japanese barberry on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Japanese honeysuckle

(*Lonicera japonica*)

LOJA

Background and characteristics: Japanese honeysuckle is a woody vine of the honeysuckle family (Caprifoliaceae). It is used as a groundcover and ornamental, introduced from Japan in 1806 (Smith 1997). Its ornamental value is due to the prolific fragrant flowers (Fig. 79) and dense, rapid growth. Japanese honeysuckle is a shade tolerant vine that can grow to 30.0 feet or more (Czarapata 2005). This IPS climbs on vegetation, where it can impact photosynthesis of other plants and break or girdle stems. Its vines increase the surface area of trees, creating a sail factor which escalates the probability of blow down. There is also increased fire risk from Japanese honeysuckle because of the increased fuel load and the likelihood of a crown fire due to the fuel continuity created by the plant growing up and over forest vegetation (Zouhar et al. 2008).

Figure 79.—Japanese honeysuckle in flower. Licensed photo by Chris Evans, University of Illinois/Bugwood.org.

Aside from its ecological impacts, Japanese honeysuckle has important medicinal uses. Honeysuckle is drunk as a tea and is traditionally used for dysentery, coughs, fevers, enteritis, laryngitis, colds, flu, rheumatism, sores, tumors (especially breast cancer), infected boils, scabies, and swelling. Experimentally it has been shown to make tuberculosis static, be antiviral, antibacterial, and lower cholesterol (Foster and Duke 2000).

In the NRS region, Japanese honeysuckle is climatically restricted. According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious vine can survive to -13.0 °F and requires cold stratification, 24.0 to 60.0 inches of precipitation annually, 130 or more frost free days, pH levels between 4.9 and 7.8, and a minimum rooting depth of 10.0 inches. Factors restricting the presence of Japanese honeysuckle are its intolerance of salinity, the presence of coarse and calcareous soils (USDA NRCS 2023), and deep shade (Smith 1997).

Current distribution: Since its introduction in 1806, Japanese honeysuckle has spread to Puerto Rico, and 38 states, with 4 northeastern states (Connecticut, Missouri, New York, and North Carolina) classifying it as invasive and/or prohibited (USDA NRCS 2023).

Plot presence: Japanese honeysuckle is the 6th most commonly observed IPS, occurring on 339 of the 4,244 NRS FIA plots in 2019 (8.0 percent; Table 5). Looking at 2014, 7.5 percent of plots (Table 6) had Japanese honeysuckle whereas in 2009, 5.8 percent of plots had this aggressive invader (Table 7). Figures 80, 81, and 82 show how this species has changed in cover and spread in the region over time on FIA plots. The percent of plots with Japanese honeysuckle increased over time; however, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009), making change harder to see. What is apparent from the figures is there was more regional spread in 2009 and 2014 whereas in 2019 presence is primarily clustered in the southern part of the region. Additionally, the abundance of plots with cover over 72 percent is less in the 2019 survey.

Of the 24 NRS FIA states, Delaware has the highest percentage of plots with Japanese honeysuckle at 46.7 percent in 2019. Massachusetts had 57.1 percent of plots with this aggressive vine in 2014, and 50.0 percent of plots in 2009. It is important to note the low sample size in Delaware with just over a dozen plots being sampled this inventory. Japanese honeysuckle is present in 13 of the 24 states in 2019.

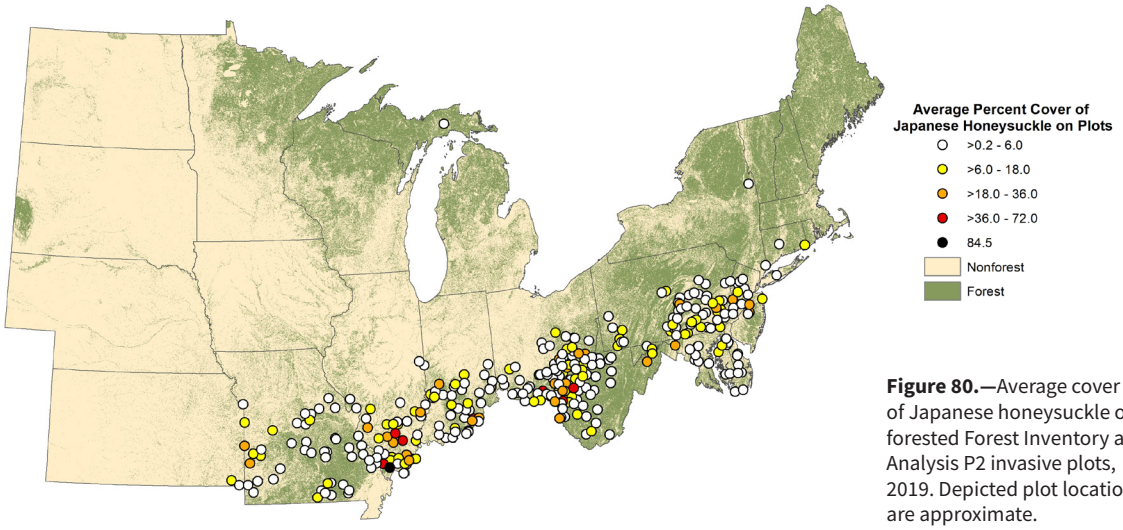

Figure 80.—Average cover of Japanese honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

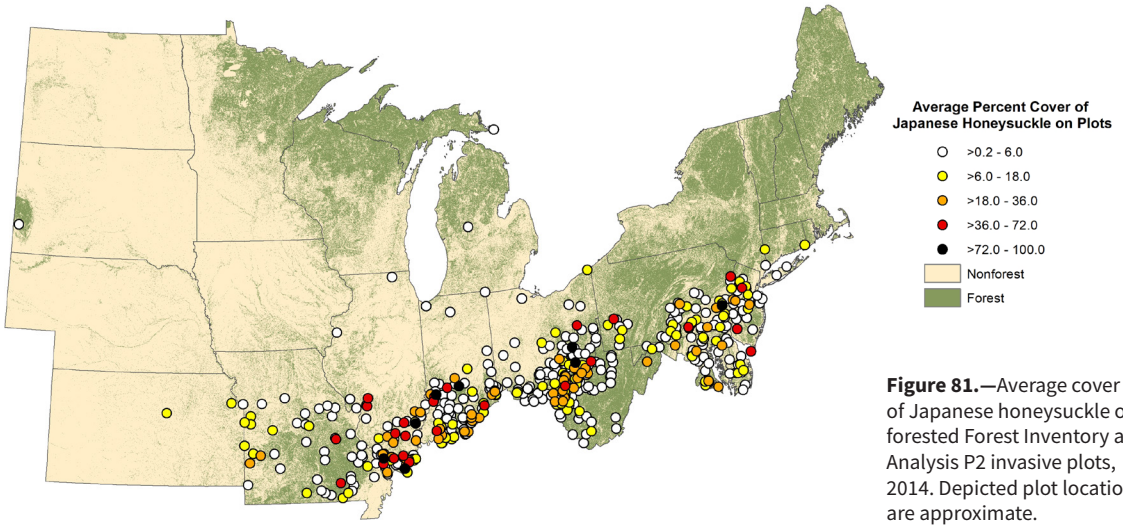

Figure 81.—Average cover of Japanese honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

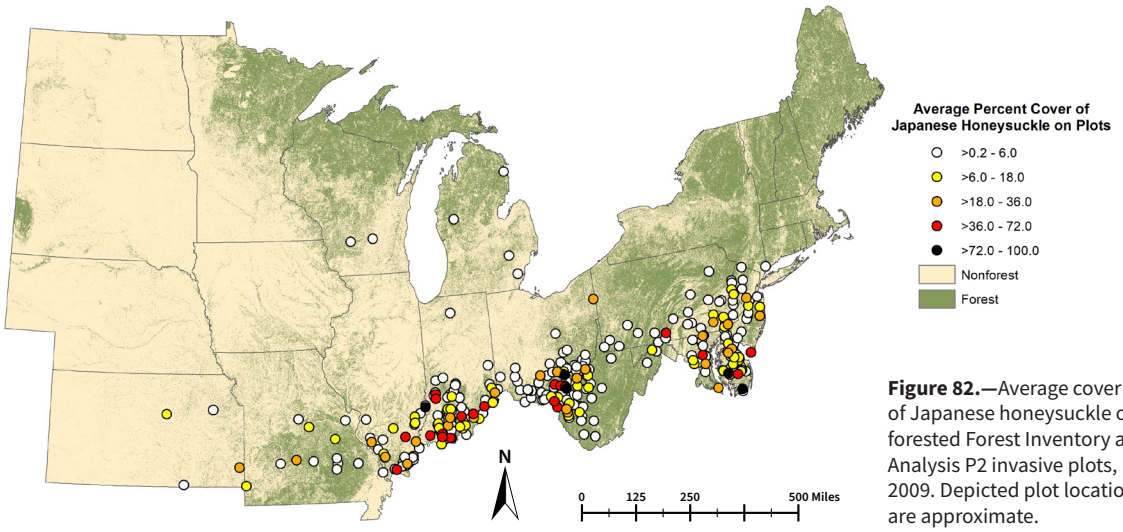

Figure 82.—Average cover of Japanese honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Japanese knotweed

(*Polygonum cuspidatum* syn. *Fallopia cuspidatum, Reynoutria cuspidatum*)

POCU6

Figure 83.—Japanese knotweed in flower. Licensed photo by Randy Westbrooks, Invasive Plant Control, Inc./Bugwood.org.

Background and characteristics: Japanese knotweed, also known as Mexican bamboo, is an herbaceous perennial of the buckwheat family (Polygonaceae). It is native to eastern Asia and was introduced in the late 1800s to the United States from Japan, via the United Kingdom, for fodder, erosion control, and ornamental use (Czarapata 2005, Gould and Stuckey 1992, Kaufman and Kaufman 2007). Optimal growth occurs in full sun though it is tolerant of shade as well as drought, salinity, and high temperatures (Brakke 2006, Kaufman and Kaufman 2007). Japanese knotweed is frequently found along rights-of-way and near homesteads where the long, arching branches with sprays of flowers (Fig. 83) are visible. The stems of this IPS are unique in that they are bamboo-like with raised nodes. These distinctive stems are reported to be edible when young (Kaufman and Kaufman 2007, Peterson 1977) and the somewhat older stems can be made into jam (Peterson 1977). Allowed to grow, the plants can reach up to 10.0 feet (Kaufman and Kaufman 2007).

An aggressive spreading species, the presence of Japanese knotweed is a concern. Japanese knotweed is difficult to control and can damage pavement by sending rhizomes underneath highways from one side of the road to the other. The stems can even penetrate asphalt (Gould and Stuckey 1992). Japanese knotweed is also worrisome along railroads because when dormant it poses a fire hazard (Czarapata 2005).

Current distribution: Since its introduction in the late 1800s, this herbaceous perennial has spread to 41 states, with six states listing it as noxious, prohibited, and/or invasive (USDA NRCS 2023).

Plot presence: Japanese knotweed is the 26th most commonly observed IPS, occurring on 13 of the 4,244 NRS FIA plots in 2019 (0.3 percent; Table 5). Looking at 2014, 0.4 percent of plots (Table 6) had Japanese knotweed whereas in 2009, 0.3 percent of plots had this aggressive invader (Table 7). Figures 84, 85, and 86 show how this species has changed in cover and spread in the region over time on FIA plots. It does show there has been some eastward spread. The percent of plots with Japanese knotweed fluctuated over time; however, it is important to note the variation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, Pennsylvania has the highest number of observations of Japanese knotweed in 2019 (6 observations; 0.9 percent of plots). West Virginia is the only other state with more than one occurrence of this IPS on plots (3 observations; 1.4 percent of plots). As a percentage, Rhode Island has the highest amount of plots with this species, at 16.7. However, the state only has six P2 invasive plots. Japanese knotweed is present on one plot in Rhode Island. Regionwide, Japanese knotweed is present in 6 of the 24 states in 2019.

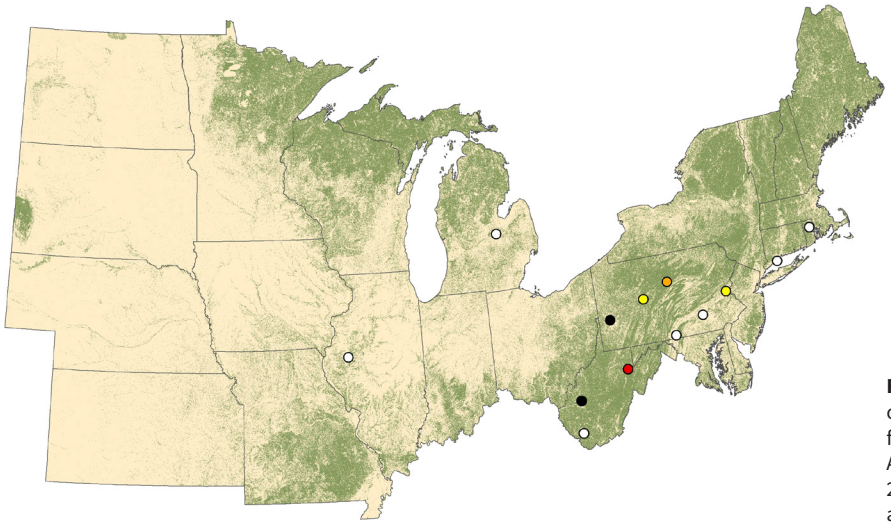

Figure 84.—Average cover of Japanese knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

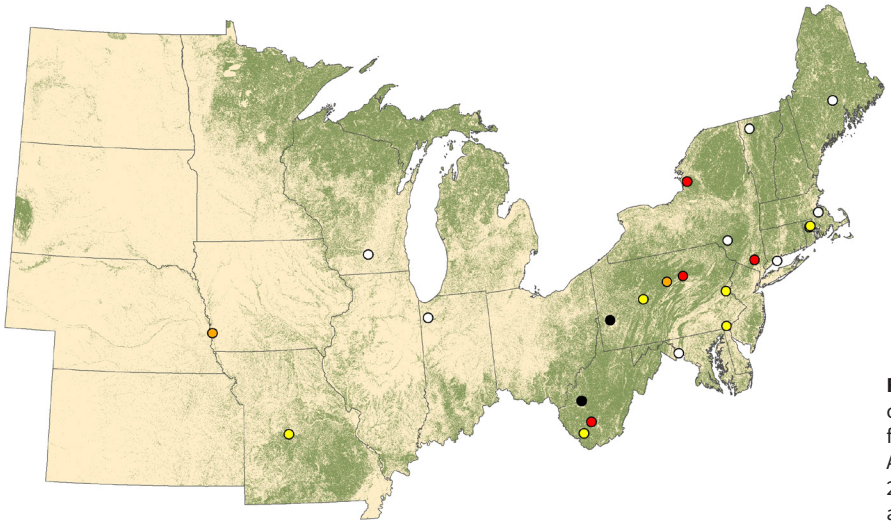

Figure 85.—Average cover of Japanese knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

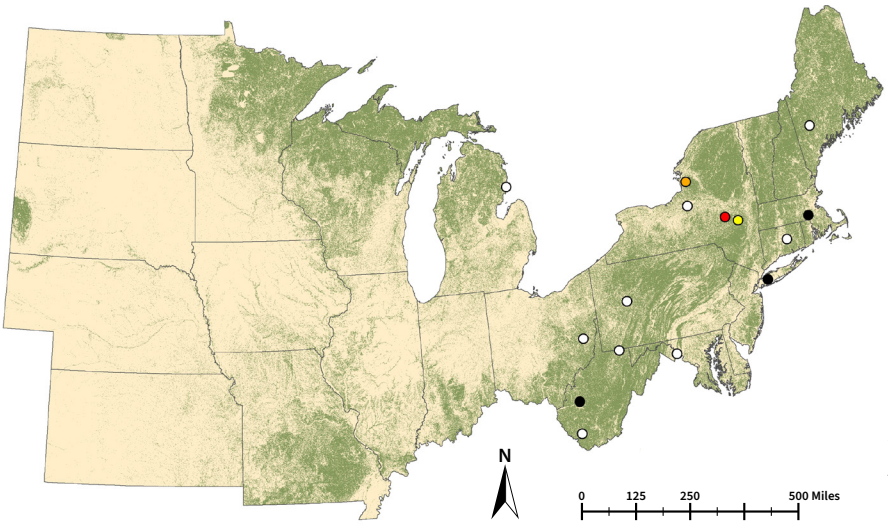

Figure 86.—Average cover of Japanese knotweed on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Japanese meadowsweet

(*Spiraea japonica*)

SPJA

Background and characteristics: Japanese meadowsweet, also known as Japanese spiraea, is a woody shrub of the rose family (Rosaceae) that was introduced around 1870 to the northeastern United States as an ornamental from Asia (Kaufman and Kaufman 2007). It is still widely available from nurseries and is a popular plant since it is low-maintenance and has attractive form, foliage, and flowers (Fig. 87). The popularity of Japanese meadowsweet as a landscape plant has resulted in the introduction of several cultivars. Japanese meadowsweet spreads from those areas where it is planted and forms dense shrub layers that shade out understory plants. Primary means of spread are by wind, water, and vegetative propagules where it often invades disturbed sites; these traits may enable Japanese meadowsweet to be a serious invasive plant in the future (Martine et al. 2008).

Figure 87.—Japanese meadowsweet in flower. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

According to the PLANTS Database (USDA NRCS 2023), it is suggested that Japanese meadowsweet can survive to -23.0 °F and requires 35.0 to 60.0 inches of precipitation annually, 145 or more frost free days, pH levels between 5.0 and 6.8, and a minimum rooting depth of 14.0 inches. Additional growth limitations are its intermediate shade tolerance and intolerance of anaerobic and calcareous soils.

Current distribution: Japanese meadowsweet occurs in 22 states, all in the eastern half of the United States (USDA NRCS 2023).

Plot presence: Japanese meadowsweet is the 27th most commonly observed IPS, occurring on 11 of the 4,244 NRS FIA plots in 2019 (0.3 percent; Table 5). Looking at 2014, 0.2 percent of plots (Table 6) had Japanese meadowsweet whereas in 2009, 0.2 percent of plots had this aggressive invader (Table 7). Figures 88, 89, and 90 show how this species has changed in cover and spread in the region over time on FIA plots. Based on plot observations, it is suggested this species has remained in approximately the same region. The percentage of plots with Japanese meadowsweet increased slightly; however, it is important to note the increase was very small (0.1 percent) and the number of plots monitored each inventory varied (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, West Virginia has the highest number of observations of Japanese meadowsweet in 2019 (9 observations; 4.2 percent of plots). New Jersey and Pennsylvania are the only other two states where Japanese meadowsweet is observed with one observation in each state. In 2014, this species was also found in Indiana, Pennsylvania, and West Virginia but was not found in New Jersey. In 2009, it was found in New York, Pennsylvania, and West Virginia. Throughout the inventory, West Virginia had the highest number and greatest percentage of observations. This species is present in three of the 24 states of the region in 2019.

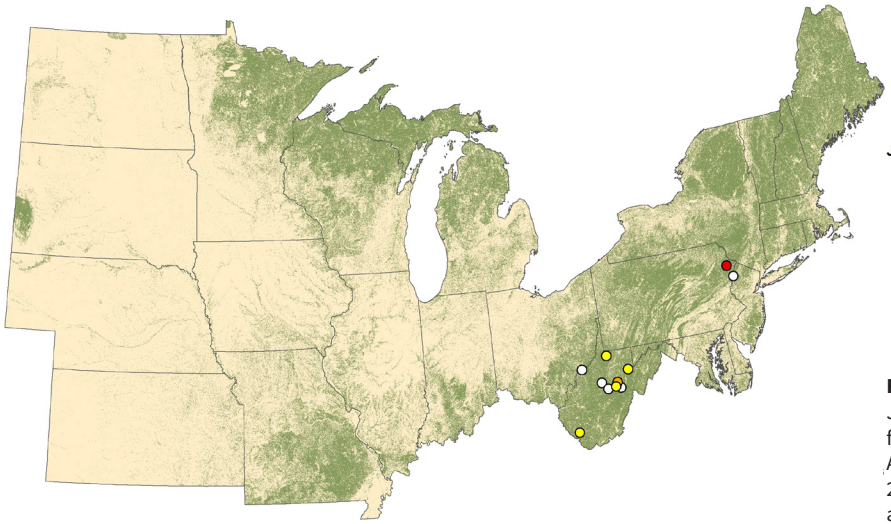

Figure 88.—Average cover of Japanese meadowsweet on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

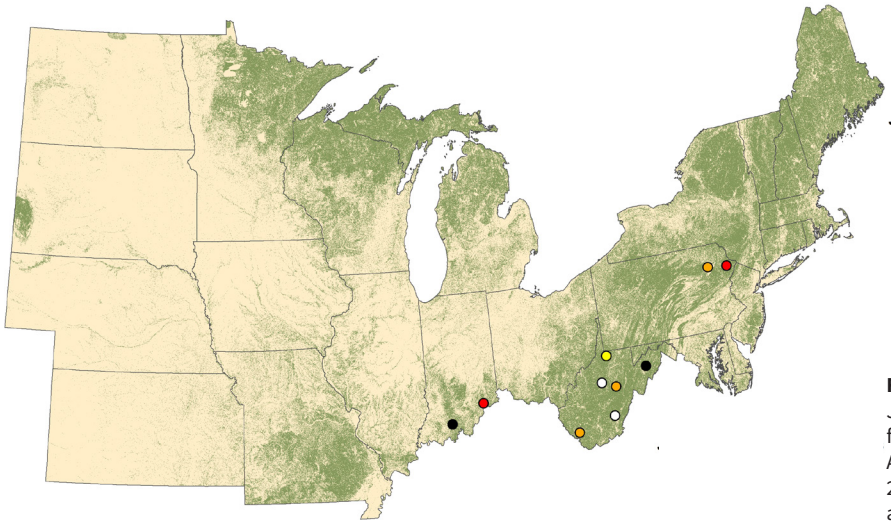

Figure 89.—Average cover of Japanese meadowsweet on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

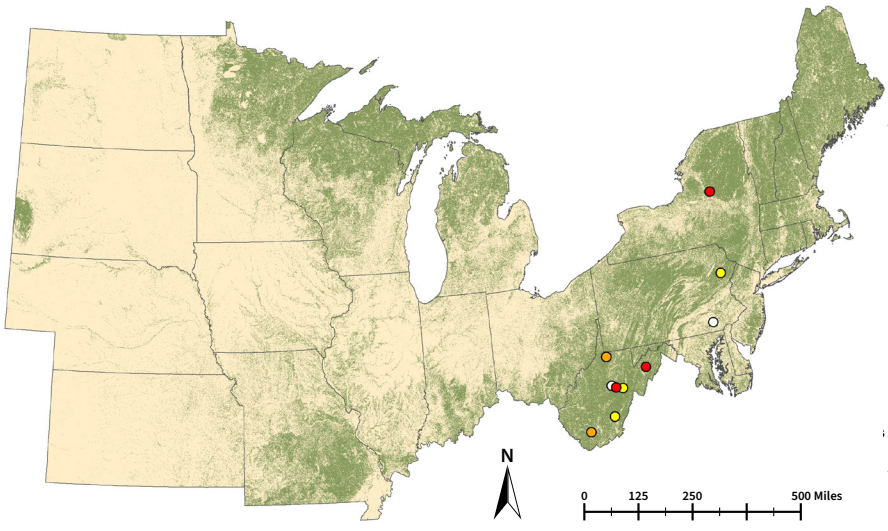

Figure 90.—Average cover of Japanese meadowsweet on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Japanese stiltgrass (Nepalese browntop)

(*Microstegium vimineum*)

MIVI

Background and characteristics: Japanese stiltgrass, also known as Nepalese browntop, is a member of the grass (Poaceae) family commonly known as packing grass. It is native to southeastern Asia and was introduced to Tennessee in 1919 through Oriental porcelain packing material that contained seeds (Barden 1987, Kaufman and Kaufman 2007). The success of Japanese stiltgrass can partly be attributed to its ability to grow in sun or shade (Fig. 91). The seeds of this IPS are viable 3 to 5 years, and each plant can yield up to 1,000 seeds annually (Czarapata 2005). It prefers to grow in acidic to neutral, highly organic soils in floodplain forests and stream banks, however this invader can grow in forests, fields, and slightly alkaline soils (Kaufman and Kaufman 2007). Where Japanese stiltgrass establishes, it can change the nutrient cycle as the decaying plants increase soil organic matter and pH (Kaufman and Kaufman 2007).

Figure 91.—Japanese stiltgrass infestation. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Facilitating the spread of Japanese stiltgrass is its ability to root where the nodes contact the soil. Deer may also promote this species since they do not browse it and instead browse other species, creating soil disturbances that facilitate germination (Kaufman and Kaufman 2007, Rawinski 2008). This has been seen in an eastern hemlock forest where deer promoted invasion by Japanese stiltgrass (Booth et al. 2010). Colonization occurs rapidly on disturbed sites with slower invasion on sites that have not been disturbed (Barden 1987). Within 5 years this aggressive invader can take over a plant community (Kaufman and Kaufman 2007).

Current distribution: Japanese stiltgrass is now found in Puerto Rico and 24 states, primarily in the east/southeastern part of North America. Alabama lists this aggressive invader as a Class C noxious weed, Connecticut, Missouri, New York, and North Carolina list this invader as invasive and or prohibited. Michigan has Japanese stiltgrass on the watch list (USDA NRCS 2023).

Plot presence: Japanese stiltgrass is the 4th most commonly observed IPS, occurring on 404 of the 4,244 NRS FIA plots in 2019 (9.5 percent; Table 5). Looking at 2014, 6.6 percent of plots (Table 6) had Japanese stiltgrass whereas in 2009, 5.0 percent of plots had this aggressive invader (Table 7). This large change in occurrence is noteworthy in that the species rank of Japanese stiltgrass went from the seventh most commonly observed IPS in 2009 and 2014 to the fourth most common in 2019. Figures 92, 93, and 94 show how this species has changed in cover and spread in the region over time on FIA plots. It is hard to see the increase in Japanese stiltgrass via the figures because of the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, West Virginia has the largest percentage of plots with Japanese stiltgrass in 2019 (91 observations; 42.7 percent of plots). Indiana (35.7 percent) and Ohio (34.3 percent) also have over 1/3 of plots with this invasive graminoid. Eleven states in the NRS region have Japanese stiltgrass present in 2019. This has been fairly consistent over the inventories.

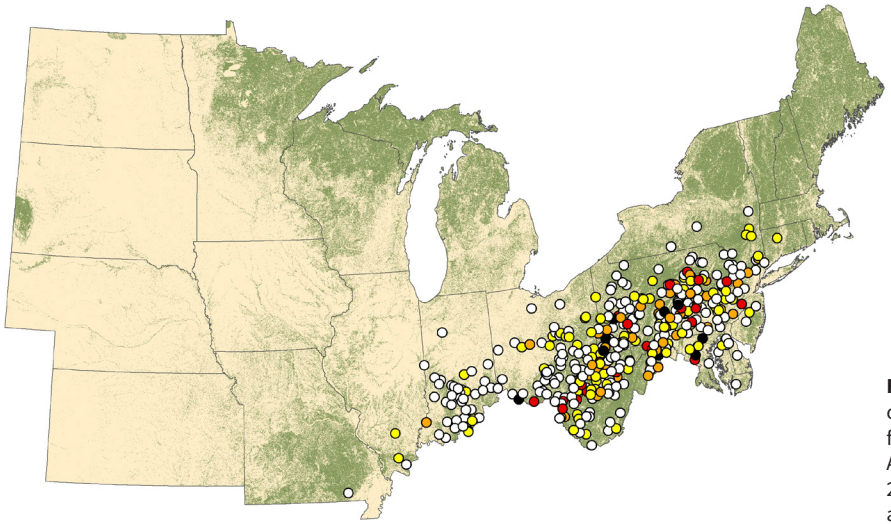

Figure 92.—Average cover of Japanese stiltgrass on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

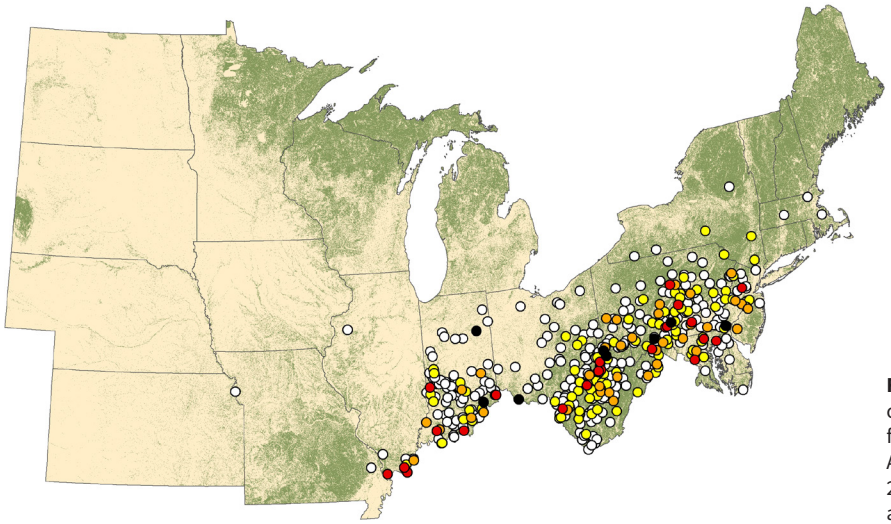

Figure 93.—Average cover of Japanese stiltgrass on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

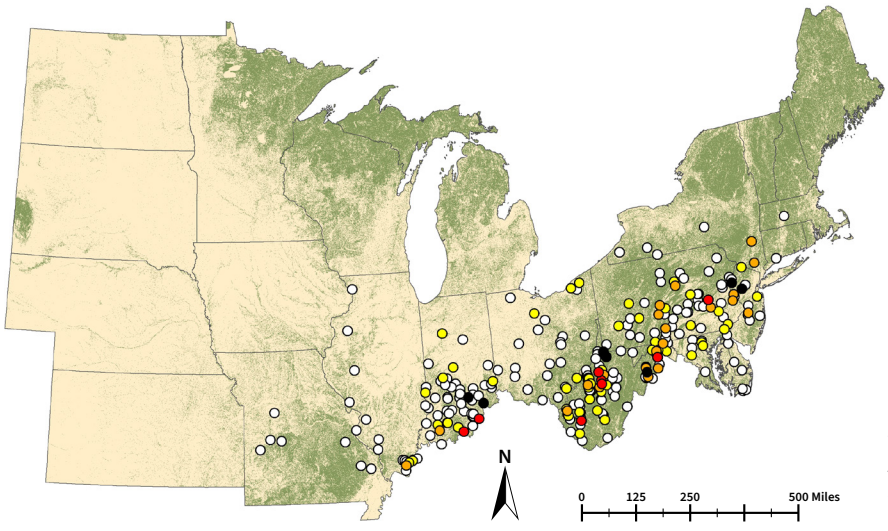

Figure 94.—Average cover of Japanese stiltgrass on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Kudzu

(*Pueraria montana*)

PUMO

Figure 95.—Kudzu infestation. USDA Forest Service photo by Kerry Britton/Bugwood.org.

Background and characteristics: Kudzu is a perennial, semi-woody vine of the pea family (Fabaceae). It was brought to the United States from Japan in 1876 during the Centennial Exposition in Philadelphia, PA from the Japanese government's garden of native plants (Kaufman and Kaufman 2007, Shurtleff and Aoyagi 1977). After its introduction, kudzu became a highly desired ornamental with beautiful fragrant flowers, quick growth, and lush foliage. Optimal growth occurs in full sun. Its seeds are generally not viable, so spread is primarily through vegetative propagules. This drought tolerant vine can grow 6.0 inches in a day and has a massive root system that is able to penetrate 10.0 feet into the ground and can weigh over 100.0 pounds (Kaufman and Kaufman 2007). Kudzu's deep roots can penetrate beneath depleted surface soil and send minerals up to the leaves, giving it a nutritional value equal to clover and alfalfa (Shurtleff and Aoyagi 1977).

After discovering the nutritional value and rapid growth rate of kudzu, widespread planting occurred. In the 1930s unprofitable red clay soils were abandoned in the South, and government crews planted thousands of acres with kudzu for erosion control (Kaufman and Kaufman 2007). In the 1940s the government encouraged farmers to plant kudzu, offering $8.00 per acre to plant it in fields (Kaufman and Kaufman 2007). After decades of planting this species as an ornamental and for forage, the U.S. Department of Agriculture removed it from its approved cover crops in 1953 (Kaufman and Kaufman 2007). Other countries have also experimented with growing kudzu. Brazil imported this IPS for apiaries and suggested that the honey is of highest quality, delightful in fragrance and flavor (Shurtleff and Aoyagi 1977).

Kudzu is estimated to be spreading at a rate of 124,000 acres per year and has infested 7.0 million acres of land (Kaufman and Kaufman 2007, Pappert et al. 2000). The aggressive growth of kudzu (Fig. 95) can impede photosynthesis, increase the likelihood of stem breakage, and girdle trees. Its vines can grow to over 100.0 feet (Kaufman and Kaufman 2007). The vines have important fire implications due to increasing fuel continuity by growing up and over forest vegetation which can potentially increase the fuel load and likelihood of a crown fire (Zouhar et al. 2008).

Kudzu is a medicinally important plant that is readily available to purchase. The Chinese have been using it for herbal medicine for over 2,000 years, and the Japanese make a starch from the roots which is thought to have an effect on prostate health and some cancers (Kaufman and Kaufman 2007). Kudzu has also been reported to be valuable for headaches, diarrhea, dysentery, intestinal obstruction, gastroenteritis, measles, sores, swellings, mastitis, sore throats, deafness, to sober an intoxicated person, and induce sweating, as well as experimentally to lower blood sugar and pressure, prevent the development of tumors, and stimulate liver tissue regeneration while protecting against liver toxins (Foster and Duke 2000). Furthermore teas, jellies, and syrups are made from this invader (Kaufman and Kaufman 2007).

Current distribution: Kudzu is recorded in 30 states (USDA NRCS 2023).

Plot presence: Kudzu is not currently found on NRS FIA P2 invasive plots in the NRS region. In a previous report of FIA plots, which dates back to the 2005 inventory, Kurtz (2013) found this IPS present in two states in the NRS FIA region, Indiana (two plots) and Missouri (one plot).

Leafy spurge
(*Euphorbia esula*)
EUES

Background and characteristic: Leafy spurge, an herbaceous perennial of the spurge family (Euphorbiaceae), is from the Caucaus region of western Asia and was introduced from impure seed to Newbury, Massachusetts in 1827 (Kaufman and Kaufman 2007, Stein and Flack 1996, Royer and Dickinson 1999, Westbrooks 1998). It is a major concern throughout the United States, causing huge economic impacts by reducing agricultural potential, wildlife quality, plant diversity, and aesthetic value. An additional concern with leafy spurge is that it may be allelopathic, producing allelochemicals that interfere with the growth of other plants (Czarapata 2005, Royer and Dickinson 1999).

Figure 96.—Leafy spurge infestation. Licensed photo by Utah State University/Bugwood.org.

Leafy spurge is spread by seeds that are expelled from a capsule up to 15.0 feet and can float along waterways, as well as by the roots which can extend to 21.0 feet (Kaufman and Kaufman 2007). Where the plants establish, their dense growth can shade out neighboring vegetation (Fig. 96). Its negative effects are so great that it ranks among The Nature Conservancy's "Dirty Dozen" alien species (Stein and Flack 1996).

Leafy spurge is especially problematic in agricultural areas and causes economic strife to ranchers. Sheep can graze this noxious invader without harmful effects (Royer and Dickinson 1999). However, cattle will not graze an area with as little as 10.0 percent leafy spurge cover as the milky sap irritates their digestive tract and causes lesions around their eyes and mouths (Westbrooks 1998). Czarapata (2005) indicated that four western states (Montana, North Dakota, South Dakota, and Wyoming) had decreased annual livestock revenue from reduced grazing capacity via leafy spurge infestations which resulted in a loss of approximately 1,433 jobs and $129 million in direct and secondary economic impacts.

Another example of the economic toll caused by leafy spurge is in Kalmath County, Oregon where a 1,360-acre ranch was abandoned because of the lost productivity from this plant; the ranch eventually sold for $22.00 an acre, 83.0 percent less than the value of similar noninfested land that was valued from $125.00 to $150.00 per acre (Czarapata 2005, Westbrooks 1998). The estimate to control the leafy spurge on this ranch was $65,000, but the new owner spent substantially more than that, making practically no headway (Westbrooks 1998).

Further impacts caused by this species are noted by Czarapata (2005) in North Dakota where leafy spurge has infested over 1.2 million acres of rangeland at a then estimated annual loss of nearly $75 million. A previous annual estimate of the direct and secondary impacts of this perennial on grazing land, wildlife, and the state's economy was over $87 million (Westbrooks 1998).

Ecologically, the seed is eaten by mourning doves (*Zenaida macroura*) and leafy spurge provides nesting habitat for western meadowlarks. However, in areas where leafy spurge has become prevalent, populations of grasshopper sparrows (*Ammodramus savannuarum*) and savannah sparrows (*Passerculus sandwichensis*) have been reduced. This species has also reduced habitat for bison, deer, elk, and the endangered western prairie fringed orchid (*Platanthera praeclara*; St. John and Tilley 2014).

Current distribution: The distribution of leafy spurge in the United States and Canada is substantial. A 2007 report (Kaufman and Kaufman 2007) estimated the United States and southern Canada to have more than 5 million acres invaded by leafy spurge. This herbaceous invader is currently found in 35 states (all of the lower 48 except the South/Southeast and Delaware; USDA NRCS 2023), with 22 states listing leafy spurge as a noxious weed (St. John and Tilley 2014).

Plot presence: Leafy spurge is the 30th most commonly observed IPS, occurring on 7 of the 4,244 NRS FIA plots in 2019 (0.2 percent; Table 5). Inventory years 2014 and 2009 also had 0.2 percent of plots with this aggressive invader (Tables 6 and 7). Figures 97, 98, and 99 show how this species has changed in cover and spread in the region over time on FIA plots. By looking at the figures, the distribution seems to change each inventory in no clear pattern. It is important to know the fluctuation in the number of plots monitored each inventory when looking at the figures (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, North Dakota has the highest percentage of plots with leafy spurge each inventory. In 2019, 20 percent (3 plots) have this species, in 2014 there were 9.7 percent (2 plots), and in 2009 there were 11.8 percent (2 plots). Nebraska has three plots with leafy spurge on them in 2019 which was 5.7 percent of plots. In 2014, 7.1 percent of plots had this invader (4 plots) and in 2009, 2.6 percent of plots had leafy spurge present (1 plot). Across the region, leafy spurge is present in 3 of the 24 states in 2019.

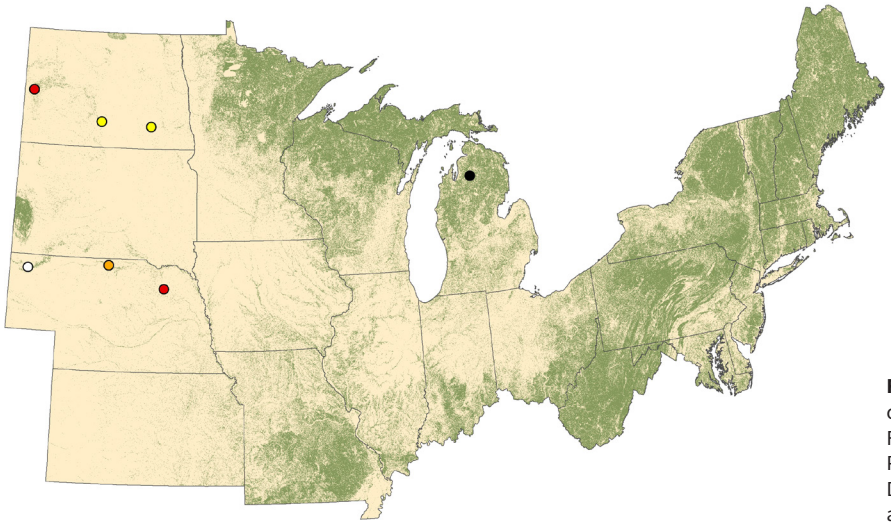

Figure 97.—Average cover of leafy spurge on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

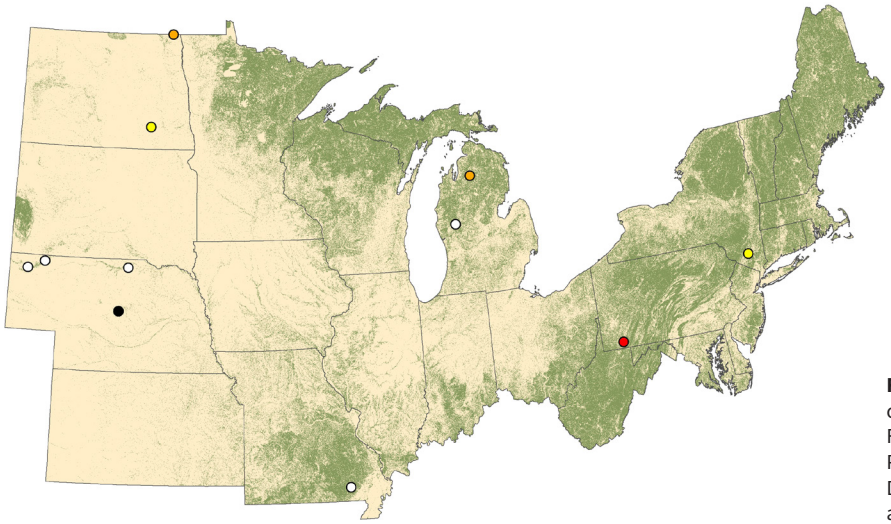

Figure 98.—Average cover of leafy spurge on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

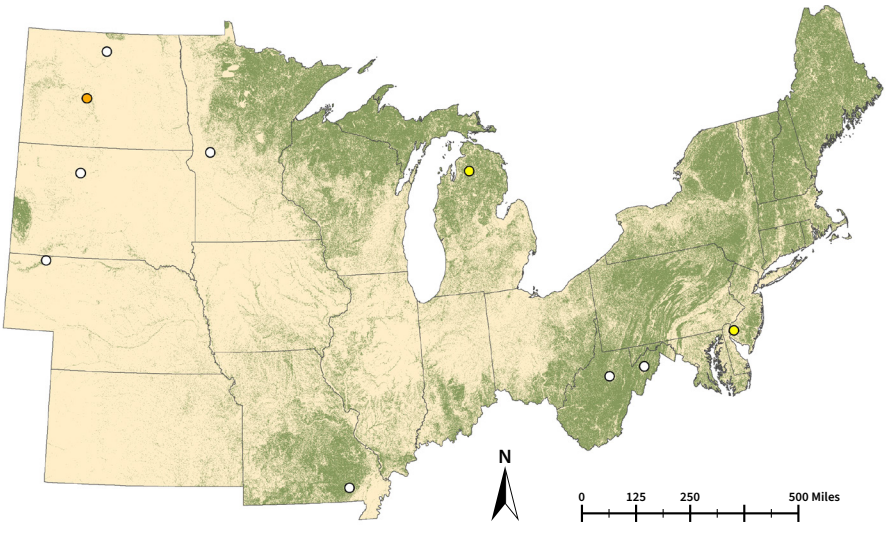

Figure 99.—Average cover of leafy spurge on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Louise's swallow-wort

(*Cynanchum louiseae*)

CYLO11

Background and characteristics: Louise's swallow-wort, also known as Louis swallow-wort and black swallow-wort, is an herbaceous perennial vine of the milkweed family (Asclepiadaceae). This aggressive vine is synonymously known as *Vincetoxicum nigrum* and *Cynanchum nigrum*. It is native to Western Europe and was introduced to Ipswich, MA as an ornamental in 1854 (Kaufman and Kaufman 2007). The plant has dainty dark purple to nearly black flowers (Fig. 100).

Figure 100.—Louise's swallow-wort, flowering. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Louise's swallow-wort can persist in sun or shade and threatens rare lichens, moss, and other plant communities growing on thin soils over bedrock (Kaufman and Kaufman 2007). Since Louise's swallow-wort is a member of the milkweed family, it is concerning because monarch butterflies (*Danaus plexippus*) oviposit their eggs on the plants, and mortality is increased compared to laying their eggs on native milkweed (*Asclepias syriaca*) (Boos et al. 2010, Czarapata 2005, Kaufman and Kaufman 2007). The presence of grassland birds also declines when Louise's swallow-wort invades their habitat (Boos et al. 2010, Kaufman and Kaufman 2007).

This herbaceous perennial is a nuisance due to several troublesome traits. It spreads by seed (2,000 seeds per square yard) as well as from underground rhizomes (Kaufman and Kaufman 2007). Deer may increase the establishment of Louise's swallow-wort since they do not browse it and instead browse other species, creating soil disturbance which facilitates germination of the swallow-wort seed (Rawinski 2008). Once the plant establishes, it can grow to 6.0 feet long (Czarapata 2005, Kaufman and Kaufman 2007). As the stems grow, they can become difficult to traverse, hence its name "dog-strangling vine". The dense thickets (Fig. 101) reduce the vigor and photosynthetic ability of the host plant.

Figure 101.—Louise's swallow-wort infestation. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Current distribution: Louise's swallow-wort is found throughout the NRS region. Currently the PLANTS Database (USDA NRCS 2023) shows its presence in 21 states, with Connecticut, Michigan, and New York listing it as invasive and/or prohibited.

Plot presence: Louise's swallow-wort is the 33rd most commonly observed IPS, occurring on two of the 4,244 NRS FIA plots in 2019 (0.0 percent; Table 5). Looking at 2014, three plots (Table 6) had Louise's swallow-wort whereas in 2009, one plot had this aggressive invader (Table 7). This shows a fairly consistent occurrence over time. Figures 102, 103, and 104 show how this species has changed in cover and spread in the region over time on FIA plots. It is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009). For the most part, the invasive vine has remained in the eastern part of the region with one plot in southern Michigan and one in central New York in 2019, observations in Massachusetts and New York in 2014, and Massachusetts in 2009.

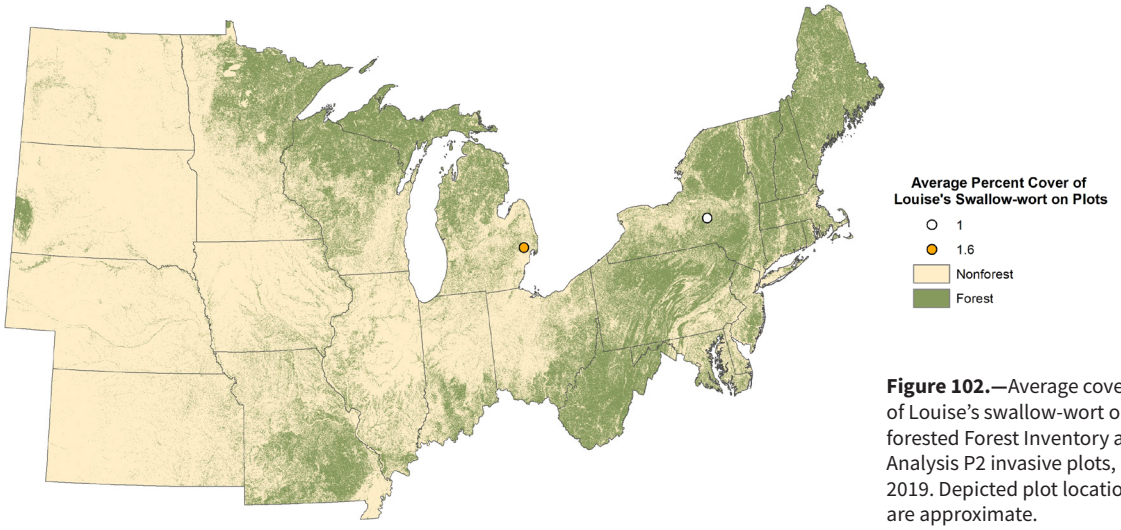

Figure 102.—Average cover of Louise's swallow-wort on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

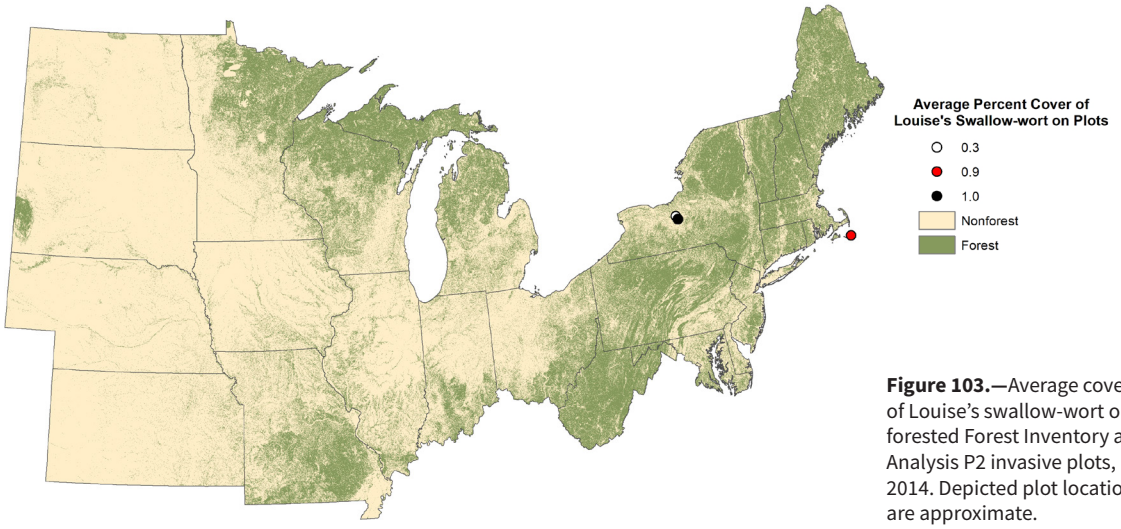

Figure 103.—Average cover of Louise's swallow-wort on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

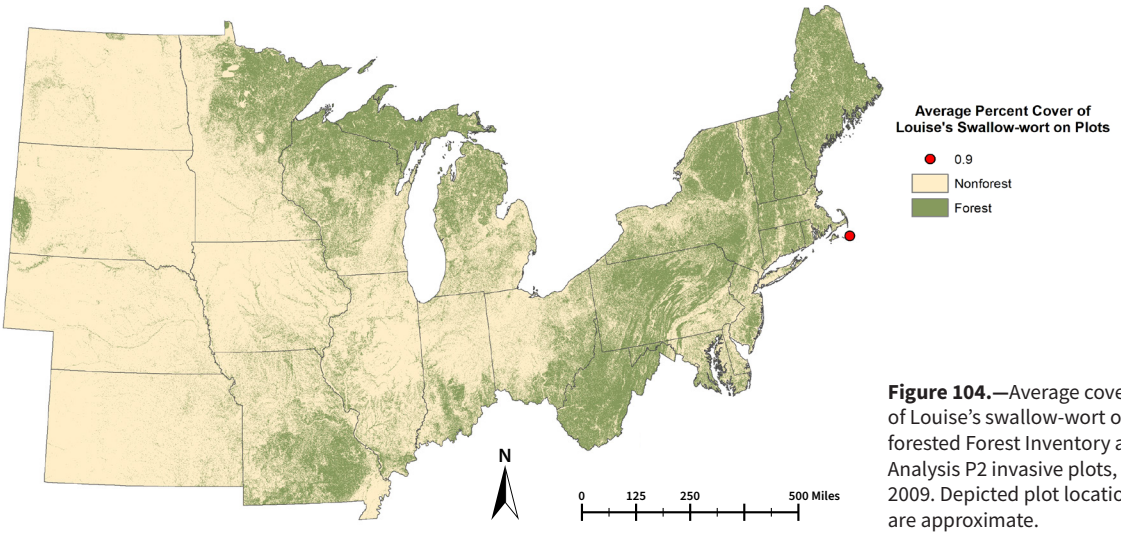

Figure 104.—Average cover of Louise's swallow-wort on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Morrow's honeysuckle

(*Lonicera morrowii*)

LOMO2

Background and characteristics: Morrow's honeysuckle, a woody shrub of the honeysuckle family (Caprifoliaceae), was introduced in 1875 from Japan for ornamental use and wildlife (Gould and Stuckey 1992, Rathfon 2006). Because of horticultural interest in this species as a hedge with attractive flowers and fruit (Fig. 105), it is commonly found near cities. The presence of Morrow's honeysuckle is also high in disturbed areas due to its affinity for sun, though it will tolerate some shade at the expense of growth (Rathfon 2006).

Figure 105.—Morrow's honeysuckle, flowering. Licensed photo by Richard Gardner/Bugwood.org.

The establishment of Morrow's honeysuckle is problematic since it leafs out early and reduces nutrient and moisture availability for other plants. It often forms dense thickets that shade out competing understory. Spread occurs by animals, which are a major source of seed dispersal. The fruit is problematic because the pigments cause color variants in cedar waxwing (*Bombycilla cedrorum*) feathers, creating orange tail bands (Witmer 1996). The effect of the fruit's pigment may impact waxwing breeding success since plumage affects social behavior and mate selection. An additional problem with Morrow's honeysuckle is its ability to hybridize with Tatarian honeysuckle (*Lonicera tatarica*), resulting in the hybrid showy fly honeysuckle, also known as Bell's honeysuckle (*Lonicera xbella*).

Current distribution: Morrow's honeysuckle is found in 28 states with 3 (Connecticut, Missouri, and New York) classifying it as invasive, potentially invasive, and/or prohibited (USDA NRCS 2023).

Plot presence: Morrow's honeysuckle is the 14th most commonly observed IPS, occurring on 191 of the 4,244 NRS FIA plots in 2019 (4.5 percent; Table 5). Looking at 2014, 5.3 percent (Table 6) had Morrow's honeysuckle whereas in 2009, 3.8 percent had this aggressive invader (Table 7). This shows a fairly consistent occurrence over time. Figures 106, 107, and 108 show how this species has changed in cover and spread in the region over time on FIA plots. Looking at the figures, it seems that Morrow's honeysuckle has declined in both cover and spread. It does seem unusual for the species to no longer be present on plots in Minnesota, Iowa, Missouri, and Wisconsin. Some of this may be due to changes in field crew or recording the species at the genus instead of at the species level (or both). It is also important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009). Future monitoring of this trend will be necessary.

Of the 24 NRS FIA states, the highest number of observations is in Pennsylvania with 114 plots in 2019 (16.6 percent). While New York has the second highest number of plots with Morrow's honeysuckle (47 plots; 12.2 percent), New Jersey has the second highest percentage of plots with this aggressive shrub (7 plots; 13.5 percent). This differed from 2014 and 2009 when New York had the highest percentage and greatest number of plots with Morrow's honeysuckle in our region. Across the region, Morrow's honeysuckle is present in 9 of the 24 states in 2019.

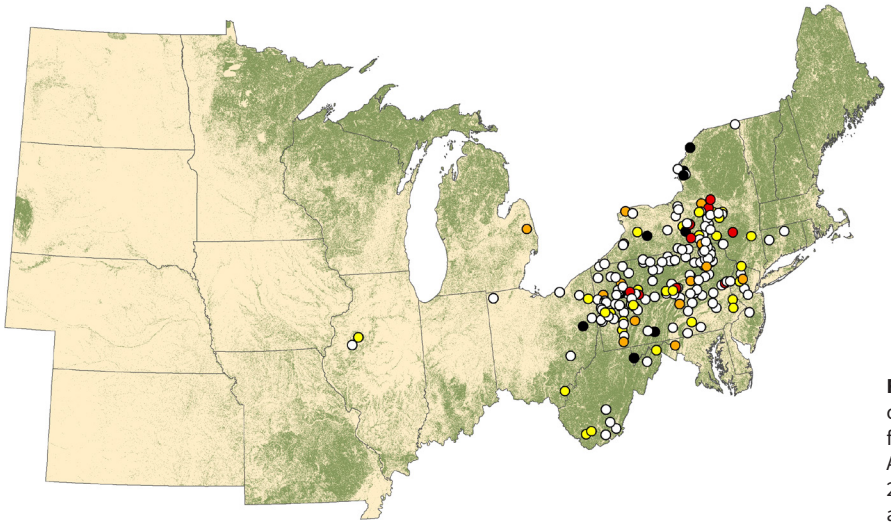

Figure 106.—Average cover of Morrow's honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

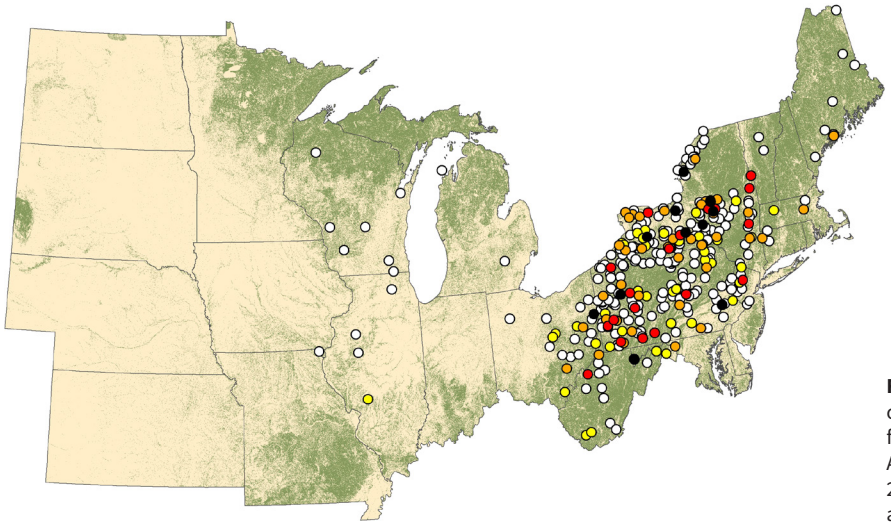

Figure 107.—Average cover of Morrow's honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

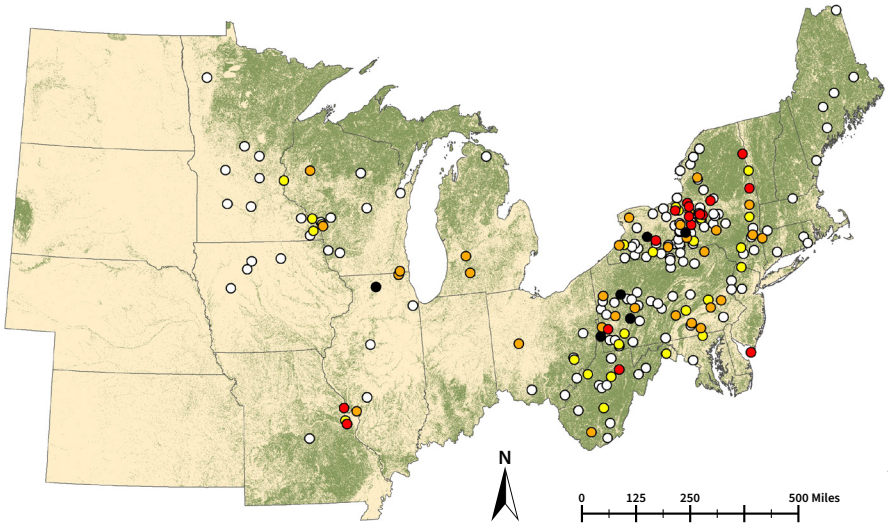

Figure 108.—Average cover of Morrow's honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Multiflora rose

(*Rosa multiflora*)

ROMU

Background and characteristics: Multiflora rose, a woody shrub of the rose family (Rosaceae), was introduced to the eastern United States in 1866 from Japan as rootstock for ornamental roses (Gould and Stuckey 1992, Kaufman and Kaufman 2007). This shrub's ability to survive in harsh environments is critical to its success as an invader. Multiflora rose is most commonly found near forest edges with the highest presence within 160.0 feet of an edge (Kurtz 2010). The species exhibits optimal growth in full sun, but high propagule pressure can result in establishment within the forest interior, although the resulting germinants lack vigor and flower production (Kaufman and Kaufman 2007). Growth is also reduced by low and high water tables (Kurtz 2010).

Figure 109.—Multiflora rose infestation, flowering. USDA Forest Service photo by James H. Miller//Bugwood.org.

Many agencies, such as conservation groups, highway departments, and state and local governments, plant multiflora rose for living fences, erosion control, and food and cover for wildlife (Gould and Stuckey 1992, Kaufman and Kaufman 2007, Moser et al. 2009). The use of this aggressive shrub for such projects increases propagule pressure. Deer (*Odocoileus* spp.) may contribute to the spread of multiflora rose since they may preferentially browse other plant species, creating soil disturbances which facilitate germination (Rawinski 2008). The spread of multiflora rose is aided by the proliferation of flowers which can annually yield one million seeds that are viable for up to 20 years (Brakke 2006, Kaufman and Kaufman 2007), making restoration problematic since clearing a site can result in regeneration for many years. Since multiflora rose is able to root where the canes contact the soil, these shrubs can create large, impenetrable masses (Fig. 109) with sharp thorns along the canes that can gash the eyes and skin of domestic animals, cattle, and humans. This shrub's dense growth substantially reduces sun, nutrient, and moisture availability.

In the NRS region, the presence of multiflora rose appears to be climatically restricted. Moser et al. (2009) noted the absence of multiflora rose above 44.0 °N latitude, indicative of its northern limit of cold tolerance (-28.0 °F; Czarapata 2005). While this species has been recorded in Canada, the sites may have unique microclimates such as urban heat islands or near buildings. The growth of multiflora rose is also restricted in the southern United States since the seeds require 30 days of cold stratification (Kazaz et al. 2010). However, it can be grown from cuttings.

Current distribution: It is now found in 39 states, with Alabama classifying it as noxious and Connecticut, Michigan, Missouri, New York, and North Carolina classifying it as invasive or prohibited (USDA NRCS 2023).

Plot presence: Multiflora rose is the most commonly observed IPS, occurring on 1,328 of the 4,244 NRS FIA plots in 2019 (31.3 percent; Table 5). Looking at 2014, 28.8 percent (Table 6) had multiflora rose whereas in 2009, 23.6 percent had this aggressive invader (Table 7). This shows a steady increase over time. Figures 106, 107, and 108 show how this species has changed in cover and spread in the region over time on FIA plots. Looking at Figures 110, 111, and 112 it seems that multiflora rose cover has decreased, however, averaged over the inventory and region, it has actually increased. Indiana is an exception where average cover decreased throughout the span of years. For Indiana, in 2009, the average cover was 7.9 percent, in 2014 it decreased to 5.8 percent, and in 2019 the average cover is 4.0 percent, nearly half of the 2009 value. In looking at the figures, it is also important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of multiflora rose observations in 2019 is in Ohio with 159 plots (87.8 percent). Ohio remained the state with the highest number of observations in 2014 as well with 240 plots (88.2 percent). However, in 2009, Indiana had the highest number of observations (173; 68.4 percent) but Ohio still had a higher percentage of plots with multiflora rose (83.2 percent; 164 plots). Across the region, multiflora rose is present in 21 of the 24 states in 2019.

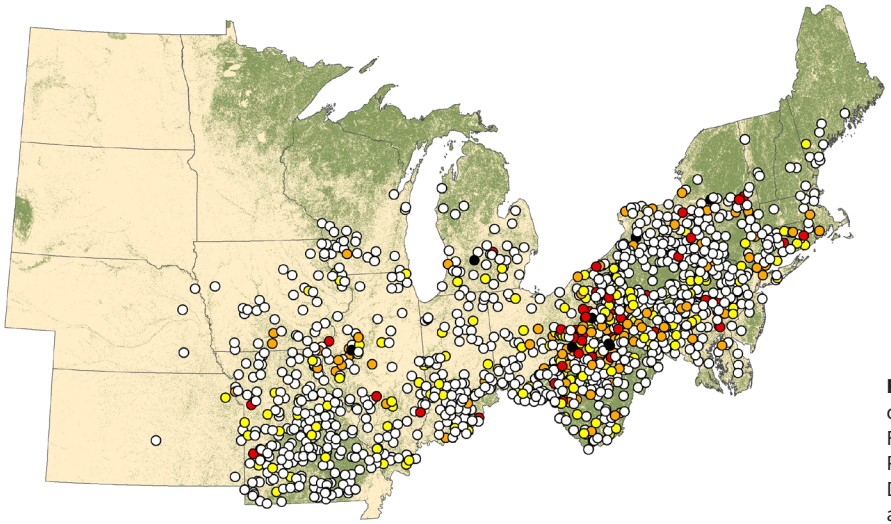

Figure 110.—Average cover of multiflora rose on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

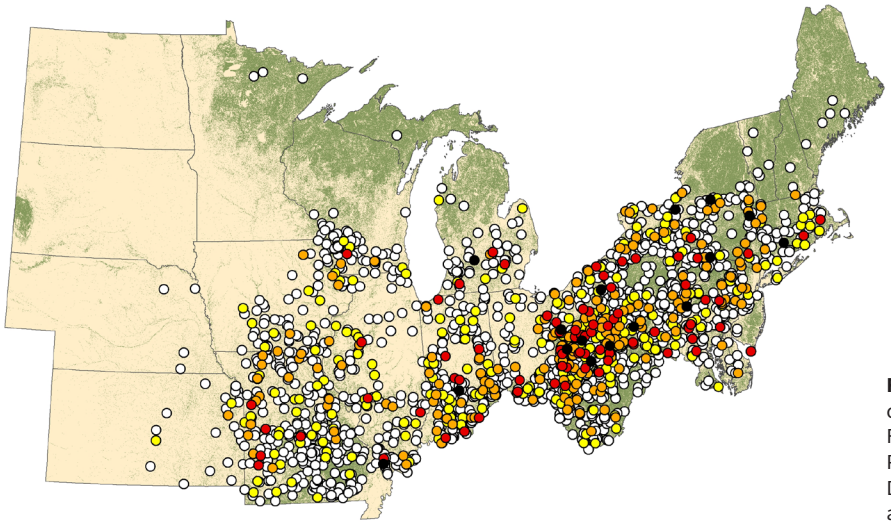

Figure 111.—Average cover of multiflora rose on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

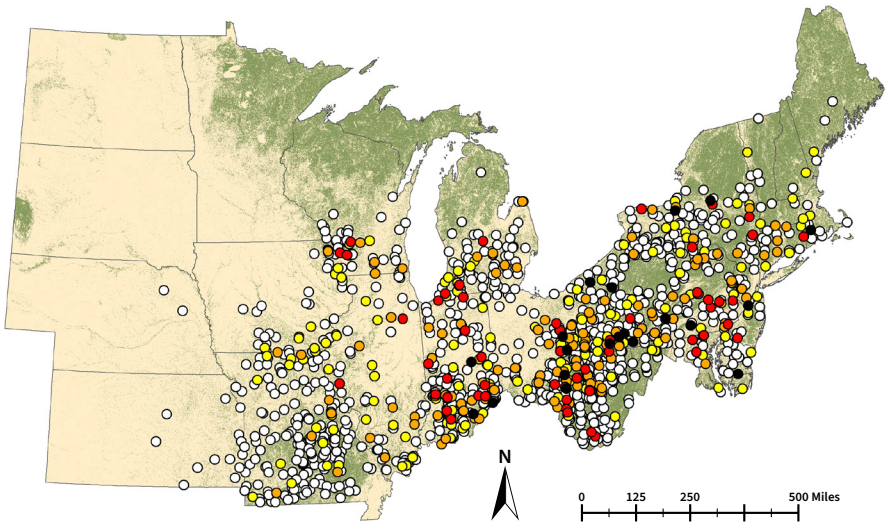

Figure 112.—Average cover of multiflora rose on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Nonnative bush honeysuckles

(*Lonicera* spp.)

LONIC

Background and characteristics: The nonnative bush honeysuckle species present in this region were imported from Eurasia for ornamental use. They produce an abundance of flowers (Fig. 113) and fruit that animals, including the robin (*Turdus migratorius*) and wild turkey (*Meleagris gallopavo*), commonly disperse. Nonnative bush honeysuckles were planted to assist with turkey recovery, which in turn spread the plants through seed dispersal (Zouhar et al. 2008). Humans have also played a large role in the distribution of these shrubs since they are commonly used as ornamental shrubs, and federal agencies promoted planting them. Kurtz (2010) found the presence of this genus greatest near cities and forest edges, reflecting anthropogenic influence and their affinity for full sun.

Figure 113.—Nonnative bush honeysuckle, flowering. Licensed photo by John M. Randall, The Nature Conservancy/Bugwood.org.

Nonnative bush honeysuckles have several traits that contribute to their success as invaders. They leaf out before many native plants and hold their leaves later in the season, giving them a competitive advantage by having a longer time to photosynthesize. Once established, the plants form dense layers that reduce moisture and nutrient availability and shade out neighboring species.

Current distribution: Nonnative bush honeysuckles are found in all 50 states (USDA NRCS 2023).

Plot presence: Nonnative bush honeysuckles are the third most commonly observed IPS, occurring on 483 of the 4,244 NRS FIA plots in 2019 (11.4 percent; Table 5). Looking at 2014, 8.6 percent (Table 6) had nonnative bush honeysuckles whereas in 2009, 4.6 percent had this aggressive invader (Table 7). This shows a steady increase over time with the percent of plots having this species more than doubling. Figures 114, 115, and 116 show how this species has changed in cover and spread in the region over time on FIA plots. Comparing 2009 to 2019, the increase in presence is apparent, however, it is somewhat harder to see from the 2014 data. This change is more difficult to see due to the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of nonnative bush honeysuckle observations is in New York with 87 plots in 2019 (22.7 percent). However, as a percentage of plots, the greatest is in North Dakota, at 53.3 percent (8 observations). In 2014, Wisconsin had the highest number of occurrences at 115 (14.2 percent) though Indiana had the highest percentage of plots with this species (30.7 percent; 85 plots). In 2009, Wisconsin was again the state with the highest number of observations (61 plots; 8.1 percent) with Indiana having the highest percentage (17.4 percent; 44 plots). Across the region, nonnative bush honeysuckle is present in 20 of the 24 states in 2019.

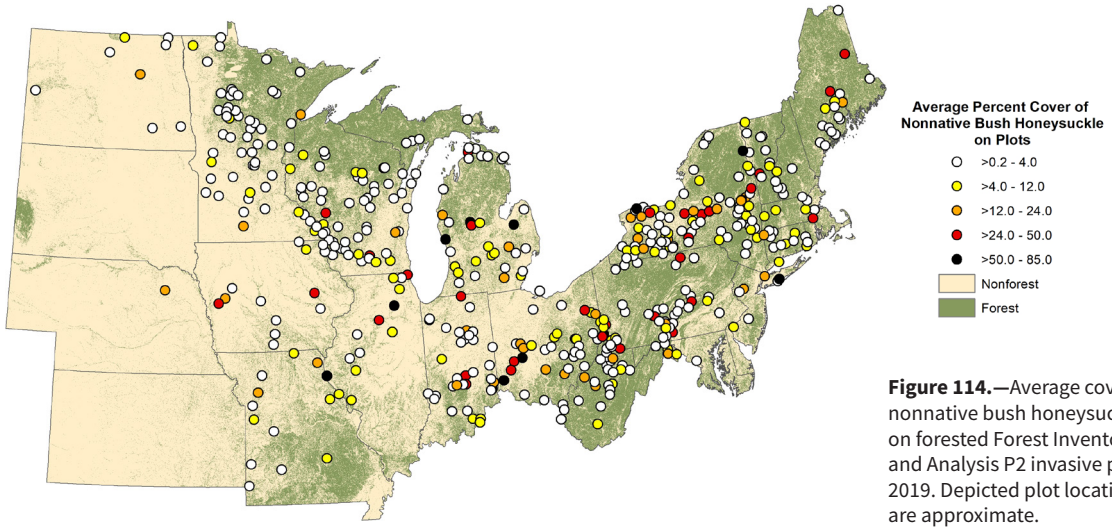

Figure 114.—Average cover of nonnative bush honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

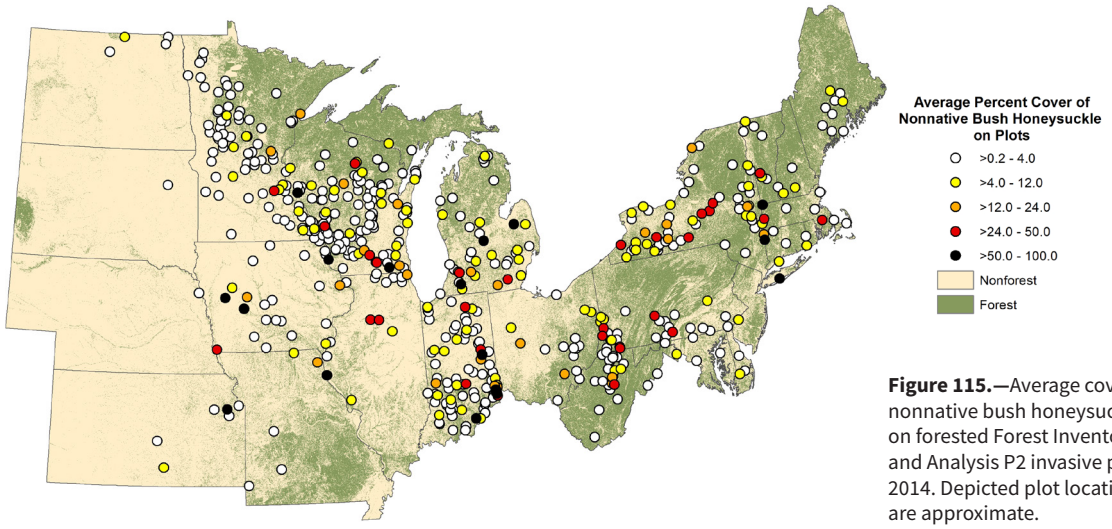

Figure 115.—Average cover of nonnative bush honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

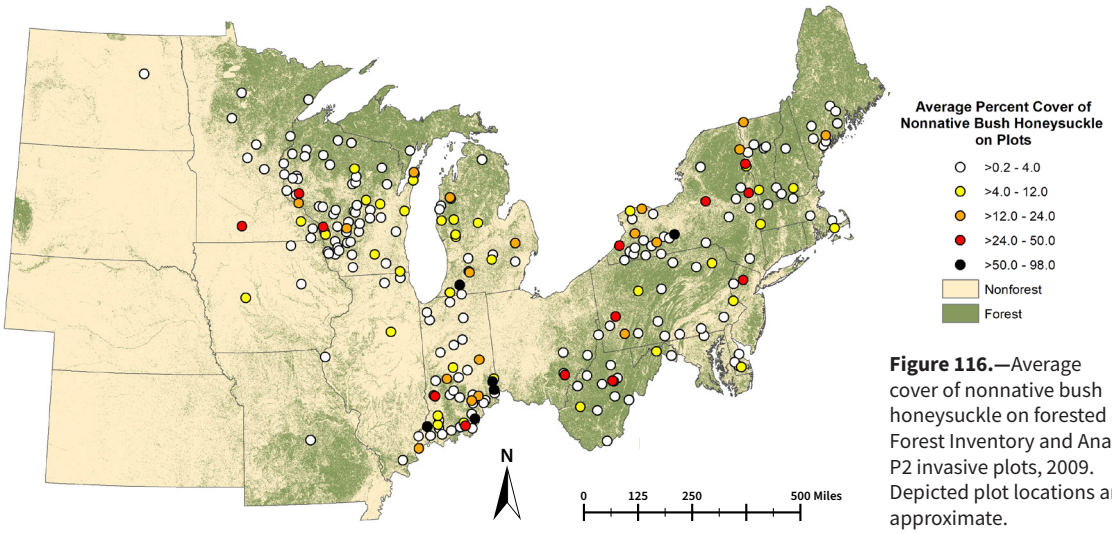

Figure 116.—Average cover of nonnative bush honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Norway maple

(*Acer platanoides*)

ACPL

Figure 117.—Norway maple. USDA Forest Service photo by Cassandra Kurtz.

Background and characteristics: Norway maple, a shade tolerant tree of the soapberry family (Sapindaceae), is native to southern Scandinavia and northern Iran and was introduced as an ornamental to Philadelphia in 1776 (Kaufman and Kaufman 2007). The popularity of Norway maple has led to the release of many cultivars. Nurseries sell this IPS as an urban shade tree (Fig. 117) because of its dense canopy, rapid growth, tolerance of air pollution and poor soils, and as a replacement for trees with Dutch elm disease (Kaufman and Kaufman 2007). Its dense canopy and shallow roots make it susceptible to blow-down and difficult for other species to establish beneath it. However, due to Norway maple's shade tolerance, it often forms dense layers on the forest floor. In areas where this tree becomes established, its allelopathic effects dramatically reduce plant diversity (Gould and Stuckey 1992, Kaufman and Kaufman 2007). Despite the ecological impact of this species, it has been among the most frequently planted street trees (Kielbaso 1990, Nowak and Rowntree 1990).

According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious tree can survive to -28.0 °F and requires cold stratification, 32.0 to 50.0 inches of precipitation annually, 130 or more frost free days, pH levels between 4.8 and 7.2, and a minimum rooting depth of 40.0 inches. Additional growth limitations are its lack of tolerance of anaerobic conditions, fine and coarse textured soils, fire, and drought.

Current distribution: Norway maple is found in 26 states, with Connecticut listing it as invasive and New York as regulated (USDA NRCS 2023).

Plot presence: Norway maple is the 20th most observed IPS, occurring on 45 of the 4,244 NRS FIA plots in 2019 (1.1 percent; Table 5). Looking at 2014, 0.8 percent (Table 6) had Norway maple whereas in 2009, 0.7 percent had this aggressive invader (Table 7). This suggests a potential increase in the presence of this IPS over time. Figures 118, 119, and 120 show how this species has changed in cover and spread in the region over time on FIA plots. Overall, with limited observations, there does not appear to be significant change through the inventories. It is worth noting that the number of plots fluctuated through the inventory years (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of Norway maple observations is in Pennsylvania with 21 plots in 2019 (3.1 percent). However, as a percentage of plots, the greatest is in Connecticut, at 9.1 percent (4 observations). Looking back at the 2014 and 2009 data, Connecticut continued to have the highest percentage of plots with this species. Norway maple is present in 10 of the 24 states in the region in 2019.

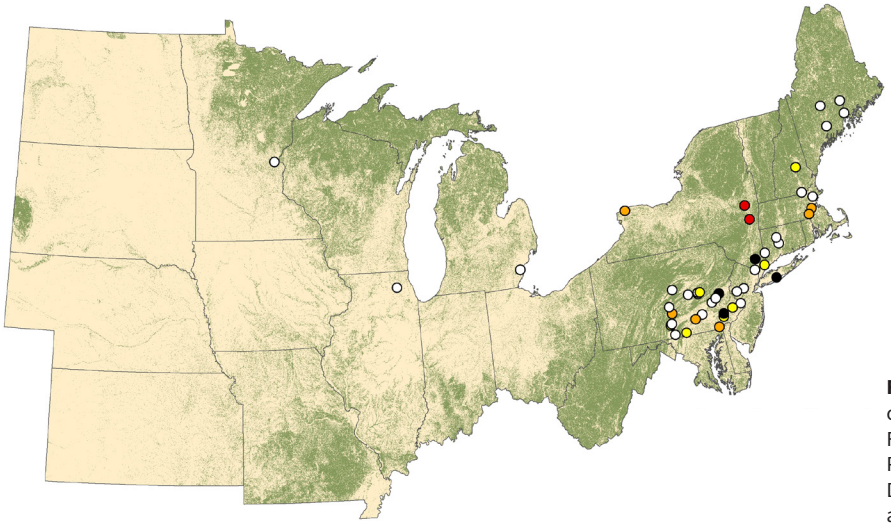

Figure 118.—Average cover of Norway maple on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

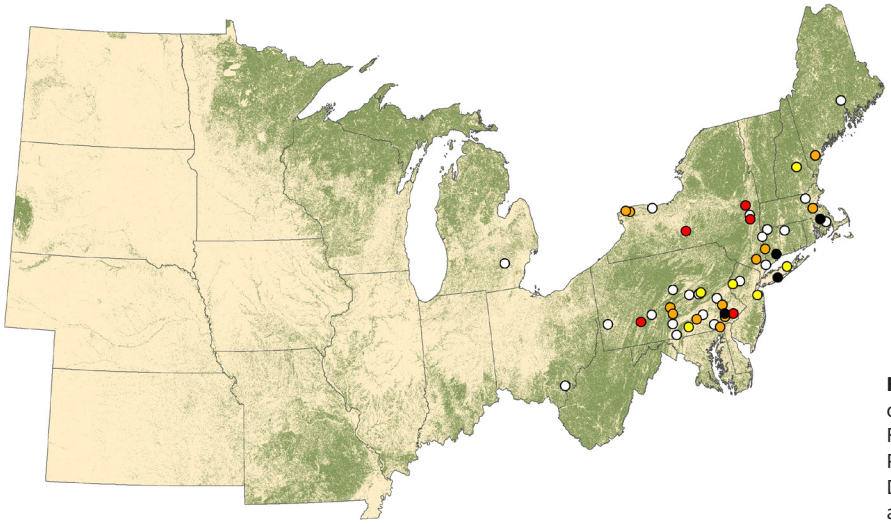

Figure 119.—Average cover of Norway maple on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

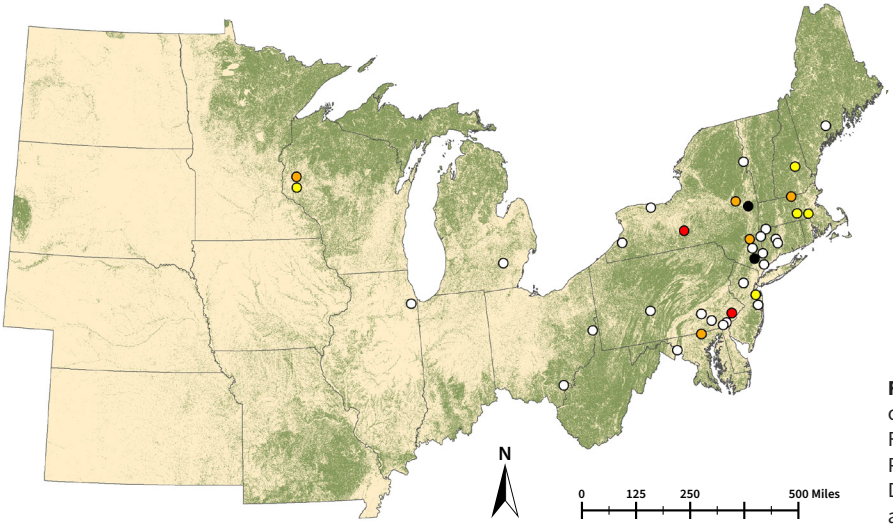

Figure 120.—Average cover of Norway maple on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Oriental bittersweet

(*Celastrus orbiculatus*)

CEOR7

Background and characteristics: Oriental bittersweet, also known as Asian bittersweet, is a woody vine of the bittersweet or staff vine family (Celastraceae) that is native to temperate Japan, China, and Korea. It was introduced from China as an ornamental vine around 1860 (Kaufman and Kaufman 2007, Leicht and Silander 2006). Its aggressive growth and picturesque fruits (Fig. 121), treasured by crafters, have contributed to the planting and spread of this species. This noxious vine has also been planted throughout the NRS region to promote the recovery of native wild turkey (*Meleagris gallopavo*), which in turn act as dispersal vectors for the seeds (Zouhar et al. 2008). Other avian species disperse the fruit as well which facilitates establishment in the forest interior (Kaufman and Kaufman 2007).

Figure 121.—Oriental bittersweet fruit. Licensed photo by Chris Evans, University of Illinois/Bugwood.org.

Another vector of this species is gardeners who have planted Oriental bittersweet for its qualities as a landscape plant or inadvertently planted this IPS since it closely resembles the native American bittersweet (*Celastrum scandens*) which has pointed leaves. This is troublesome because Oriental bittersweet hybridizes with the somewhat rare American bittersweet, posing a genetic threat (Czarapata 2005, Kaufman and Kaufman 2007, Leicht and Silander 2006).

Oriental bittersweet grows optimally in full sun but can survive in dense shade, waiting for release to expedite growth and spread (Zouhar et al. 2008). Within the forest this invasive can impede photosynthesis, add excess weight to trees which promotes breakage, and even girdle trees. The aggressive growth of this vine has worrisome fire implications as it can increase the fuel load and likelihood of a crown fire by increasing fuel continuity through growing up and over forest vegetation (Zouhar et al. 2008).

According to the PLANTS Database (USDA NRCS 2023), it is suggested this invader can survive to -38.0 °F and requires cold stratification, 30.0 to 60.0 inches of precipitation annually, 100 or more frost free days, pH levels between 5.0 and 7.5, and a minimum rooting depth of 18.0 inches. Oriental bittersweet is adapted to fine, medium, and coarse textured soils but is intolerant of anaerobic conditions.

Current distribution: The aggressive nature of this IPS is recognized throughout the northeastern United States where it is considered one of the most threatening lianas (Leicht and Silander 2006). Oriental bittersweet is currently found in 25 states, with four states (Connecticut, Michigan, Missouri, and North Carolina) listing it as invasive (USDA NRCS 2023).

Plot presence: Oriental bittersweet is the 12th most commonly observed IPS, occurring on 243 of the 4,244 NRS FIA plots in 2019 (5.7 percent; Table 5). Looking at 2014, 4.0 percent (Table 6) had Oriental bittersweet whereas in 2009, 2.3 percent had this aggressive invader (Table 7). This shows a steady increase over time with the percent of plots having this species more than doubling. Figures 122, 123, and 124 show how this species has changed in cover and spread in the region over time on FIA plots. In 2019, there were more plots with the two highest coverages than in previous years. Additionally, there was an increase in plots with Oriental bittersweet. In looking at the figures, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of Oriental bittersweet observations is in Pennsylvania with 86 plots in 2019 (12.5 percent). However, as a percentage of plots, the greatest is in Connecticut, at 63.6 percent (28 observations). For both 2014 and 2009, Pennsylvania continued to have the greatest number of Oriental bittersweet observations, but the highest percentage of plots with this IPS changed from Connecticut in 2014 (45.9 percent) to Rhode Island in 2009 (23.3 percent). Oriental bittersweet is present in 18 of the 24 states in 2019.

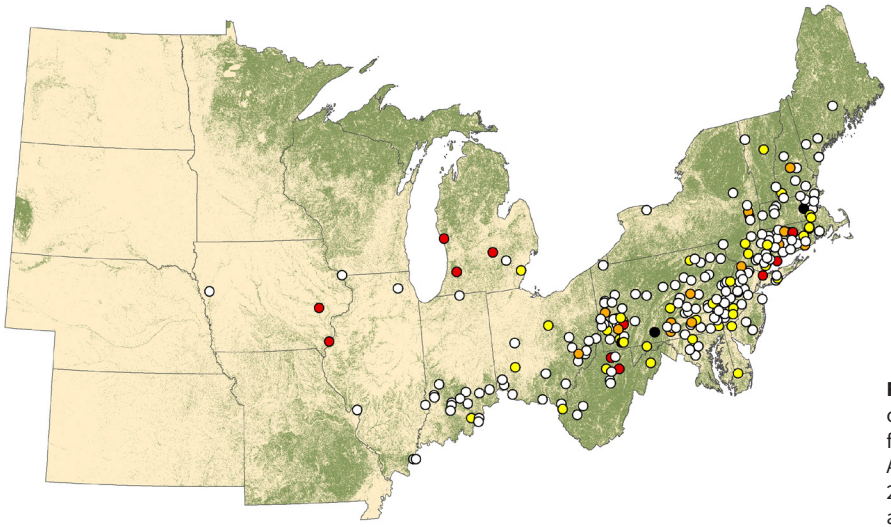

Figure 122.—Average cover of Oriental bittersweet on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

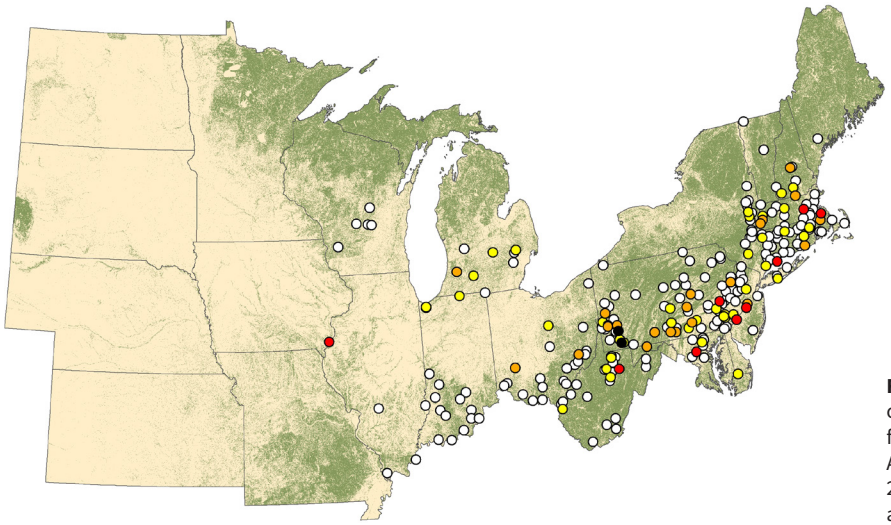

Figure 123.—Average cover of Oriental bittersweet on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

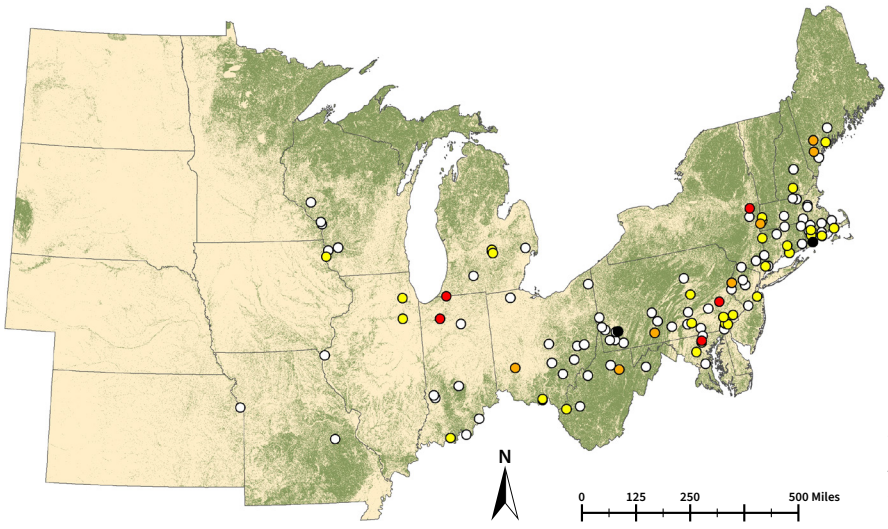

Figure 124.—Average cover of Oriental bittersweet on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Princesstree

(*Paulownia tomentosa*)

PATO2

Background and characteristics: Princesstree, a member of the figwort family (Scrophulariaceae), is a fast-growing tree native to China that was introduced to the United States in 1843 (Foster and Duke 2000). This IPS grows in full sun to part shade and is planted in urban areas for its aesthetic beauty (Fig. 125, 126). Princesstree is also planted in the United States for its valuable wood. The wood is desired for many uses such as making wardrobe furniture, cabinets, small chests, packing crates, musical instruments, bowls, and footwear (Melhuish et al. 1990). The desirability of the wood has resulted in planting this tree in some areas for agroforestry because of the high export price, especially to Japan where the wood is greatly valued (Foster and Duke 2000). Due to the widespread planting of this tree, it has begun to escape into nearby areas and displace native species.

Figure 125.—Princesstree. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Aside from the timber value, this tree serves many medicinal purposes (Foster and Duke 2000). The Chinese have traditionally used the leaves and capsules to promote hair growth and prevent graying, a leaf tea for swollen feet, the inner bark for fevers and delirium, the leaves and bark as a dressing for bruises, and the flowers (mixed with other herbs) as a treatment for liver ailments. In addition, the Japanese have reported the leaf juice to be valuable for treating warts.

The PLANTS Database (USDA NRCS 2023) suggests this noxious tree can survive to -8.0 °F and requires 30.0 to 55.0 inches of precipitation annually, 180 or more frost free days, pH levels between 4.5 and 7.5, and a minimum rooting depth of 36.0 inches. Additional growth limitations are its intolerance of salinity and anaerobic, calcareous, and fine textured soils.

Figure 126.—Princesstree flowers. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Current distribution: Princesstree is found primarily in the eastern half of the United States, occurring in 27 states. In Connecticut, this IPS is considered potentially invasive and prohibited and North Carolina considers it invasive (USDA NRCS 2023).

Plot presence: Princesstree is the 29th most commonly observed IPS, occurring on 8 of the 4,244 NRS FIA plots in 2019 (0.2 percent; Table 5). Looking at 2014, 0.2 percent (Table 6) had princesstree whereas in 2009, 0.3 percent had this aggressive invader (Table 7). This shows a steady increase over time with the percent of plots having this species more than doubling. Figures 127, 128, and 129 show how this species has changed in cover and spread in the region over time on FIA plots. As reported by the percent observations above, there is little change apparent via the figures apart from the highest coverage class being nonexistent in the 2019 figure. In looking at the figures, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, West Virginia and Ohio are the only states where princesstree is observed in 2019. Both have under 2 percent of the plots in the state with this species. In 2014, there were three states with this invader. West Virginia had eight plots with this IPS and Maryland and Pennsylvania both had two plots with princesstree present. Going back to 2009, this invasive tree was found in four states. West Virginia had 11 plots with princesstree and Delaware, Maryland, and Ohio each had one plot with this species present. In the 2019 inventory, this invasive tree is present in 2 of the 24 states in 2019.

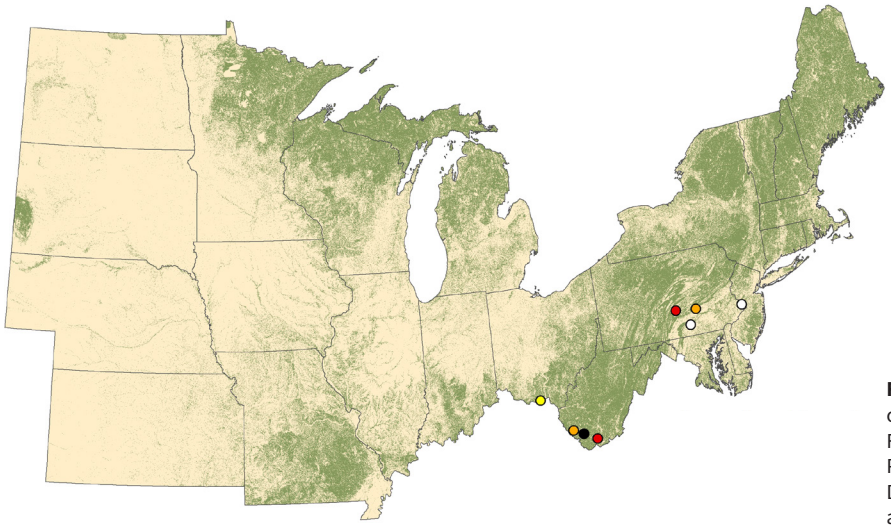

Figure 127.—Average cover of princesstree on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

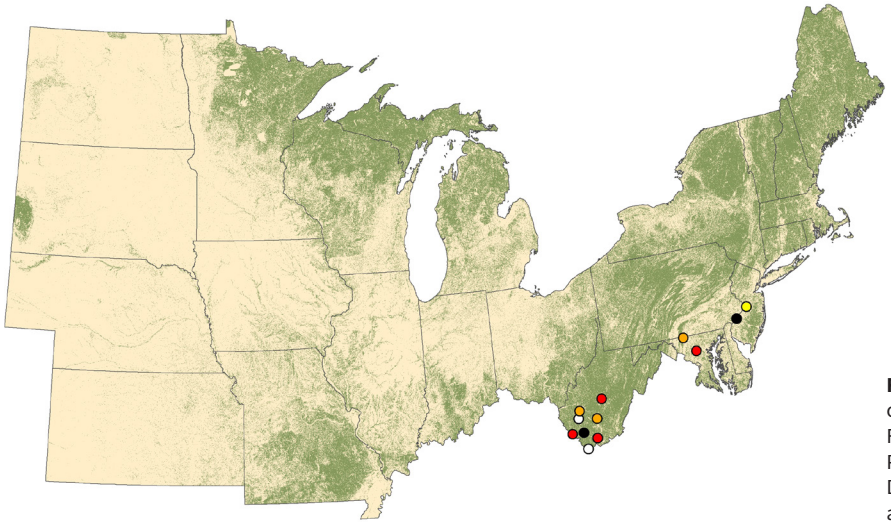

Figure 128.—Average cover of princesstree on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

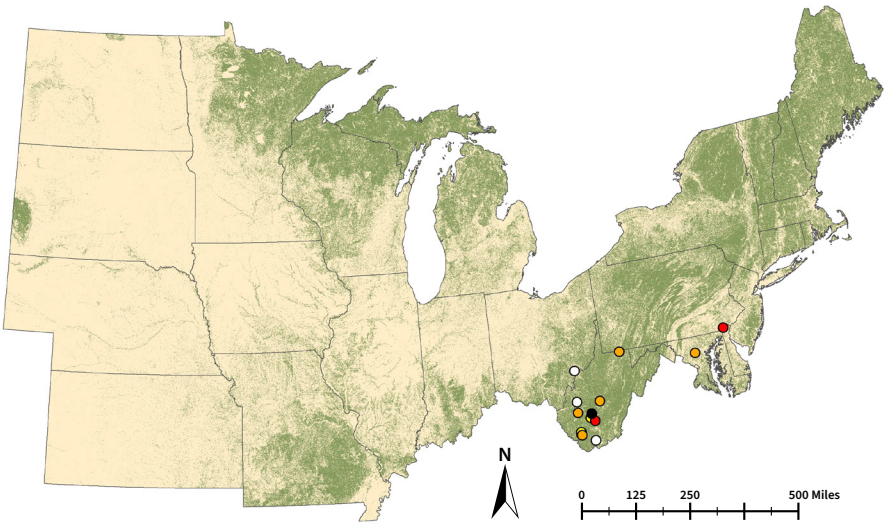

Figure 129.—Average cover of princesstree on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Punktree

(*Melaleuca quinquenervia*)

MEQU

Background and characteristics: Punktree, also known as melaleuca, paperbark tree, and cajeput tree, is a highly flammable tree of the myrtle family (Myrtaceae) that can reach up to 80.0 feet (Kaufman and Kaufman 2007). It was introduced to soak up water from the Everglades during the early 1900s (Gould and Stuckey 1992, Kaufman and Kaufman 2007). There has also been interest in this tree as an ornamental due to its unique, flakey bark. Due to its prolific spread, it is listed as the exotic weed of greatest risk to southern Florida wetlands (Turner et al. 1998).

Figure 130.—Punktree. Licensed photo by Tony Pernas, USDI National Park Service/Bugwood.org.

An aggressive species, this invader forms dense stands (Fig. 130), reducing species diversity 60.0 to 80.0 percent (Gould and Stuckey 1992, Turner et al. 1998). Not only do the dense stands alter the native plant community, they also affect the animals which depend on the displaced plant. While it is not certain how many animals rely upon these displaced species, Gould and Stuckey (1992) estimate that an average of 12 species of animals rely on each plant species outside of the tropics.

Aside from the impact punktree has on the forest community, this plant may also pose health risks. It is suggested the pollen of punktree is a mild respiratory allergen (Turner et al. 1998). Because of the ecological, health, and economic impacts caused by this species, its presence is a concern.

Current distribution: Punktree is found in Florida, Hawaii, Louisiana, and Puerto Rico and is listed as noxious in the United States (USDA NRCS 2023).

Plot presence: Punktree is not present on plots in the NRS region. However, with the ecological damage that this tree can cause, it is important to continue monitoring for this species.

Purple loosestrife

(*Lythrum salicaria*)

LYSA2

Background and characteristics: Purple loosestrife is an herbaceous perennial of the loosestrife family (Lythraceae). This noxious weed is native to Europe and Asia, and one of the first reports of its presence was in 1814 along the Northeast coast where it is now heavily concentrated (Kaufman and Kaufman 2007). Planting of this IPS occurred for medicinal and ornamental reasons as well as for the production of honey.

Figure 131.—Purple loosestrife infestation. Licensed photo by Eric Coombs, Oregon Department of Agriculture/Bugwood.org.

Purple loosestrife covers 1/2 million acres in the U.S. with its success aided by the ability to survive in a variety of moisture classes, high seed production (up to 2 million seeds), lack of natural predators, and ability to grow from plant fragments (Czarapata, 2005, Kaufman and Kaufman 2007). Additional traits that help promote the spread of this species include seeds that remain viable for 20 years and that can live submerged in water for 20 months (Czarapata 2005). Problematically, the rootstock is able to send up 30 to 50 stems and form masses up to 8.0 feet high and 5.0 feet wide (Kaufman and Kaufman 2007).

Purple loosestrife grows optimally in full sun (Fig.131) and vigor diminishes in low light levels. Where it invades, monocultures can become so dense that they can crowd out fish and waterfowl from wetlands by growing up to 80,000 stalks per acre (Czarapata 2005). Its aggressive growth and displacement of natives has pushed many species of rare amphibians and butterflies to the brink of extinction (Czarapata 2005). Purple loosestrife is also problematic in agricultural areas. This herbaceous invader can devastate cucumber (Cucumis sativus) crops since it is an alternate host for cucumber mosaic virus (Royer and Dickinson 1999).

The presence of purple loosestrife is a concern. Its negative effects are so great that it ranks among The Nature Conservancy's "Dirty Dozen" alien species (Stein and Flack 1996), which is a composite list of 12 especially intrusive invasive plants and animals. Due to the implications caused by purple loosestrife, researchers have monitored its spread over time, noticing that it spread first along canals and waterways and then along roadways (Booth et al. 2010). From 1940 to 1980 purple loosestrife spread at a rate of approximately 1.5 latitude-longitude blocks per year (Westbrooks 1998).

Aside from the negative impacts caused by purple loosestrife, medicinal properties have been found. It has traditionally been used for diarrhea, dysentery, sore throats, leukorrhea, cleansing wounds, and experimentally to stop bleeding, for inflammation, and to kill bacteria (Foster and Duke 2000).

Current distribution: Purple loosestrife has spread to all of the lower 48 states except Florida (Kaufman and Kaufman 2007). The widespread planting of purple loosestrife has resulted in Alabama, Alaska, Connecticut, Michigan, Minnesota, Missouri, New York, and North Carolina classifying this species as invasive, prohibited, noxious, and/or restricted (USDA NRCS 2023). With climate change, purple loosestrife may become an increasingly troublesome weed because of its ability to take advantage of favorable environmental conditions when they occur earlier than expected (Booth et al. 2010).

Plot presence: Purple loosestrife is the 31st most commonly observed IPS, occurring on five of the 4,244 NRS FIA plots in 2019 (0.1 percent; Table 5). Looking at 2014, 0.1 percent (Table 6) had purple loosestrife whereas in 2009, 0.2 percent had this aggressive invader (Table 7). Figures 132, 133, and 134 show how this species has changed in cover and spread in the region during the inventories. Via the figures, it appears cover and distribution have been reduced over time. With the limited number of observations, it is difficult to tell. In looking at the figures, it is also important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009). During each inventory, New York has the highest number of observations of this species with observations in the states of Maine, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Vermont. However, there are only a limited number of observations so that is important to consider when noting regional presence. In 2019, this herbaceous invader was found in 4 of the 24 states.

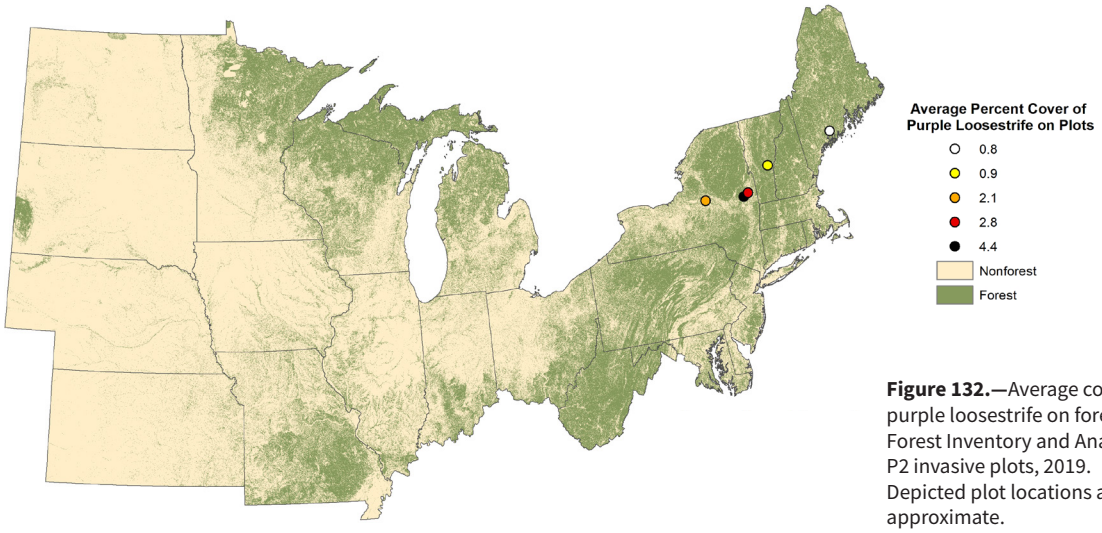

Figure 132.—Average cover of purple loosestrife on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

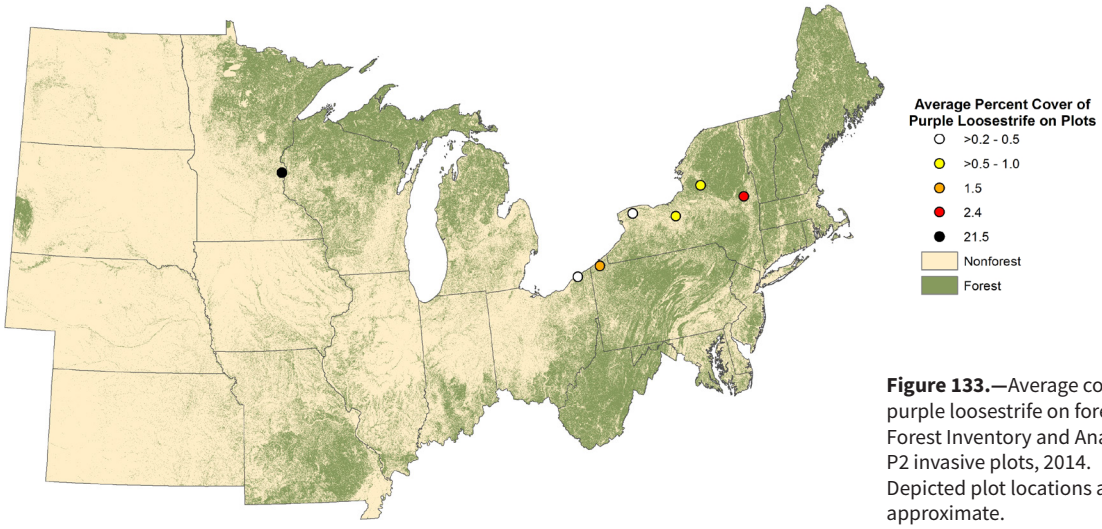

Figure 133.—Average cover of purple loosestrife on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

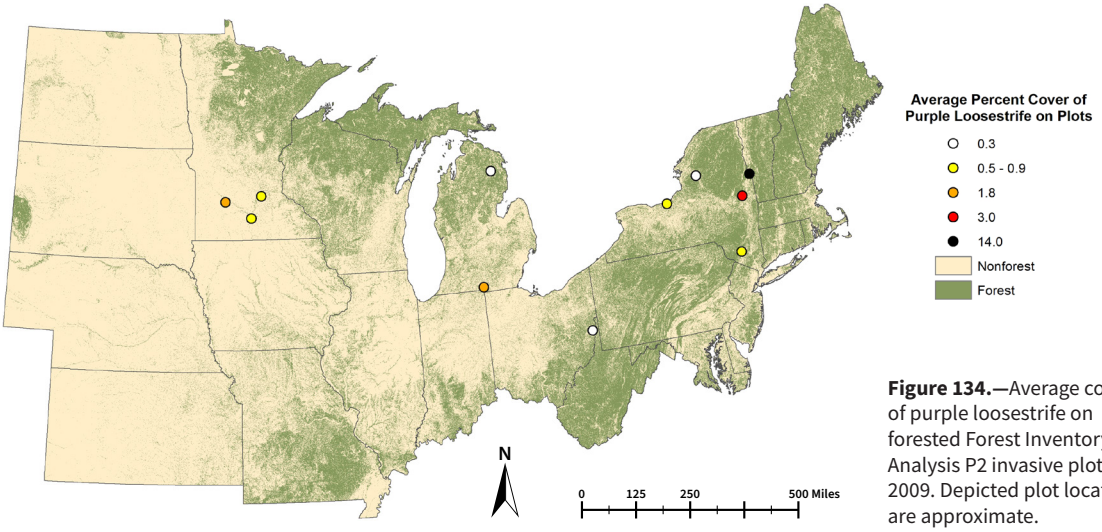

Figure 134.—Average cover of purple loosestrife on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Reed canarygrass

(*Phalaris arundinacea*)

PHAR3

Background and characteristics: Reed canarygrass, a member of the grass family (Poaceae), begins growing very early in the spring and has been bred to withstand a variety of environmental conditions. In the 1830s, New England agronomists began developing strains adaptable to a wider range of conditions (Kaufman and Kaufman 2007). Adaptation to a variety of conditions coupled with aggressive growth, has resulted in the frequent use of this IPS in restoration and agriculture. Many strains of reed canarygrass are readily available and even used as ornamentals. In restoration, it can be used for soil contaminant extraction (Kaufman and Kaufman 2007, Lavergne and Molofsky 2004). Whereas in landscaping, the readily available ribbon grass (*P. arundinacea* var. *picta*), a variety of reed canarygrass also known as gardener's garters, is grown for its white variegated leaves. Where reed canarygrass establishes, it often forms dense monocultures, excluding the growth of other plant species (Fig. 135).

Figure 135.—Reed canarygrass infestation. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

This species is found throughout the NRS region as both a native and a nonnative species. Differentiation between the native and nonnative species is very difficult. Establishment is generally in the sun, though it can occur in shaded areas such as along restored logging roads and roadways. In Europe, reed canarygrass is most common from 35.0° to 44.0 °N latitude which is consistent with its distribution in the American Midwest (Kurtz 2010). It is predicted that climate change will reduce coverage from 35.0° to 44.0 °N latitude and increase coverage from 45.0° to 71.0 °N latitude (Kurtz 2010). Lavergne and Molofsky (2004) also suggest climate change may impact the distribution of reed canarygrass since growth is typically optimal under cool, moist conditions.

According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious graminoid can survive to -38.0 °F and requires 30.0 to 65.0 inches of precipitation annually, 120 or more frost free days, pH levels between 5.5 and 8.0, and a minimum rooting depth of 14.0 inches. Additional limits to its presence are its moderate tolerance of saline and calcareous soils, and intolerance of coarse soils.

Current distribution: Widespread invasions by both the native and nonnative strains occur throughout the region monitored by the NRS. The success of reed canarygrass as an invader is evident being that it is found throughout the world, with the exception of Antarctica and Greenland (Smith 1997). Within the United States, it is found in 43 states and is classified as invasive in Connecticut, Missouri, and North Carolina (USDA NRCS 2023).

Plot presence: Reed canarygrass is the 9th most commonly observed IPS, occurring on 291 of the 4,244 NRS FIA plots in 2019 (6.9 percent; Table 5). Looking at 2014, 7.4 percent (Table 6) had reed canarygrass whereas in 2009, 7.5 percent had this aggressive invader (Table 7). Figures 136, 137, and 138 show how this species has changed in cover and spread in the region over time on FIA plots. It appears there are less plots with reed canarygrass in 2019 versus 2014, like the percentage summaries show, however some of that variation is attributed to the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of reed canarygrass observations is in Minnesota with 124 plots in 2019 (34.1 percent). North Dakota also had roughly one-third of its plots with this invader. In 2014, Minnesota remained the state with the highest number of plots with reed canarygrass (165 plots; 22.7 percent), however Iowa took the lead with the highest percentage of plots with this species (41.4 percent; 43 plots). In 2009, Wisconsin had the most observations of reed canarygrass (157 plots; 20.8 percent) with Iowa again holding the lead for the highest percent of plots with this invader (37.5 percent; 21 plots). Overall, in 2019, reed canarygrass is present on plots in 16 of the 24 states.

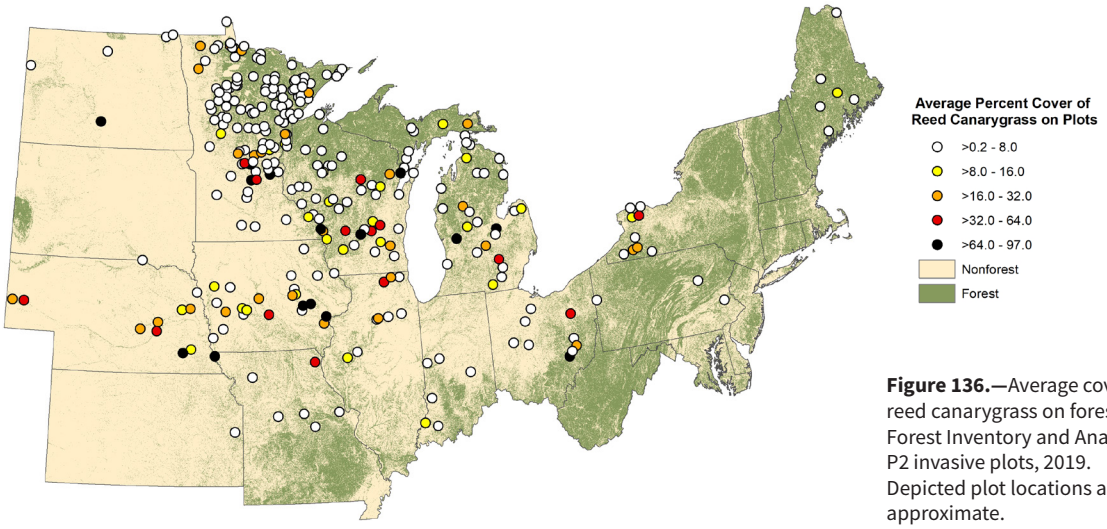

Figure 136.—Average cover of reed canarygrass on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

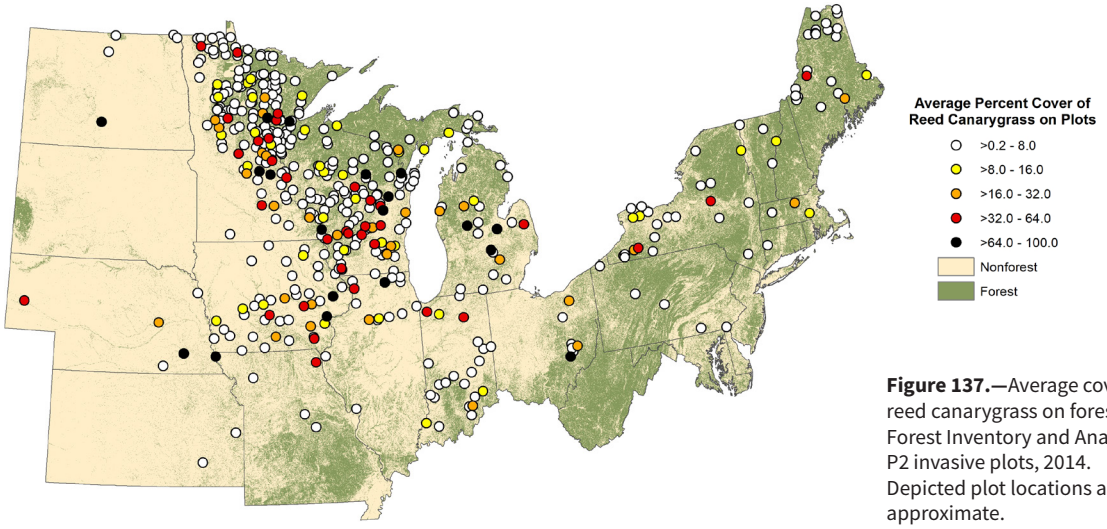

Figure 137.—Average cover of reed canarygrass on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

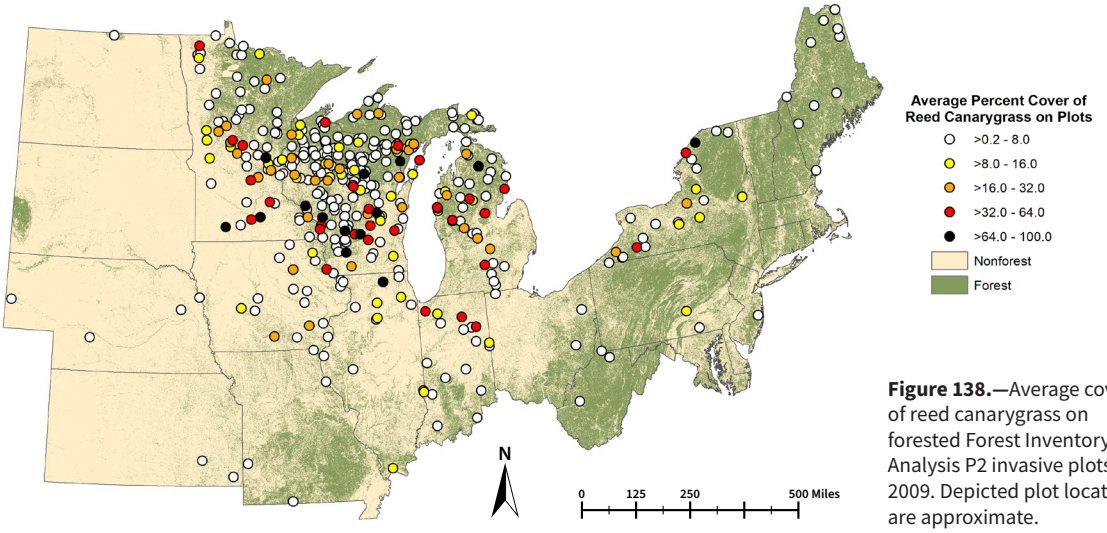

Figure 138.—Average cover of reed canarygrass on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Russian olive

(*Elaeagnus angustifolia*)

ELAN

Background and characteristics: Russian olive, a tree in the olive family (Elaeagnaceae), was introduced to the United States in the late 1800s as an ornamental plant from southeastern Europe and Asia (Kaufman and Kaufman 2007, Stannard et al. 2002). As an ornamental, its silvery foliage is often used as accent against neighboring trees. Other common uses of this tree are for wildlife, windbreaks, and shelterbelts. Optimal growth of Russian olive occurs in full sun, though it is able to grow in the shade. This species is of concern since it negatively impacts forage, vegetation, and water availability (Carman and Brotherson 1982).

Figure 139.—Russian olive infestation. Licensed photo by John M. Randall, The Nature Conservancy/Bugwood.org.

There is great concern over the presence of Russian olive in riparian areas (Fig. 139), especially in the West where it can tolerate the poor soils and wet, saline conditions. In these areas, this invasive tree draws large quantities of water from the water table in comparison to native species (Carman and Brotherson 1982). This IPS also impacts the native species by changing the composition of the plant community through fixing nitrogen and altering the nutrient cycle (Kaufman and Kaufman 2007). Russian olive not only affects the vegetation, it also impacts avian species through degraded site quality from the loss of native plants, nesting sites, and insects (Stannard et al. 2002).

Through discriminant analysis, Carman and Brotherson (1982) suggested Russian olive was found on soils with low to medium (100 to 3,500 parts per million) soluble salt levels. Based on the literature and field observations, it is suggested this noxious tree can survive to -38.0 °F and requires cold stratification, 12.0 to 40.0 inches of precipitation annually, 100 or more frost free days, pH levels between 6.0 and 9.5, and a minimum rooting depth of 20.0 inches. Russian olive is able to grow in calcareous soil and is drought tolerant but is limited by anaerobic conditions and fine textured soils (USDA NRCS 2023).

Current distribution: Russian olive is found in 37 states with no occurrences recorded in 7 southeastern states (USDA NRCS 2023). Connecticut lists it as potentially invasive and prohibited and North Carolina lists it as invasive (USDA NRCS 2023).

Plot presence: Russian olive is the 27th most commonly observed IPS, occurring on 11 of the 4,244 NRS FIA plots in 2019 (0.3 percent; Table 5). Looking at 2014, 0.3 percent (Table 6) had Russian olive whereas in 2009, 0.7 percent had this aggressive invader (Table 7). This shows an interesting decline from 2009 to present. Figures 140, 141, and 142 show a graphic display of how this species has changed in cover and spread in the region over time on FIA plots. The figures show what is noted in the tables, a reduction over time. It is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, the highest number of Russian olive observations is in Connecticut with 5 plots in 2019 (11.4 percent). Looking back at the 2014 data, Ohio had the highest number of occurrences at 5 (1.8 percent) and there were no occurrences of this species on plots in Connecticut. In 2009, Michigan, Ohio, and Pennsylvania all had 7 plots with Russian olive (1,0, 3.6, and 2.1 percent of plots, respectively). The number of states with this invader also decreased over time with 13 states having Russian olive in 2009, 10 in 2014, and 5 in 2019. This is an interesting trend and will be something to note in future analyses.

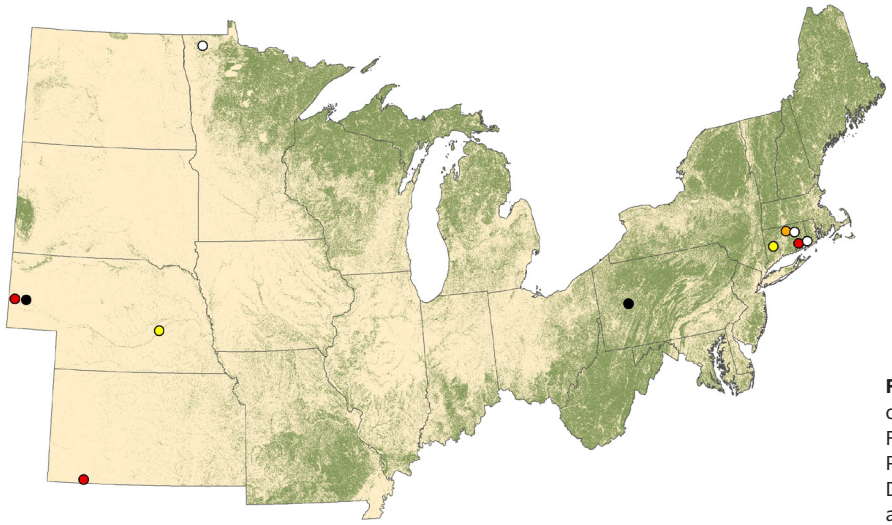

Figure 140.—Average cover of Russian olive on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

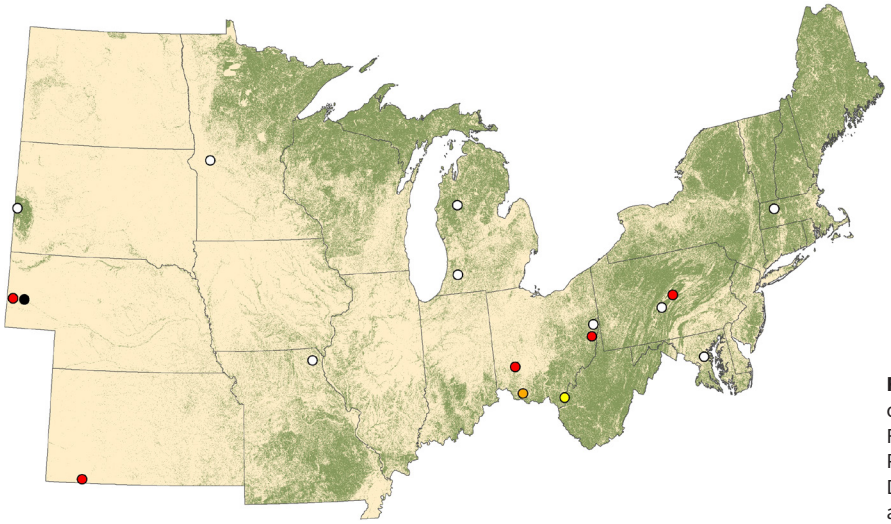

Figure 141.—Average cover of Russian olive on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

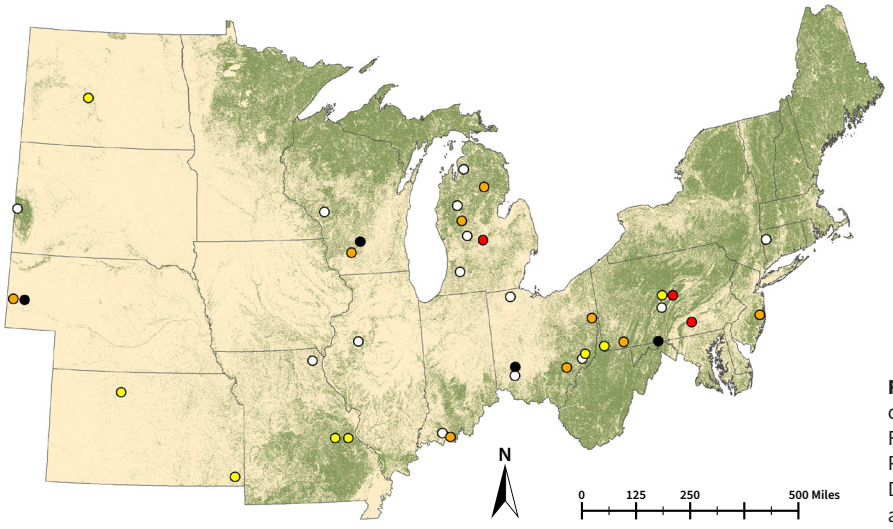

Figure 142.—Average cover of Russian olive on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Saltcedar

(*Tamarix ramosissima*)

TARA

Background and characteristics: Saltcedar is a phreatophyte of the tamarix family (Tamaricaceae). Several species were introduced in the 1820s, and taxonomists disagree on which ones are present (Kaufman and Kaufman 2007). The first escapees were found in the 1870s and by the 1920s it became evident that some species of saltcedar were becoming a serious problem (Di Tomaso 1998). Current estimates of the area invaded by this species could not be found, but previous estimates were at greater than 1 million acres (Di Tomaso 1998, Kaufman and Kaufman 2007).

Figure 143.—Saltcedar. USDA Forest Service photo by Cassandra Kurtz.

Saltcedar is a great concern in the western part of the United States because of its hydrologic implications. Introduced as an ornamental with showy foliage and flowers (Fig. 143), saltcedar has spread into natural areas. It is particularly troublesome in the arid Southwest where this species is taking over habitat along rivers and streams and changing the water flow. This IPS dried up Bylas Springs in Arizona's Apache Indian Reservation which caused insects and birds to disappear and destroyed habitat of the endangered desert pupfish (*Cyprinodon macularius*) (Westbrooks 1998).

Saltcedar is a worrisome invasive species because of its seed production (1/2 million seeds annually; Stein and Flack 1996), cold (Martine et al. 2008) and drought tolerance, high water use (due to evapotranspiration), ability to increase soil salinity from salt accumulation in its leaves, be submerged for over 2 months, and rapid growth (up to 12.0 feet annually; Di Tomaso 1998, Kaufman and Kaufman 2007). The height of this tree varies by species.

The high evapotranspiration rate of saltcedar puts other species at risk through lowering the water table level and reducing the moisture available. McCormick et al. (2010) suggest that saltcedar consumes 10 to 20 times as much water as native species, which may greatly impact riparian areas. In areas with depleted water and high salinity levels, such as where there has been extensive irrigation, saltcedar is one of a limited number of species that is able to survive. Its negative effects are so great that *Tamarix* spp. rank among The Nature Conservancy's "Dirty Dozen" alien species (Stein and Flack 1996). Aside from the negative implications caused by this IPS, it is an important species to the endangered Southwestern willow flycatcher (*Empidonax trailii extimus*) which uses this tree for shelter (Kaufman and Kaufman 2007).

Current distribution: Saltcedar is found in 19 states, with North Carolina classifying it as invasive (USDA NRCS 2023).

Plot presence: Saltcedar is the 34th most commonly observed IPS, occurring on 1 of the 4,244 NRS FIA plots in 2019 (0.0 percent; Table 5). Looking at 2014, there were no plots (Table 6) with saltcedar whereas in 2009, two plots had this aggressive invader (Table 7). Figures 144 and 145 show how plots with this species have declined in cover and number in the region. It is important to consider the few observations and the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, there is one plot with saltcedar in Nebraska in 2019 (1.9 percent). No saltcedar were found in 2014 and in 2009, there was one plot with this invader in Kansas (1.4 percent) and one in Nebraska (2.6 percent). With the prevalence of this species just south of the NRS region, it will be important to continue to watch the progression of this species with climate change.

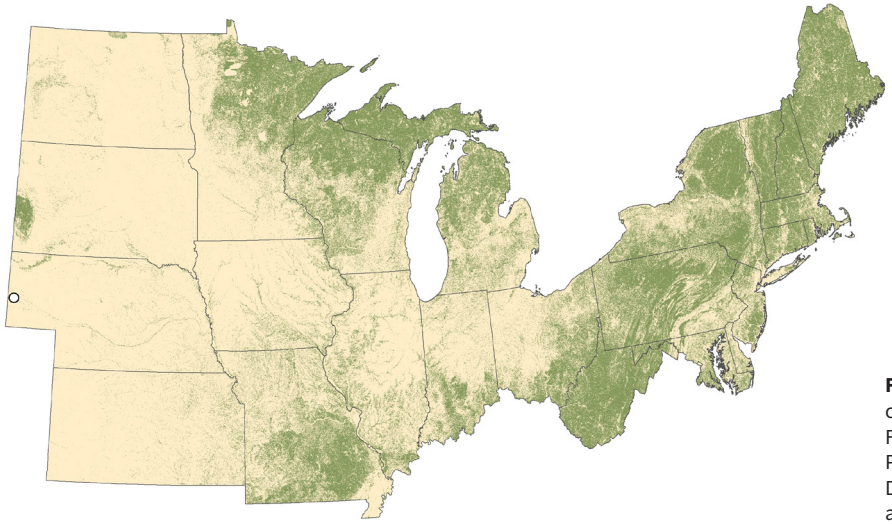

Figure 144.—Average cover of saltcedar on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

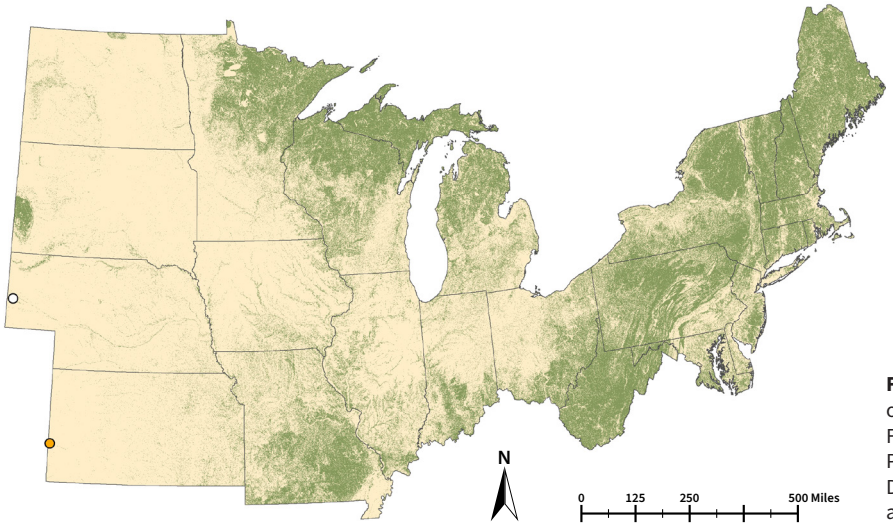

Figure 145.—Average cover of saltcedar on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Showy fly honeysuckle

(*Lonicera xbella*)

LOBE

Background and characteristics: Showy fly honeysuckle, also known as Bell's honeysuckle, is a woody shrub of the honeysuckle family (Caprifoliaceae) that occupies an approximate latitudinal range of 35.0° to 54.0 °N in North America (Barnes and Cottam 1974). A Eurasian hybrid, it is the result of hybridization between Morrow's and Tatarian honeysuckles, and differentiation between this species and its parents can be difficult. Like its parents, there is horticultural interest in this species as a hedge due to its aesthetically pleasing flowers (Fig. 146) and fruit.

Figure 146.—Showy fly honeysuckle. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Showy fly honeysuckle has several characteristics of a successful invader. It favors disturbed sites and is tolerant of a wide range of soil moisture and type, temperature, and light (Barnes and Cottam 1974). In addition, the leaves of this shrub emerge early in the growing season and are held later in the season than many native species, a competitive advantage that increases carbon gain and shades out neighboring vegetation.

Current distribution: An aggressive invader, this IPS is now found in 24 states with Connecticut, Missouri, and New York listing it as invasive and/or prohibited (USDA NRCS 2023).

Plot presence: Showy fly honeysuckle is the 32nd most commonly observed IPS, occurring on 3 of the 4,244 NRS FIA plots in 2019 (0.1 percent; Table 5). Looking at 2014, 0.7 percent of plots had this species (Table 6) and in 2009, 1.1 percent of plots had showy fly honeysuckle (Table 7). Figures 147, 148, and 149 show how this species has changed in cover and spread in the region over time on FIA plots. Based on the data, there is reduction in both cover and spread of showy fly honeysuckle over time. It is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, Pennsylvania has one plot, and Wisconsin has two plots with showy fly honeysuckle in 2019. In 2014, Massachusetts and Ohio both had 3.3 percent of plots with this species (3 and 9 plots respectively). In 2019, the largest percentage of plots with this invasive shrub occurred in Ohio (5.1 percent). In 2019 there are 2 states with this species, in 2014 there were 9 states, and in 2009 there were 10 states. The state that did not have showy fly in 2014, but did in 2009, was Illinois. Over time there has been a reduction in cover, spread, occurrence, and number of states with this species. The difficulty in identifying this species may contribute to the variation in observations in the region.

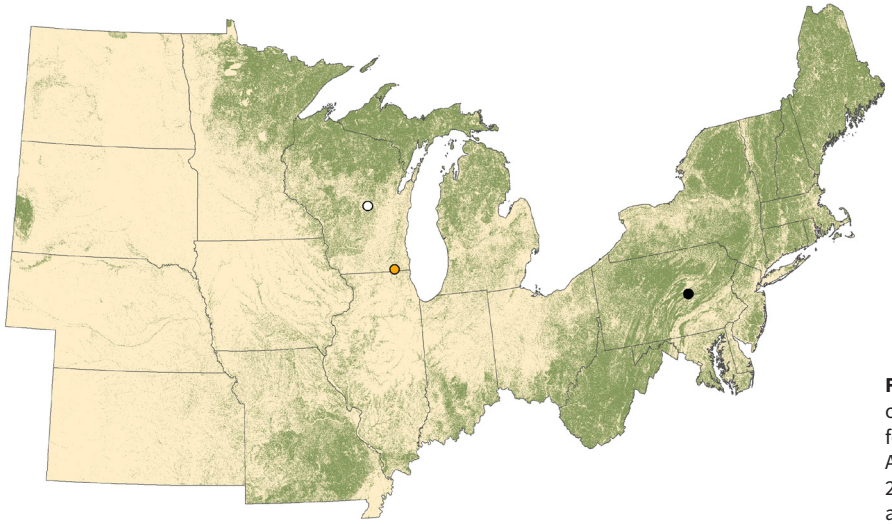

Figure 147.—Average cover of showy fly honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

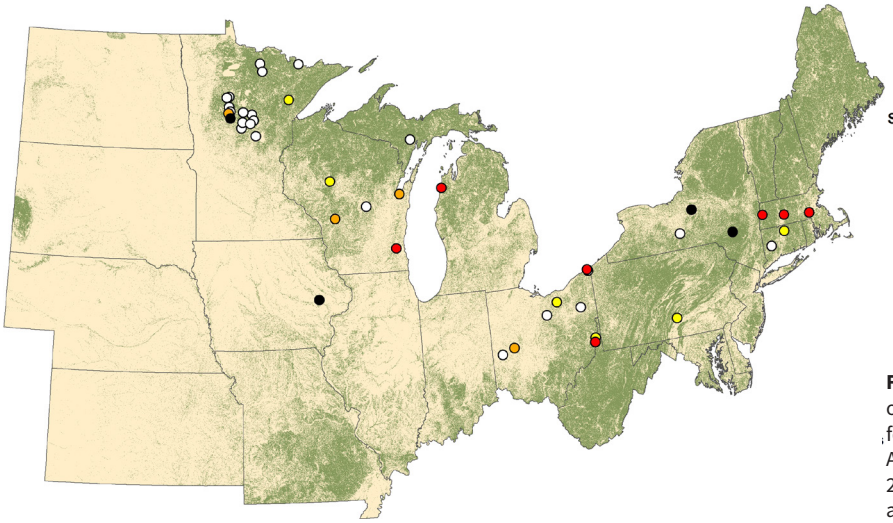

Figure 148.—Average cover of showy fly honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

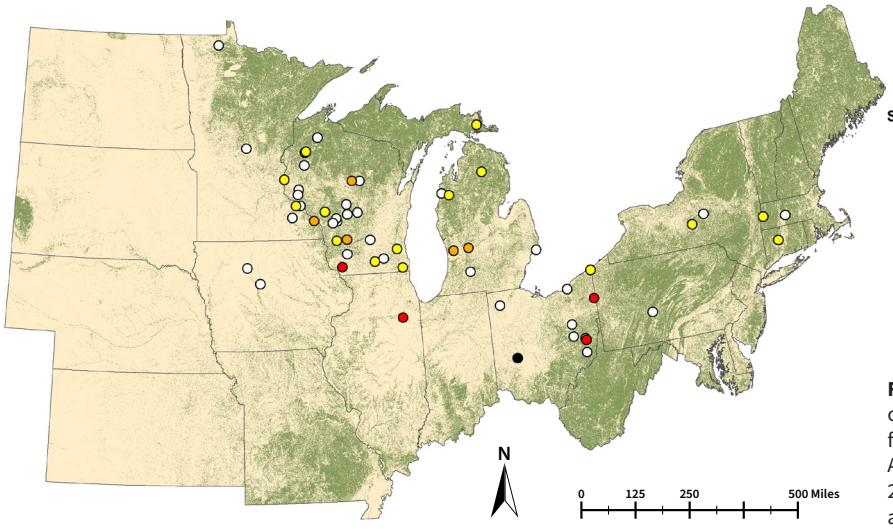

Figure 149.—Average cover of showy fly honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Siberian elm

(*Ulmus pumila*)

ULPU

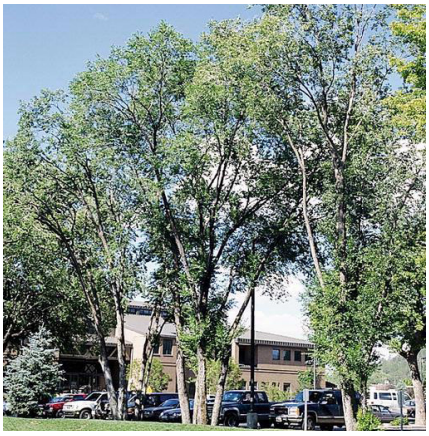

Figure 150.—Siberian elm. Licensed photo by Tom DeGomez, University of Arizona/Bugwood.org

Background and characteristics: Siberian elm, a member of the elm family (Ulmaceae), is native to northern China, eastern Siberia, Manchuria, and Korea and was introduced as a tree for windbreaks in the 1860s (Kaufman and Kaufman 2007). In eastern Asia, this IPS is a major tree species for timber, shelter, and fodder (Cogolludo-Agustín et al. 2000). Small, wind-dispersed seeds are responsible for its aggressive spread, formation of dense thickets, and displacement of native species. Siberian elm has little shade tolerance with optimal growth in the sun. Its rapid growth, cold and drought tolerance, and resistance to Dutch elm disease have made Siberian elm a desirable tree which is still commercially available. Due to its resistance to Dutch elm disease, this tree is commonly used in breeding programs (Cogolludo-Agustín et al. 2000). However, its form is less attractive (Fig. 150) than the American elm (*Ulmus americana*) and it is problematic in areas with ice and snowstorms as it tends to break because of weak wood.

According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious tree can survive to -38.0 °F and requires cold stratification, 16.0 to 50.0 inches of precipitation annually, 90 or more frost free days, pH levels between 5.5 and 8.0, and a minimum rooting depth of 24.0 inches. Its rapid growth, to 40.0 feet in 20 years, is restricted by anaerobic conditions and fires.

Current distribution: Widespread planting of Siberian elm has led to its occurrence in 44 states (USDA NRCS 2023).

Plot presence: Siberian elm is the 21st most commonly observed IPS, occurring on 37 of the 4,244 NRS FIA plots in 2019 (0.9 percent; Table 5). Looking at 2014, 0.7 percent (Table 6) had Siberian elm whereas in 2009, 0.5 percent had this aggressive invader (Table 7). This shows a slight increase in presence over time. Figures 151, 152, and 153 show a graphic display of how this species has changed in cover and spread in the region over time on FIA plots. The figures do seem to suggest an increase in cover and potentially higher occurrence in the region of highest presence, mirroring what the data suggests. However, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009) which makes the survey variation more difficult to see.

Of the 24 NRS FIA states, there are 9 states with Siberian elm in 2019. In 2014, there were 11 states and in 2009 there were 10 states. It ranked the 21st most common for the two most recent surveys. In 2009, it was the 26th most common species. Over 13 percent of plots in Nebraska and North Dakota have Siberian elm in 2019 (7 and 2 plots, respectively).

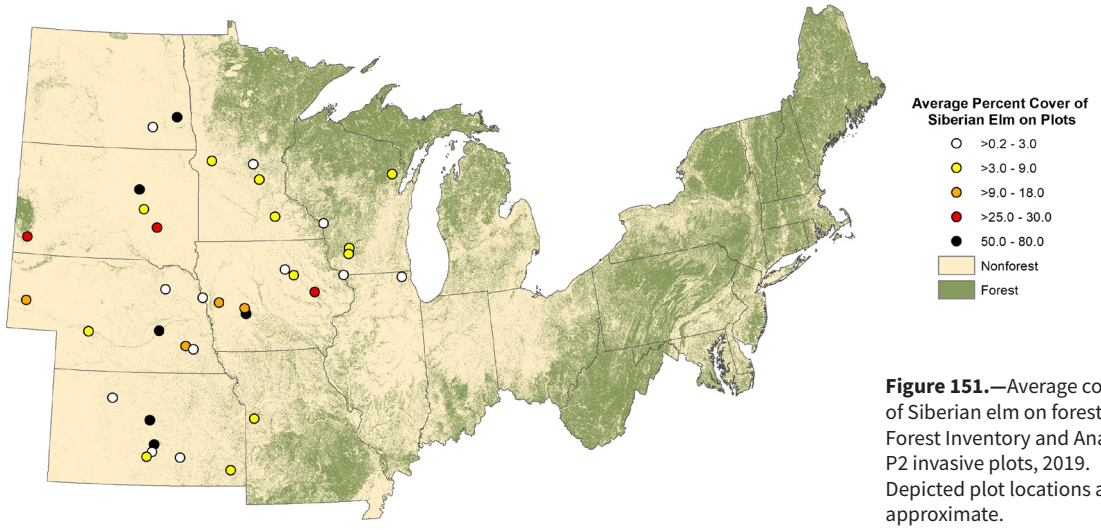

Figure 151.—Average cover of Siberian elm on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

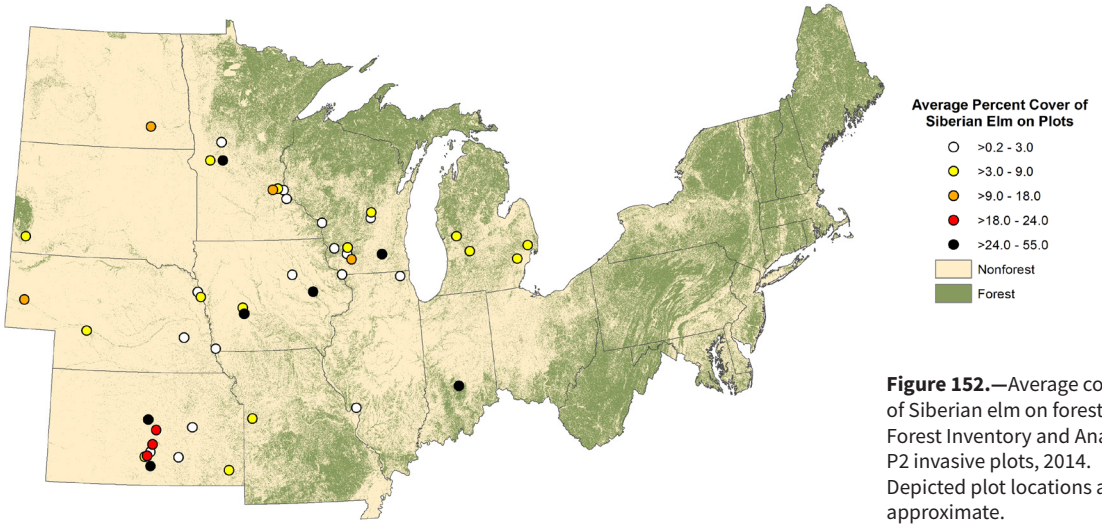

Figure 152.—Average cover of Siberian elm on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

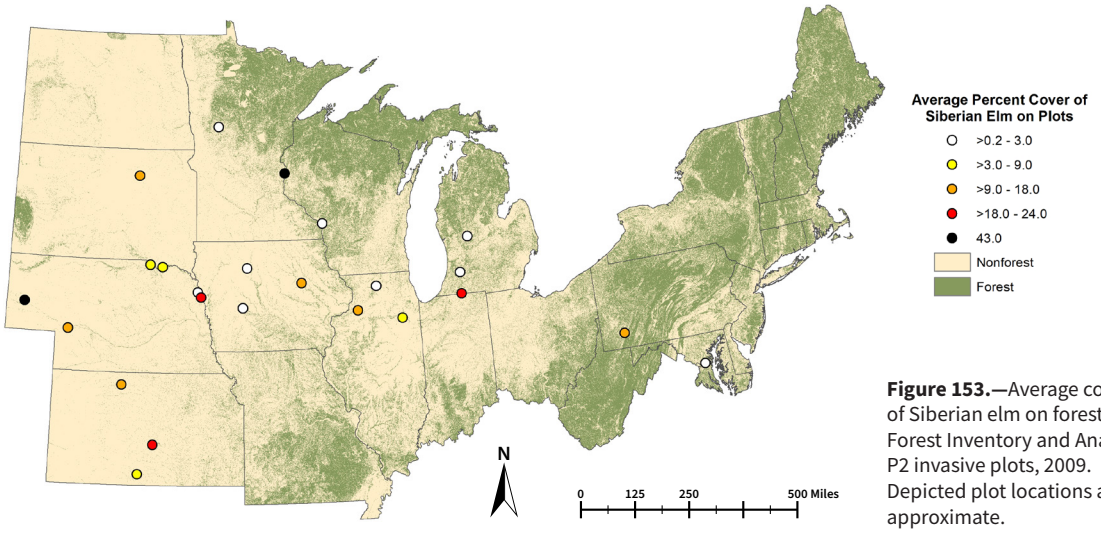

Figure 153.—Average cover of Siberian elm on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Silktree

(*Albizia julibrissin*)

ALJU

Background and characteristics: Silktree, also known as mimosa or mimosa tree, is a short-lived leguminous tree of the pea family (Fabaceae) that was introduced from Asia to Europe and then to North America in the mid-18th century (Ulyshen and Miller 2007). It is a prized landscape tree, offering aesthetically pleasing fern-like doubly compound leaves and unique, fragrant flowers that have a "fluffy" appearance (Fig. 154). A short tree, it only grows to about 40.0 feet tall (Kaufman and Kaufman 2007).

Figure 154.—Silktree. Licensed photo by John D. Byrd, Mississippi State University/Bugwood.org.

Medicinally it is an important species for insomnia caused by anxiety, depression, and restlessness, as well as a poultice for traumatic injuries (Foster and Duke 2000). However, these beneficial traits are strongly outweighed by the negative consequences caused by this invader. As an aggressive spreading tree, silktree can change the forest community by displacing native flora. It can be difficult to restore an invaded site because the trees resprout and produce suckers, and the seeds can remain viable up to 50 years (Kaufman and Kaufman 2007).

The PLANTS Database (USDA NRCS 2023) suggests silktree can survive to 2.0 °F and requires 30.0 to 60.0 inches of precipitation annually, 200 or more frost free days, pH levels between 4.8 and 7.3, and a minimum rooting depth of 30.0 inches. It can grow in floodplains, on a wide variety of soil types, and is drought, wind, and salt tolerant (Kaufman and Kaufman 2007). Other limitations to the growth of silktree include its intolerance of shade and anaerobic conditions.

Current distribution: Silktree is found in 29 states and listed as invasive in North Carolina (USDA NRCS 2023).

Plot presence: Silktree is one of the least commonly observed IPS of those monitored by NRS on plots (Figs. 155, 156, and 157). It is tied with Louise's swallow-wort as the 33rd most commonly observed species and has remained relatively uncommon in our region across inventories. In past inventories, it was only found on one plot in Missouri (Figs. 156, 157). However, during the 2019 inventory, it was not found in Missouri but was found in Illinois and Indiana (Fig. 155).

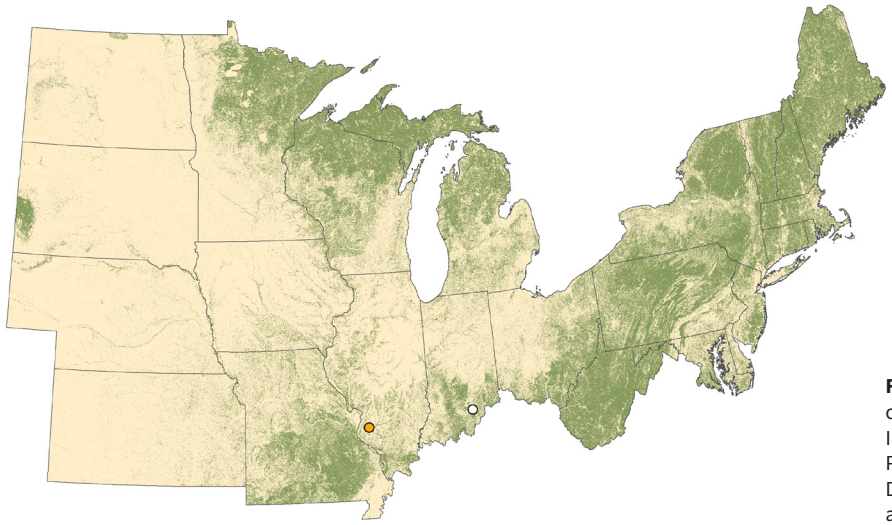

Figure 155.—Average cover of silktree on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

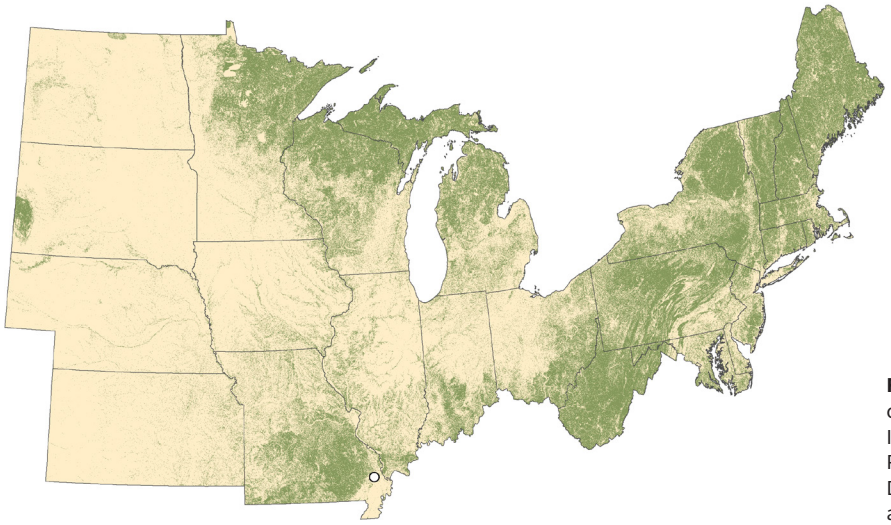

Figure 156.—Average cover of silktree on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

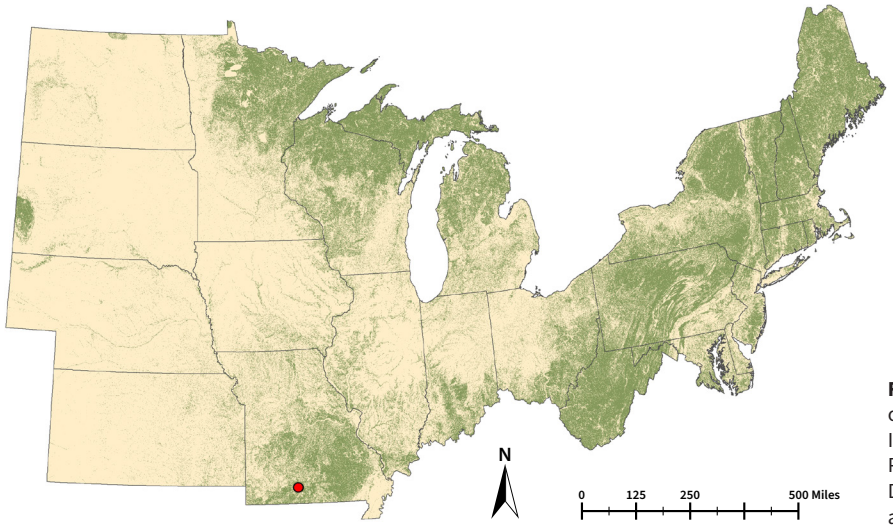

Figure 157.—Average cover of silktree on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Spotted knapweed

(*Centaurea stoebe* syn. *C. biebersteinii, C. maculosa*)

CEST8

Background and characteristics: Spotted knapweed, a short-lived perennial of the aster family (Asteraceae), is native to Eurasia and was probably introduced in the 1890s via ship ballast water or contaminated hay or alfalfa (*Medicago sativa*) seeds (Czarapata 2005, Kaufman and Kaufman 2007). This IPS thrives in sun or light shade and is very drought tolerant. Spotted knapweed is often found in disturbed areas (Fig. 158) such as along hiking trails and roads as well as in pastures where livestock preferentially graze the other species and facilitate its spread by disturbing the soil. A single plant can produce 1,000 seeds that are generally viable from 5 to 8 years (Kaufman and Kaufman 2007).

Figure 158.—Spotted knapweed infestations. USDA Agricultural Research Service photo by Norman E. Rees/Bugwood.org.

Another characteristic which contributes to the success of spotted knapweed is its phytotoxicity. Spotted knapweed produces catechin, an allelochemical that is poisonous to other plants and stays in the soil, making restoration difficult and changing the faunal and floral community (Czarapata 2005, Kaufman and Kaufman 2007, Royer and Dickinson 1999). In addition to effects on the floral community, elk (*Cervus elaphus*) in Montana have also suffered from spotted knapweed infestations by reducing their winter forage 50.0 to 90.0 percent (Czarapata 2005).

Another negative impact of spotted knapweed was found in a Montana where it was found that runoff increased 56.0 percent and sediment yield increased 92.0 percent in areas dominated by spotted knapweed versus native bunchgrass vegetation (Czarapata 2005). Spotted knapweed has caused widespread impacts and previous estimates of infestation were at over 8,500 acres of rangeland in British Columbia and hundreds of thousands of acres in the northwestern United States (Royer and Dickinson 1999). Economically, the effects caused by spotted knapweed have been substantial. Czarapata (2005) reported Montana's infestation cost is estimated at $14 million annually, with direct and secondary impacts totaling $42 million, enough to support over 500 jobs in the state.

Current distribution: Spotted knapweed is found in 46 states (not present in Alaska, Mississippi, Oklahoma, and Texas). Connecticut, Michigan, and New York list it as invasive and/or prohibited (USDA NRCS 2023).

Plot presence: Spotted knapweed is the 23rd most commonly observed IPS, occurring on 34 of the 4,244 NRS FIA plots in 2019 (0.9 percent; Table 5). Looking at 2014 and 2009, 0.8 percent (Table 6 and 7) had spotted knapweed. This shows a relatively stable presence over time. Figures 159, 160, and 161 show a graphic display of how this species has changed in cover and spread in the region over time on FIA plots. The figures closely reflect what the tables show in that presence has remained relatively similar over time. In looking at the figures, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, there are six states with spotted knapweed in 2019. There were seven states in 2014 and eight states in 2009. Its ranking has changed over time: ranking 23rd in commonality in 2019, 18th in 2014, and 22nd in 2009. Spotted knapweed presence is highest in Michigan at 6.4 percent of P2 invasive plots in 2019 (26 plots). There has been an increase in the percentage of plots with spotted knapweed in Michigan over time (5.5 percent in 2014 and 3.4 percent in 2009).

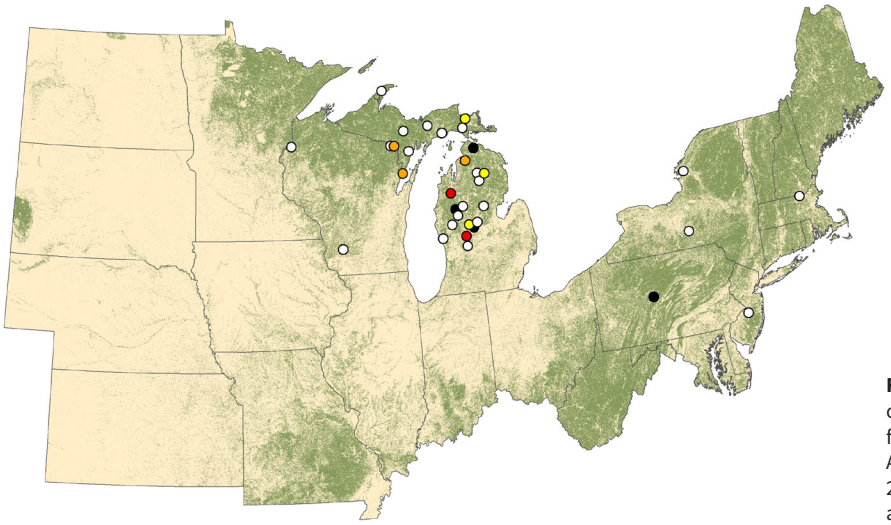

Figure 159.—Average cover of spotted knapweed on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

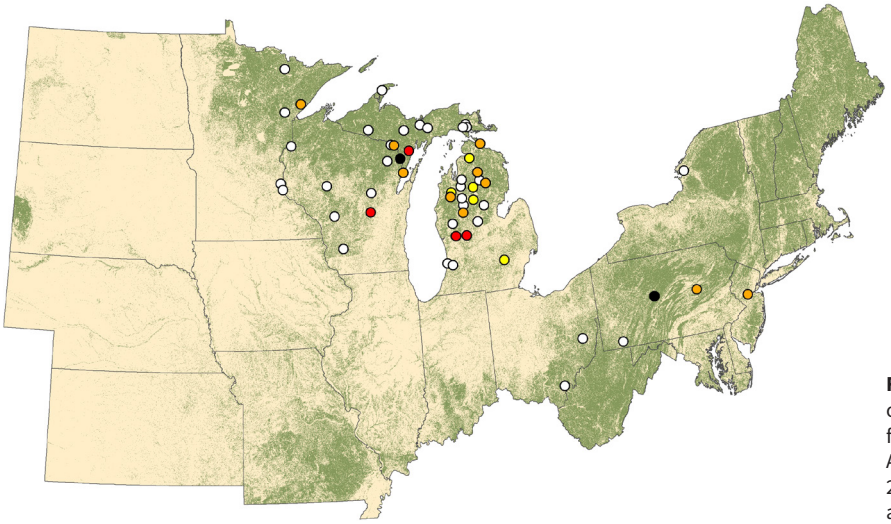

Figure 160.—Average cover of spotted knapweed on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

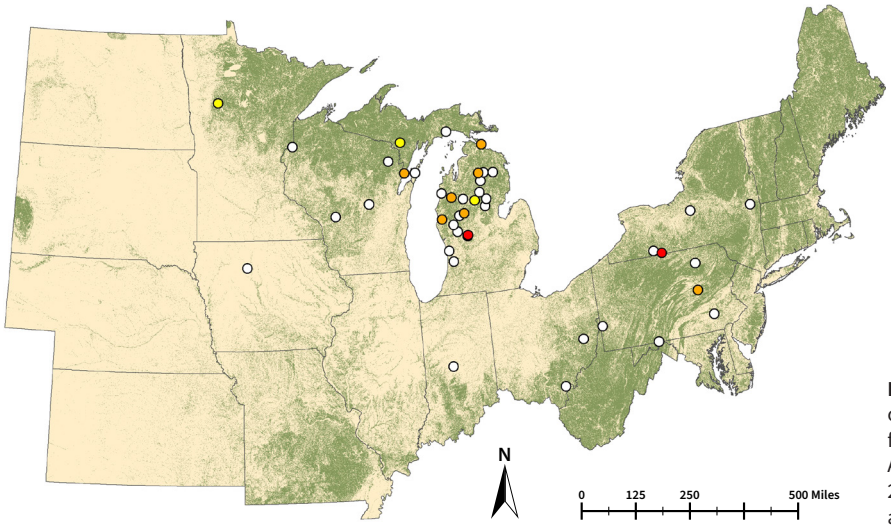

Figure 161.—Average cover of spotted knapweed on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Tallow tree

(*Triadica sebifera*)

TRSE6

Background and characteristics: Tallow tree, also known as Chinese tallow tree, popcorn tree, chicken tree, vegetable tallow, and Florida aspen, is a tree of the spurge family (Euphorbiaceae) that can reach up to 60.0 feet. It was introduced for soap and candle making, arriving in Charleston, SC in 1776. The U.S. Department of Agriculture promoted the tallow tree for oil production in the 1920s and 1930s (Kaufman and Kaufman 2007). Its value as an oil resource resulted in the Chinese and American forces using this species for diesel in World War II, and it is being further investigated as a renewable fuel for use in jet engines (Mason 1997). Tallow tree can annually yield 500.0 gallons of fats and oils per acre.

Figure 162.—Tallow tree. Licensed photo by Joseph LaForest, University of Georgia/ Bugwood.org.

Despite the fact that tallow tree has value as a renewable fuel, its presence is a concern. This fast-growing IPS is able to survive in sun or shade, produces an abundance of seeds (Fig. 162) which are dispersed by birds and waterways, tolerates high salinity levels, and is allelopathic (Stein and Flack 1996). The decomposition of its foliage can change the chemistry of soil and water by increasing nitrogen and phosphorus levels (Kaufman and Kaufman 2007). In addition, tallow tree is toxic to animals and humans (Kaufman and Kaufman 2007). Its negative effects are so great that it ranks among The Nature Conservancy's "Dirty Dozen" alien species (Stein and Flack 1996).

Current distribution: Tallow tree is found in 10 states with North Carolina listing it as invasive (USDA NRCS 2023).

Plot presence: Tallow tree is not present on plots in the NRS region. However, with the ecological damage that this tree can cause, it is important to continue monitoring for this species.

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Tatarian honeysuckle

(*Lonicera tatarica*)

LOTA

Background and characteristics: Tatarian honeysuckle, a member of the honeysuckle family (Caprifoliaceae), was introduced as an ornamental shrub in 1752 (Barnes and Cottam 1974) from Russia (Gould and Stuckey 1992, Rathfon 2006). Tatarian honeysuckle exhibits optimal growth in full sun but can adapt to other light levels (Brakke 2006), even invading the forest interior (Woods 1993). It is commonly used as a hedge, offering beautiful pink (rarely white) flowers (Fig. 163) and red to orange berries, as well as for wildlife planting. Birds are a common vector of this invasive shrub.

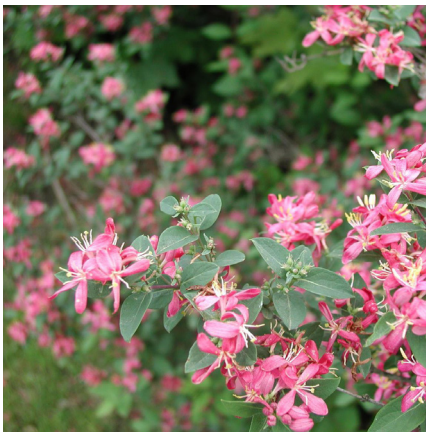

Figure 163.—Tatarian honeysuckle, flowering. Licensed photo by Leslie J. Mehrhoff, University of Connecticut/Bugwood.org.

Tatarian honeysuckle is a concern in forested areas because where this shrub establishes it can form a nearly impenetrable layer. The establishment of this shrub reduces mineral, nutrient, and light available to native species, impacting regeneration and changing future forest dynamics. It also is troublesome in the forest community because it leafs out early. Woods (1993) found leaf expansion of Tatarian honeysuckle begins about 2 weeks before the trees in northwestern Massachusetts and southwestern Vermont forests, light to the forest floor is reduced approximately 60.0 percent, and its leaves are held longer than other woody species.

Even though Tatarian honeysuckle is able to invade a wide variety of habitats, there are limitations to its presence. According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious shrub can survive to -38.0 °F and requires cold stratification, 32.0 to 50.0 inches of precipitation annually, 120 or more frost free days, pH levels between 5.2 and 7.5, and a minimum rooting depth of 16.0 inches. Additional growth limitations are its intolerance of anaerobic and fine textured soils.

Current distribution: Tatarian honeysuckle is now found in 36 states, being absent from the Southeast, Arizona, and Nevada, and is listed as invasive and/or prohibited in Connecticut, Missouri, and New York (USDA NRCS 2023).

Plot presence: Tatarian honeysuckle is the 25th most commonly observed IPS, occurring on 15 of the 4,244 NRS FIA plots in 2019 (0.4 percent; Table 5). Looking at 2014, 0.7 percent (Table 6 and 7) had Tatarian honeysuckle and in 2009, 1.8 percent had this species. This shows a reduction in presence over time. Figures 164, 165, and 166 show a graphic display of how this species has changed in cover and spread in the region over time on FIA plots. The figures closely reflect what the tables show in that presence has declined over time. In looking at the figures, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, there are 6 states with Tatarian honeysuckle in 2019. There were 12 states in 2014 and 13 states in 2009. With the decline in occurrences and number of states where it occurs, its commonality ranking has changed over time: 25th in 2019, 21st in 2014, and 18th in 2009. The highest number of observations was in Minnesota (6 plots; 1.6 percent). The change in observations may be due to difficulties in determining which species of honeysuckle is observed on plots by field crew. It will be important to note the changes in occurrence of this species in future inventories.

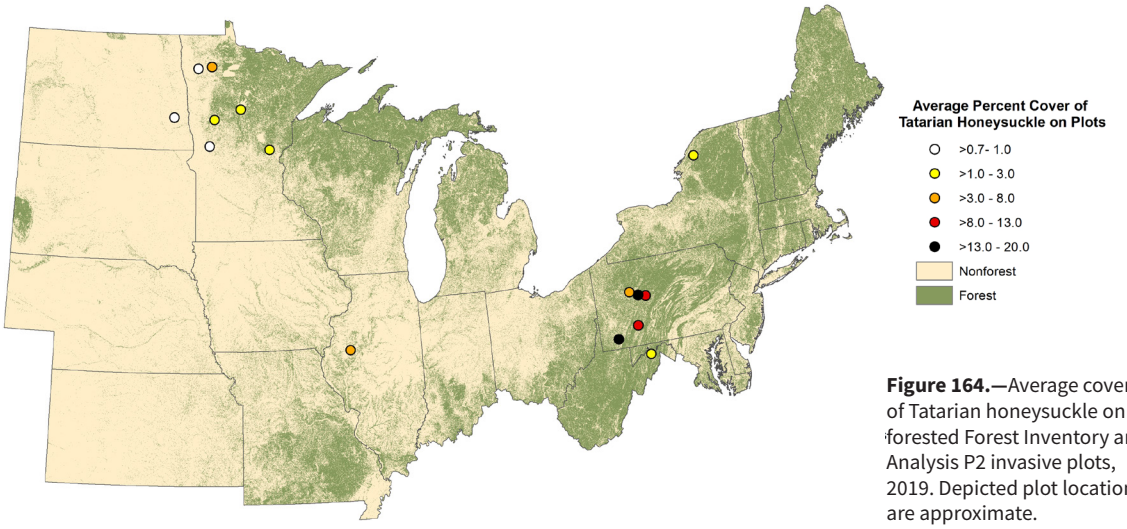

Figure 164.—Average cover of Tatarian honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

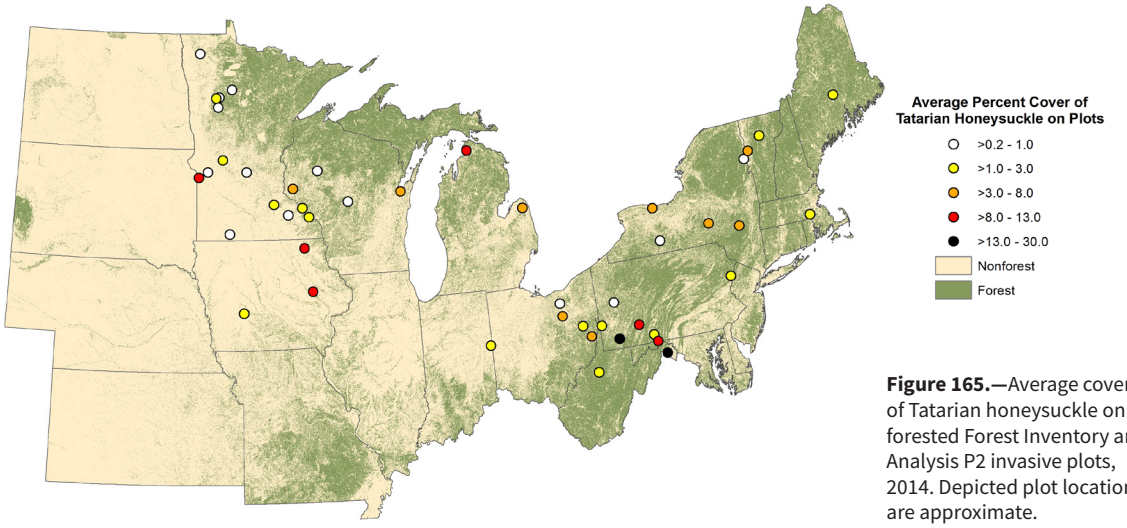

Figure 165.—Average cover of Tatarian honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

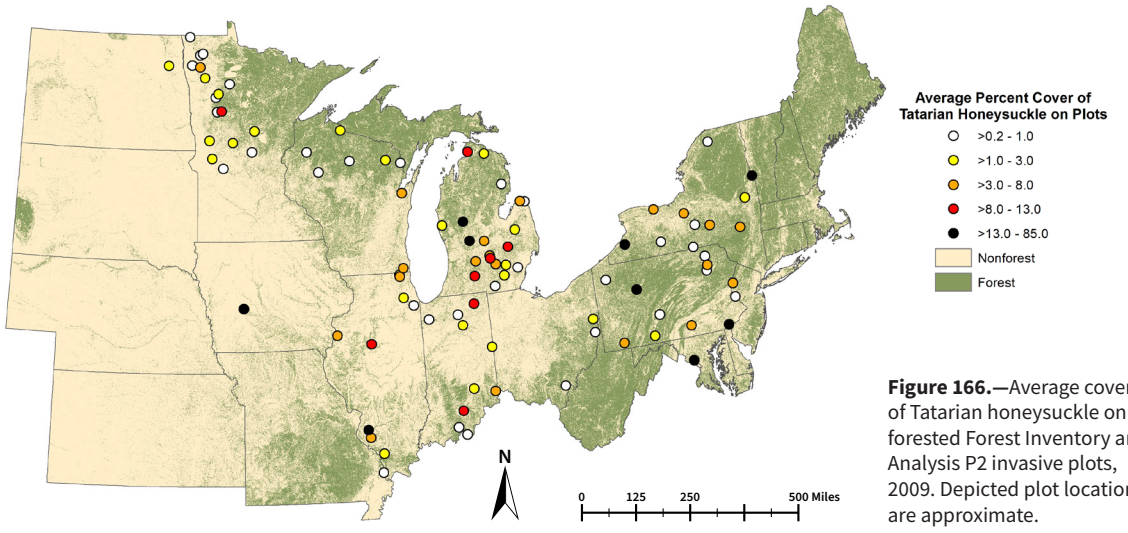

Figure 166.—Average cover of Tatarian honeysuckle on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Tree-of-heaven

(*Ailanthus altissima*)

AIAL

Background and characteristics: Tree-of-heaven, a member of the Quassia family (Simaroubaceae), is native to China and was introduced to the United States in 1748 by a gardener in Philadelphia, PA. In the 1850s, seeds were brought to the West Coast by Chinese immigrants during the Gold Rush. This aggressive tree became known as "tree of heaven" due to its ability to grow out of the rocks on mountains where other trees were unable to grow (Kaufman and Kaufman 2007).

Figure 167.—Tree-of-heaven. Licensed photo by Annemarie Smith, ODNR Division of Forestry/Bugwood.org.

Tree-of-heaven's characteristic rapid growth, aesthetic beauty (Fig. 167), and tolerance of poor sites are reasons this species is valued by landowners and the nursery trade. This invasive tree tolerates very little shade (Kaufman and Kaufman 2007, Knapp and Canham 2000), but given adequate light, it can quickly become a nuisance. Tree-of-heaven can grow in heavily polluted and mine spoil areas and produces more than 300,000 winged seeds (Kaufman and Kaufman 2007). Within the forest, this species is a concern in canopy gaps because of its rapid growth and allelopathic affects (Gould and Stuckey 1992, Heisey 1990, Kaufman and Kaufman 2007). Its rapid growth is problematic because this tree quickly matures, reproduces, and shades out native plant species.

In addition to spread by landowners and during mine reclamation, the presence of this species may also be attributed to deer. These hoofed animals browse the understory, creating disturbances which facilitate germination, and may contribute to the spread of tree-of-heaven, an unpalatable species (Knapp and Canham 2000, Rawinski 2008). Additionally, as a host species, this tree facilitates the spread of spotted lanternfly (*Lycorma delicatula*), a problematic invasive insect (Barringer and Ciafré 2020).

Aside from the negative aspects of tree-of-heaven, this tree has medicinal importance (Foster and Duke 2000). The bark is reported to be of value for diarrhea, dysentery, leucorrhea, and tapeworm, and it is also used in traditional Chinese medicine and for malaria. Tree-of-heaven has several antimalarial compounds, some of which are more potent than the standard antimalarial drug chloroquine. Even though there may be benefits to the use of this plant, caution must be used as this species produces sap which contains quassinoids that can cause dermatitis, heart problems, debilitating headaches, and nausea (Kaufman and Kaufman 2007).

According to the PLANTS Database (USDA NRCS 2023), it is suggested this noxious tree can survive to -18.0 °F and requires cold stratification, 14.0 to 90.0 inches of precipitation annually, 150 or more frost free days, pH levels between 4.1 and 7.9, and a minimum rooting depth of 30.0 inches.

Current distribution: Tree-of-heaven is now found in 42 states, with Connecticut, Michigan, and North Carolina classifying this invader as invasive and/or prohibited (USDA NRCS 2023).

Plot presence: Tree-of-heaven is the 16th most commonly observed IPS, occurring on 129 of the 4,244 NRS FIA plots in 2019 (3.0 percent; Table 5). Looking at 2014, 2.2 percent (Table 6 and 7) had tree-of-heaven and in 2009, 1.8 percent had this species. This shows a reduction in presence over time. Figures 168, 169, and 170 show a graphic display of how this species has changed in cover and spread in the region over time on FIA plots. Since the 2009 inventory, tree-of-heaven has increased in occurrence and cover. In looking at the figures, it is important to note the fluctuation in the number of plots monitored each inventory (4,244 in 2019, 6,361 in 2014, and 5,309 in 2009).

Of the 24 NRS FIA states, there are 10 states with tree-of-heaven in 2019. There were 12 states with this aggressive tree in 2014 and 2009. Despite the increased presence since the 2009 inventory, ranking has changed but remained relatively stable. In 2019, it was the 16th most common species. In 2014, this IPS ranked number 15 and in 2009, it was the 17th most common. Pennsylvania had the greatest number of observations (45 plots; 6.5 percent) whereas West Virginia had the highest percentage of plots with tree-of-heaven (18.8 percent; 40 plots).

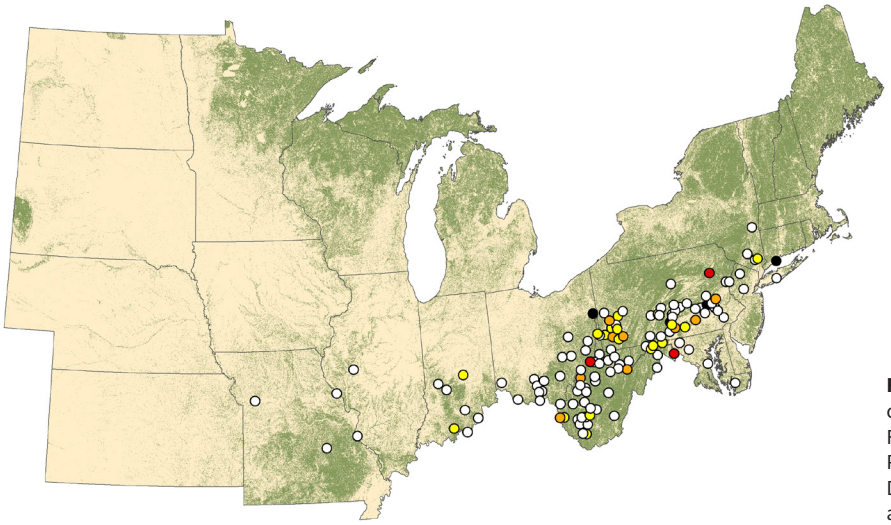

Figure 168.—Average cover of tree-of-heaven on forested Forest Inventory and Analysis P2 invasive plots, 2019. Depicted plot locations are approximate.

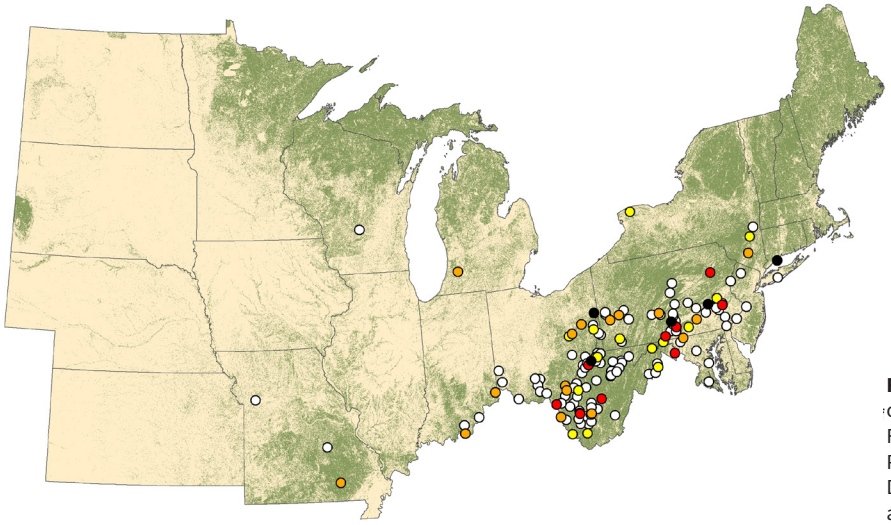

Figure 169.—Average cover of tree-of-heaven on forested Forest Inventory and Analysis P2 invasive plots, 2014. Depicted plot locations are approximate.

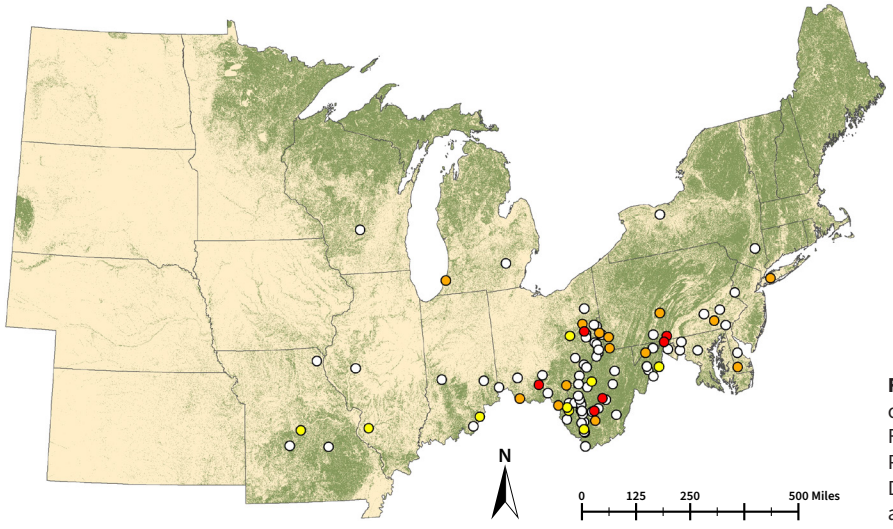

Figure 170.—Average cover of tree-of-heaven on forested Forest Inventory and Analysis P2 invasive plots, 2009. Depicted plot locations are approximate.

Projection: Albers Equal Area Conic USGS. State layer source: ESRI Data and Maps 2005. Cartographer: Cassandra Kurtz

Table 1.—Number of invasive plant species per Forest Inventory and Analysis plot by state, 2009, 2014, and 2019

State and inventory year	Number of invasive plant species per plot							
	0	1	2	3	4	5	6	7
Connecticut 2009	27	11	4	6	1	2	0	0
Connecticut 2014	18	11	8	7	8	4	2	1
Connecticut 2019	10	3	6	7	5	5	4	3
Delaware 2009	24	18	6	7	0	0	0	0
Delaware 2014	5	7	2	3	1	1	0	0
Delaware 2019	7	2	3	1	2	0	0	0
Illinois 2009	46	34	34	18	13	4	0	0
Illinois 2014	26	32	50	35	20	8	1	1
Illinois 2019	14	14	28	33	21	7	3	1
Indiana 2009	36	61	64	42	28	17	2	2
Indiana 2014	22	53	71	50	43	17	8	9
Indiana 2019	4	14	23	35	14	11	8	4
Iowa 2009	10	13	16	11	5	0	0	1
Iowa 2014	6	35	32	15	13	2	1	0
Iowa 2019	6	24	14	18	7	6	1	0
Kansas 2009	42	22	6	2	1	0	0	0
Kansas 2014	67	32	12	5	0	0	0	0
Kansas 2019	40	24	5	3	0	0	0	0
Maine 2009	325	26	8	8	0	0	0	0
Maine 2014	438	46	3	5	1	0	0	0
Maine 2019	340	34	5	4	1	1	0	0
Maryland 2009	20	11	10	7	4	5	2	4
Maryland 2014	30	6	7	8	8	4	6	3
Maryland 2019	20	7	3	1	7	3	5	1
Massachusetts 2009	50	15	6	5	3	3	0	1
Massachusetts 2014	50	12	5	11	7	3	0	4
Massachusetts 2019	38	9	6	4	4	1	1	1
Michigan 2009	415	138	62	38	19	4	3	1
Michigan 2014	416	108	48	19	12	7	7	4
Michigan 2019	247	73	38	20	13	11	3	1

Number of invasive plant species per plot							
8	9	10	11	12	13	Number of plots monitored	Percent constancy
2	0	0	0	0	0	53	49.1
2	0	0	0	0	0	61	70.5
0	0	1	0	0	0	44	77.3
2	1	0	0	0	0	58	58.6
1	1	0	0	0	0	21	76.2
0	0	0	0	0	0	15	53.3
1	2	1	1	0	0	154	70.1
1	0	1	0	0	0	175	85.1
0	0	1	1	0	0	123	88.6
0	1	0	0	0	0	253	85.8
3	0	1	0	0	0	277	92.1
2	0	0	0	0	0	115	96.5
0	0	0	0	0	0	56	82.1
0	0	0	0	0	0	104	94.2
0	0	0	0	0	0	76	92.1
0	0	0	0	0	0	73	42.5
0	0	0	0	0	0	116	42.2
0	0	0	0	0	0	72	44.4
0	0	0	0	0	0	367	11.4
0	0	0	0	0	0	493	11.2
0	0	0	0	0	0	385	11.7
1	0	0	0	0	0	64	68.8
3	0	0	0	0	0	75	60.0
2	0	0	0	0	0	49	59.2
0	0	0	0	0	0	83	39.8
0	0	0	0	0	0	92	45.7
0	0	0	0	0	0	64	40.6
0	1	0	0	0	0	681	39.1
1	1	0	0	0	0	623	33.2
0	0	0	0	0	0	406	39.2

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Table 1. (Continued)—Number of invasive plant species per Forest Inventory and Analysis plot by state, 2009, 2014, and 2019

State and inventory year	Number of invasive plant species per plot							
	0	1	2	3	4	5	6	7
Minnesota 2009	595	95	45	13	6	2	0	0
Minnesota 2014	374	209	92	35	11	5	0	0
Minnesota 2019	152	99	67	29	13	4	0	0
Missouri 2009	177	161	35	4	1	1	0	0
Missouri 2014	197	206	61	27	5	2	0	0
Missouri 2019	131	123	50	33	7	3	0	0
Nebraska 2009	24	9	4	1	1	0	0	0
Nebraska 2014	37	13	4	1	1	0	0	0
Nebraska 2019	27	16	5	2	3	0	0	0
New Hampshire 2009	96	9	2	2	0	0	0	0
New Hampshire 2014	125	7	2	3	1	0	1	0
New Hampshire 2019	78	6	4	2	2	0	1	0
New Jersey 2009	23	4	5	2	5	2	2	3
New Jersey 2014	35	5	2	9	2	3	4	3
New Jersey 2019	23	6	4	2	5	3	1	2
New York 2009	191	53	43	46	21	13	10	3
New York 2014	258	79	69	51	33	25	14	7
New York 2019	177	50	55	45	22	20	7	6
North Dakota 2009	8	6	2	1	0	0	0	0
North Dakota 2014	9	9	2	2	0	0	0	0
North Dakota 2019	1	5	8	1	0	0	0	0
Ohio 2009	15	42	38	35	30	20	8	4
Ohio 2014	15	36	50	57	50	36	14	10
Ohio 2019	3	20	30	39	40	25	12	7
Pennsylvania 2009	133	48	49	38	26	11	10	15
Pennsylvania 2014	267	98	69	82	57	44	25	22
Pennsylvania 2019	246	89	81	72	59	50	32	25
Rhode Island 2009	14	12	2	1	1	0	0	0
Rhode Island 2014	11	3	1	4	0	0	0	0
Rhode Island 2019	2	0	1	3	0	0	0	0
South Dakota 2009	30	18	0	0	0	0	0	0
South Dakota 2014	45	14	2	0	0	0	0	0
South Dakota 2019	31	18	1	0	0	65	0	0

Number of invasive plant species per plot							
8	9	10	11	12	13	Number of plots monitored	Percent constancy
0	0	0	0	0	0	756	21.3
0	0	0	0	0	0	726	48.5
0	0	0	0	0	0	364	58.2
0	0	0	0	0	0	379	53.3
0	0	0	0	0	0	498	60.4
0	0	0	0	0	0	347	62.2
0	0	0	0	0	0	39	38.5
0	0	0	0	0	0	56	33.9
0	0	0	0	0	0	53	49.1
0	0	0	0	0	0	109	11.9
0	0	0	0	0	0	139	10.1
0	0	0	0	0	0	93	16.1
1	2	0	0	0	0	49	53.1
2	1	1	0	0	0	67	47.8
3	3	0	0	0	0	52	55.8
3	0	0	0	0	0	383	50.1
1	1	1	0	0	0	539	52.1
2	0	0	0	0	0	384	53.9
0	0	0	0	0	0	17	52.9
0	0	0	0	0	0	22	59.1
0	0	0	0	0	0	15	93.3
3	2	0	0	0	0	197	92.4
3	1	0	0	0	0	272	94.5
1	3	1	0	0	0	181	98.3
2	3	2	0	0	0	337	60.5
12	4	6	2	0	0	688	61.2
17	11	5	0	0	1	688	64.2
0	0	0	0	0	0	30	53.3
0	0	0	0	0	0	19	42.1
0	0	0	0	0	0	6	66.7
0	0	0	0	0	0	48	37.5
0	0	0	0	0	0	61	26.2
0	0	0	0	0	0	115	73.0

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Table 1. (Continued)—Number of invasive plant species per Forest Inventory and Analysis plot by state, 2009, 2014, and 2019

State and inventory year	Number of invasive plant species per plot							
	0	1	2	3	4	5	6	7
Vermont 2009	90	12	4	3	0	0	0	0
Vermont 2014	91	14	5	6	3	1	0	0
Vermont 2019	76	9	3	6	1	1	1	0
West Virginia 2009	59	57	40	38	30	23	7	3
West Virginia 2014	63	52	61	35	44	23	15	9
West Virginia 2019	46	37	35	30	25	15	11	9
Wisconsin 2009	414	207	67	38	11	9	6	3
Wisconsin 2014	468	177	79	47	24	11	3	0
Wisconsin 2019	191	77	42	22	13	2	2	3
Grand total 2009	2,864	1,082	552	366	206	116	50	40
Grand total 2014	3,073	1,264	737	517	344	196	101	73
Grand total 2019	1,910	759	517	412	264	168	92	63
Percentage of plots with IPS 2009	53.9	20.4	10.4	6.9	3.9	2.2	0.9	0.8
Percentage of plots with IPS 2014	48.3	19.9	11.6	8.1	5.4	3.1	1.6	1.1
Percentage of plots with IPS 2019	45.0	17.9	12.2	9.7	6.2	4.0	2.2	1.5
Change in percentage of plots with IPS since 2009	-8.9	-2.5	1.8	2.8	2.3	1.8	1.2	0.7
Change in percentage of plots with IPS since 2014	-3.3	-2.0	0.6	1.6	0.8	0.9	0.6	0.3

Number of invasive plant species per plot							
8	9	10	11	12	13	Number of plots monitored	Percent constancy
0	0	0	0	0	0	109	17.4
0	0	0	0	0	0	120	24.2
0	0	0	0	0	0	97	21.6
0	1	1	0	0	0	59	77.2
4	0	0	0	0	0	306	79.4
2	2	1	0	0	0	213	78.4
0	0	0	0	0	0	755	45.2
2	0	0	0	0	0	811	42.3
0	0	0	0	0	0	352	45.7
15	13	4	1	0	0	5,309	46.1
35	9	10	2	0	0	6,361	51.7
29	19	9	1	0	1	4,244	55.0
0.3	0.2	0.1	0.0	0.0	0.0	--	--
0.6	0.1	0.2	0.0	0.0	0.0	--	--
0.7	0.4	0.2	0.0	0.0	0.0	--	--
0.4	0.2	0.1	0.0	0.0	0.0	--	--
0.1	0.3	0.1	0.0	0.0	0.0	--	--

Table 2.—Rank of monitored invasive plant species found on Forest Inventory and Analysis plots, 2019

Species	Percentage of Phase 2 invasive plots observed	Abundance rank*
Multiflora rose (*Rosa multiflora*)	31.3	1
Garlic mustard (*Alliaria petiolata*)	13.1	2
Nonnative bush honeysuckle (*Lonicera* spp.)	11.4	3
Japanese stiltgrass (***Mi**crostegium vimineum*)	9.5	4
Autumn olive (*Elaeagnus umbellata*)	8.7	5
Japanese honeysuckle (*Lonicera japonica*)	8.0	6
Japanese barberry (*Berberis thunbergii*)	7.9	7
Common buckthorn (*Rhamnus cathartica*)	7.0	8
Reed canarygrass (*Phalaris arundinacea*)	6.9	9
Black locust (*Robinia pseudoacacia*)	6.2	10
Amur honeysuckle (*Lonicera maackii*)	5.8	11
Oriental bittersweet (*Celastrus orbiculatus*)	5.7	12
Canada thistle (*Cirsium arvense*)	4.6	13
Morrow's honeysuckle (*Lonicera morrowii*)	4.5	14
European privet (*Ligustrum vulgare*)	3.8	15
Tree of heaven (*Ailanthus altissima*)	3.0	16
Glossy buckthorn (*Frangula alnus*)	2.4	17
Bull thistle (*Cirsium vulgare*)	2.3	18
Creeping jenny (*Lysimachia nummularia*)	1.7	19
Norway maple (*Acer platanoides*)	1.1	20
Dames rocket (*Hesperis matronalis*)	0.9	21
Siberian elm (*Ulmus pumila*)	0.9	21
Common barberry (*Berberis vulgaris*)	0.8	22
European cranberrybush (*Viburnum opulus*)	0.8	22
Spotted knapweed (*Centaurea stoebe* ***ssp****. micranthos*)	0.8	23
Common reed (*Phragmites australis*)	0.4	24
Tatarian honeysuckle (*Lonicera tatarica*)	0.4	25
Japanese knotweed (*Polygonum cuspidatum*)	0.3	26
Japanese meadowsweet (*Spiraea japonica*)	0.3	27
Russian olive (*Elaeagnus angustifolia*)	0.3	27
English ivy (*Hedera helix*)	0.2	28
Princesstree (*Paulownia tomentosa*)	0.2	29
Leafy spurge (*Euphorbia esula*)	0.2	30
Purple loosestrife (*Lythrum salicaria*)	0.1	31
Giant knotweed (*Polygonum sachalinense*)	0.1	32
Showy fly honeysuckle (*Lonicera xbella*)	0.1	32
Louise's swallow-wort (*Cynanchum louiseae*)	0.0	33
Silktree (*Albizia julibrissin*)	0.0	33
European swallow-wort (*Cynanchum rossicum*)	0.0	34
Saltcedar (*Tamarix ramosissima*)	0.0	34

*Abundance rank can be the same for multiple species if the species were observed on the same number of plots.

Table 3.—Rank of monitored invasive plant species found on Forest Inventory and Analysis plots, 2014

Species	Percentage of Phase 2 invasive plots observed	Abundance rank*
Multiflora rose (*Rosa multiflora*)	28.8	1
Garlic mustard (*Alliaria petiolata*)	9.8	2
Nonnative bush honeysuckle (*Lonicera* spp.)	8.6	3
Japanese honeysuckle (*Lonicera japonica*)	7.5	4
Reed canarygrass (*Phalaris arundinacea*)	7.4	5
Autumn olive (*Elaeagnus umbellata*)	6.7	6
Common buckthorn (*Rhamnus cathartica*)	6.6	7
Japanese stiltgrass (*Microstegium vimineum*)	6.6	7
Black locust (*Robinia pseudoacacia*)	6.4	8
Japanese barberry (*Berberis thunbergii*)	6.0	9
Morrow's honeysuckle (*Lonicera morrowii*)	5.3	10
Amur honeysuckle (*Lonicera maackii*)	4.0	11
Oriental bittersweet (*Celastrus orbiculatus*)	4.0	11
Canada thistle (*Cirsium arvense*)	3.8	12
European privet (*Ligustrum vulgare*)	2.4	13
Glossy buckthorn (*Frangula alnus*)	2.3	14
Tree of heaven (*Ailanthus altissima*)	2.2	15
Bull thistle (*Cirsium vulgare*)	2.1	16
Creeping jenny (*Lysimachia nummularia*)	1.9	17
Spotted knapweed (*Centaurea stoebe* ***ssp****. micranthos*)	0.8	18
Dames rocket (*Hesperis matronalis*)	0.8	19
Norway maple (*Acer platanoides*)	0.8	20
Siberian elm (*Ulmus pumila*)	0.7	21
Tatarian honeysuckle (*Lonicera tatarica*)	0.7	21
Showy fly honeysuckle (*Lonicera xbella*)	0.7	22
Common barberry (*Berberis vulgaris*)	0.6	23
Common reed (*Phragmites australis*)	0.4	24
Japanese knotweed (*Polygonum cuspidatum*)	0.4	24
Russian olive (*Elaeagnus angustifolia*)	0.3	25
Spotted knapweed (*Centaurea stoebe* ***ssp****. micranthos*)	0.2	26
Princesstree (*Paulownia tomentosa*)	0.2	26
Leafy spurge (*Euphorbia esula*)	0.2	27
Japanese meadowsweet (*Spiraea japonica*)	0.2	28
Purple loosestrife (*Lythrum salicaria*)	0.1	29
Giant knotweed (*Polygonum sachalinense*)	0.1	30
English ivy (*Hedera helix*)	0.1	31
Louise's swallow-wort (*Cynanchum louiseae*)	0.0	32
Chinaberrytree (*Melia azedarach*)	0.0	33
Silktree (*Albizia julibrissin*)	0.0	33

*Abundance rank can be the same for multiple species if the species were observed on the same number of plots.

Table 4.—Rank of monitored invasive plant species found on Forest Inventory and Analysis plots, 2009

Species	Percentage of Phase 2 invasive plots observed	Abundance rank*
Multiflora rose (*Rosa multiflora*)	23.6	1
Reed canarygrass (*Phalaris arundinacea*)	7.5	2
Garlic mustard (*Alliaria petiolata*)	7.4	3
Japanese honeysuckle (*Lonicera japonica*)	5.8	4
Common buckthorn (*Rhamnus cathartica*)	5.5	5
Black locust (*Robinia pseudoacacia*)	5.0	6
Japanese stiltgrass (*Microstegium vimineum*)	5.0	7
Autumn olive (*Elaeagnus umbellata*)	4.9	8
Japanese barberry (*Berberis thunbergii*)	4.8	9
Nonnative bush honeysuckle (*Lonicera* spp.)	4.6	10
Morrow's honeysuckle (*Lonicera morrowii*)	3.8	11
Canada thistle (*Cirsium arvense*)	3.3	12
Amur honeysuckle (*Lonicera maackii*)	2.9	13
Bull thistle (*Cirsium vulgare*)	2.7	14
Oriental bittersweet (*Celastrus orbiculatus*)	2.3	15
Glossy buckthorn (*Frangula alnus*)	2.2	16
Tree of heaven (*Ailanthus altissima*)	1.8	17
Tatarian honeysuckle (*Lonicera tatarica*)	1.8	18
European privet (*Ligustrum vulgare*)	1.7	19
Creeping jenny (*Lysimachia nummularia*)	1.1	20
Showy fly honeysuckle (*Lonicera xbella*)	1.1	21
Dames rocket (*Hesperis matronalis*)	0.8	22
Spotted knapweed (*Centaurea stoebe* ***ssp****. micranthos*)	0.8	22
Russian olive (*Elaeagnus angustifolia*)	0.7	23
Norway maple (*Acer platanoides*)	0.7	24
Common barberry (*Berberis vulgaris*)	0.5	25
Siberian elm (*Ulmus pumila*)	0.5	26
Common reed (*Phragmites australis*)	0.3	27
Japanese knotweed (*Polygonum cuspidatum*)	0.3	27
Princesstree (*Paulownia tomentosa*)	0.3	28
European cranberrybush (*Viburnum opulus*)	0.2	29
Purple loosestrife (*Lythrum salicaria*)	0.2	30
Japanese meadowsweet (*Spiraea japonica*)	0.2	31
Leafy spurge (*Euphorbia esula*)	0.2	31
Bohemian knotweed (*Polygonum xbohemicum*)	0.0	32
English ivy (*Hedera helix*)	0.0	32
Saltcedar (*Tamarix ramosissima*)	0.0	32
European swallow-wort (*Cynanchum rossicum*)	0.0	33
Giant knotweed (*Polygonum sachalinense*)	0.0	33
Louise's swallow-wort (*Cynanchum louiseae*)	0.0	33
Silktree (*Albizia julibrissin*)	0.0	33

*Abundance rank can be the same for multiple species if the species were observed on the same number of plots.

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Table 5.—Number and percent of Phase 2 invasive plots each species is observed on by state, 2019

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Number of plots monitored	44	15	123	115	76	72	385	49	64	406	364
Amur honeysuckle (*Lonicera maackii*)	0 (0.0%)	0 (0.0%)	68 (55.3%)	9 (7.8%)	28 (36.8%)	8 (11.1%)	0 (0.0%)	2 (4.1%)	0 (0.0%)	3 (0.7%)	0 (0.0%)
Autumn olive (*Elaeagnus umbellata*)	6 (13.6%)	0 (0.0%)	33 (26.8%)	21 (18.3%)	8 (10.5%)	2 (2.8%)	1 (0.3%)	4 (8.2%)	3 (4.7%)	43 (10.6%)	0 (0.0%)
Black locust (*Robinia pseudoacacia*)	1 (2.3%)	0 (0.0%)	7 (5.7%)	9 (7.8%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	10 (20.4%)	1 (1.6%)	4 (1.0%)	3 (0.8%)
Bull thistle (*Cirsium vulgare*)	0 (0.0%)	0 (0.0%)	2 (1.6%)	3 (2.6%)	3 (3.9%)	3 (4.2%)	7 (1.8%)	0 (0.0%)	0 (0.0%)	10 (2.5%)	30 (8.2%)
Canada thistle (*Cirsium arvense*)	1 (2.3%)	0 (0.0%)	1 (0.8%)	5 (4.3%)	3 (3.9%)	0 (0.0%)	10 (2.6%)	0 (0.0%)	0 (0.0%)	53 (13.1%)	71 (19.5%)
Common barberry (*Berberis vulgaris*)	0 (0.0%)	0 (0.0%)	1 (0.8%)	1 (0.9%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	1 (1.6%)	2 (0.5%)	0 (0.0%)
Common buckthorn (*Rhamnus cathartica*)	4 (9.1%)	0 (0.0%)	11 (8.9%)	6 (5.2%)	6 (7.9%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	7 (10.9%)	18 (4.4%)	69 (19.0%)
Common reed (*Phragmites australis*)	4 (9.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	0 (0.0%)	4 (1.0%)	1 (0.3%)
Creeping jenny (*Lysimachia nummularia*)	0 (0.0%)	0 (0.0%)	3 (2.4%)	12 (10.4%)	2 (2.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.5%)	0 (0.0%)
Dames rocket (*Hesperis matronalis*)	0 (0.0%)	0 (0.0%)	2 (1.6%)	1 (0.9%)	1 (1.3%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
English ivy (*Hedera helix*)	0 (0.0%)	1 (6.7%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (4.1%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
European cranberrybush (*Viburnum opulus*)	0 (0.0%)	0 (0.0%)	4 (3.3%)	0 (0.0%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	16 (3.9%)	11 (3.0%)
European privet (*Ligustrum vulgare*)	1 (2.3%)	2 (13.3%)	0 (0.0%)	9 (7.8%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	0 (0.0%)	3 (0.7%)	0 (0.0%)
European swallow-wort (*Cynanchum rossicum*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Garlic mustard (*Alliaria petiolata*)	8 (18.2%)	0 (0.0%)	34 (27.6%)	40 (34.8%)	23 (30.3%)	13 (18.1%)	0 (0.0%)	15 (30.6%)	1 (1.6%)	14 (3.4%)	4 (1.1%)
Giant knotweed (*Polygonum sachalinense*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Glossy buckthorn (*Frangula alnus*)	1 (2.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (1.0%)	0 (0.0%)	16 (25.0%)	11 (2.7%)	7 (1.9%)
Japanese barberry (*Berberis thunbergii*)	25 (56.8%)	0 (0.0%)	5 (4.1%)	7 (6.1%)	5 (6.6%)	0 (0.0%)	1 (0.3%)	10 (20.4%)	7 (10.9%)	13 (3.2%)	3 (0.8%)
Japanese honeysuckle (*Lonicera japonica*)	3 (6.8%)	7 (46.7%)	40 (32.5%)	41 (35.7%)	0 (0.0%)	2 (2.8%)	0 (0.0%)	17 (34.7%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Japanese knotweed (*Polygonum cuspidatum*)	1 (2.3%)	0 (0.0%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Japanese meadowsweet (*Spiraea japonica*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Japanese stiltgrass (*Microstegium vimineum*)	1 (2.3%)	4 (26.7%)	3 (2.4%)	41 (35.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15 (30.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
347	53	93	52	384	15	181	688	6	50	97	213	352	4,244
25 (7.2%)	1 (1.9%)	0 (0.0%)	2 (3.8%)	7 (1.8%)	0 (0.0%)	25 (13.8%)	45 (6.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (1.9%)	19 (5.4%)	246 (5.8%)
26 (7.5%)	0 (0.0%)	2 (2.2%)	6 (11.5%)	17 (4.4%)	0 (0.0%)	40 (22.1%)	91 (13.2%)	0 (0.0%)	0 (0.0%)	1 (1.0%)	52 (24.4%)	14 (4.0%)	370 (8.7%)
11 (3.2%)	1 (1.9%)	0 (0.0%)	1 (1.9%)	12 (3.1%)	0 (0.0%)	29 (16.0%)	96 (14.0%)	0 (0.0%)	0 (0.0%)	2 (2.1%)	71 (33.3%)	3 (0.9%)	262 (6.2%)
5 (1.4%)	3 (5.7%)	0 (0.0%)	1 (1.9%)	2 (0.5%)	0 (0.0%)	3 (1.7%)	5 (0.7%)	0 (0.0%)	7 (14.0%)	0 (0.0%)	3 (1.4%)	11 (3.1%)	98 (2.3%)
0 (0.0%)	4 (7.5%)	0 (0.0%)	0 (0.0%)	4 (1.0%)	2 (13.3%)	5 (2.8%)	9 (1.3%)	0 (0.0%)	8 (16.0%)	0 (0.0%)	0 (0.0%)	20 (5.7%)	196 (4.6%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.8%)	0 (0.0%)	4 (2.2%)	11 (1.6%)	0 (0.0%)	0 (0.0%)	4 (4.1%)	4 (1.9%)	3 (0.9%)	36 (0.8%)
3 (0.9%)	2 (3.8%)	2 (2.2%)	2 (3.8%)	77 (20.1%)	2 (13.3%)	5 (2.8%)	12 (1.7%)	1 (16.7%)	1 (2.0%)	9 (9.3%)	0 (0.0%)	57 (16.2%)	295 (7.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (3.8%)	3 (0.8%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.9%)	19 (0.4%)
4 (1.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	18 (4.7%)	0 (0.0%)	13 (7.2%)	13 (1.9%)	0 (0.0%)	0 (0.0%)	2 (2.1%)	2 (0.9%)	3 (0.9%)	74 (1.7%)
0 (0.0%)	3 (5.7%)	0 (0.0%)	1 (1.9%)	10 (2.6%)	0 (0.0%)	1 (0.6%)	16 (2.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	38 (0.9%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	1 (0.3%)	0 (0.0%)	1 (0.6%)	2 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.5%)	2 (0.6%)	36 (0.8%)
5 (1.4%)	0 (0.0%)	0 (0.0%)	6 (11.5%)	12 (3.1%)	0 (0.0%)	35 (19.3%)	69 (10.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15 (7.0%)	1 (0.3%)	160 (3.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
17 (4.9%)	1 (1.9%)	0 (0.0%)	11 (21.2%)	64 (16.7%)	1 (6.7%)	63 (34.8%)	188 (27.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	25 (11.7%)	32 (9.1%)	554 (13.1%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.1%)
0 (0.0%)	0 (0.0%)	8 (8.6%)	0 (0.0%)	14 (3.6%)	0 (0.0%)	9 (5.0%)	10 (1.5%)	1 (16.7%)	0 (0.0%)	5 (5.2%)	1 (0.5%)	14 (4.0%)	101 (2.4%)
0 (0.0%)	0 (0.0%)	6 (6.5%)	16 (30.8%)	17 (4.4%)	0 (0.0%)	33 (18.2%)	151 (21.9%)	2 (33.3%)	0 (0.0%)	5 (5.2%)	25 (11.7%)	3 (0.9%)	334 (7.9%)
47 (13.5%)	0 (0.0%)	0 (0.0%)	10 (19.2%)	2 (0.5%)	0 (0.0%)	73 (40.3%)	59 (8.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	37 (17.4%)	0 (0.0%)	339 (8.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (0.9%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	3 (1.4%)	0 (0.0%)	13 (0.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (4.2%)	0 (0.0%)	11 (0.3%)
1 (0.3%)	0 (0.0%)	0 (0.0%)	11 (21.2%)	11 (2.9%)	0 (0.0%)	62 (34.3%)	164 (23.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	91 (42.7%)	0 (0.0%)	404 (9.5%)

continued on next page

Table 5. (Continued)—Number and percent of Phase 2 invasive plots each species is observed on by state, 2019

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Leafy spurge (*Euphorbia esula*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Louise's swallow-wort (*Cynanchum louiseae*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Morrow's honeysuckle (*Lonicera morrowii*)	2 (4.5%)	0 (0.0%)	2 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (4.1%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Multiflora rose (*Rosa multiflora*)	27 (61.4%)	4 (26.7%)	84 (68.3%)	99 (86.1%)	42 (55.3%)	5 (6.9%)	9 (2.3%)	18 (36.7%)	7 (10.9%)	36 (8.9%)	0 (0.0%)
Non-native bush honeysuckle (*Lonicera* spp.)	13 (29.5%)	0 (0.0%)	13 (10.6%)	34 (29.6%)	13 (17.1%)	0 (0.0%)	0 (0.0%)	2 (4.1%)	7 (10.9%)	37 (9.1%)	57 (15.7%)
Norway maple (*Acer platanoides*)	4 (9.1%)	0 (0.0%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	1 (0.3%)
Oriental bittersweet (*Celastrus orbiculatus*)	28 (63.6%)	1 (6.7%)	5 (4.1%)	15 (13.0%)	3 (3.9%)	0 (0.0%)	4 (1.0%)	5 (10.2%)	13 (20.3%)	5 (1.2%)	0 (0.0%)
Princesstree (*Paulownia tomentosa*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Purple loosestrife (*Lythrum salicaria*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Reed canarygrass (*Phalaris arundinacea*)	0 (0.0%)	0 (0.0%)	9 (7.3%)	6 (5.2%)	23 (30.3%)	1 (1.4%)	6 (1.6%)	0 (0.0%)	0 (0.0%)	33 (8.1%)	124 (34.1%)
Russian olive (*Elaeagnus angustifolia*)	5 (11.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)
Saltcedar (*Tamarix ramosissima*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Showy fly honeysuckle (*Lonicera xbella*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Siberian elm (*Ulmus pumila*)	0 (0.0%)	0 (0.0%)	1 (0.8%)	0 (0.0%)	6 (7.9%)	7 (9.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (1.1%)
Silktree (*Albizia julibrissin*)	0 (0.0%)	0 (0.0%)	1 (0.8%)	1 (0.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Spotted knapweed (*Centaurea stoebe* spp. *micranthos*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	26 (6.4%)	0 (0.0%)
Tatarian honeysuckle (*Lonicera tatarica*)	0 (0.0%)	0 (0.0%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (1.6%)
Tree of heaven (*Ailanthus altissima*)	1 (2.3%)	0 (0.0%)	2 (1.6%)	7 (6.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (14.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Grand Total	136	19	334	368	170	43	65	112	67	341	392

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
0 (0.0%)	3 (5.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (20.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (13.5%)	47 (12.2%)	0 (0.0%)	0 (0.0%)	114 (16.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (3.8%)	0 (0.0%)	0 (0.0%)
197 (56.8%)	3 (5.7%)	3 (3.2%)	20 (38.5%)	130 (33.9%)	0 (0.0%)	159 (87.8%)	342 (49.7%)	3 (50.0%)	0 (0.0%)	0 (0.0%)	111 (52.1%)	26 (7.4%)	1,328 (31.3%)
13 (3.7%)	1 (1.9%)	4 (4.3%)	4 (7.7%)	87 (22.7%)	8 (53.3%)	34 (18.8%)	44 (6.4%)	0 (0.0%)	0 (0.0%)	13 (13.4%)	28 (13.1%)	54 (15.3%)	483 (11.4%)
0 (0.0%)	0 (0.0%)	2 (2.2%)	3 (5.8%)	5 (1.3%)	0 (0.0%)	0 (0.0%)	21 (3.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	45 (1.1%)
0 (0.0%)	0 (0.0%)	7 (7.5%)	17 (32.7%)	18 (4.7%)	0 (0.0%)	18 (9.9%)	86 (12.5%)	3 (50.0%)	0 (0.0%)	3 (3.1%)	11 (5.2%)	1 (0.3%)	243 (5.7%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (1.4%)	0 (0.0%)	8 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	0 (0.0%)	5 (0.1%)
7 (2.0%)	11 (20.8%)	0 (0.0%)	0 (0.0%)	9 (2.3%)	5 (33.3%)	9 (5.0%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	45 (12.8%)	291 (6.9%)
0 (0.0%)	3 (5.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (0.3%)
0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.6%)	3 (0.1%)
1 (0.3%)	7 (13.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (13.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (8.0%)	0 (0.0%)	0 (0.0%)	5 (1.4%)	37 (0.9%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	2 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.9%)	34 (0.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	1 (6.7%)	0 (0.0%)	5 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.5%)	0 (0.0%)	15 (0.4%)
3 (0.9%)	0 (0.0%)	0 (0.0%)	2 (3.8%)	5 (1.3%)	0 (0.0%)	0 (0.0%)	45 (6.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	40 (18.8%)	0 (0.0%)	129 (3.0%)
365	44	34	126	583	24	648	1,618	11	20	48	545	322	6,435

Table 6.—Number and percent of Phase 2 invasive plots each species is observed on by state, 2014

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Number of plots monitored	61	21	175	277	104	116	493	75	92	623	726
Amur honeysuckle (*Lonicera maackii*)	0 (0.0%)	2 (9.5%)	69 (39.4%)	15 (5.4%)	10 (9.6%)	5 (4.3%)	0 (0.0%)	4 (5.3%)	0 (0.0%)	5 (0.8%)	1 (0.1%)
Autumn olive (*Elaeagnus umbellata*)	6 (9.8%)	1 (4.8%)	28 (16.0%)	49 (17.7%)	9 (8.7%)	2 (1.7%)	1 (0.2%)	3 (4.0%)	0 (0.0%)	55 (8.8%)	0 (0.0%)
Black locust (*Robinia pseudoacacia*)	1 (1.6%)	2 (9.5%)	11 (6.3%)	35 (12.6%)	7 (6.7%)	3 (2.6%)	0 (0.0%)	16 (21.3%)	1 (1.1%)	7 (1.1%)	1 (0.1%)
Bull thistle (*Cirsium vulgare*)	0 (0.0%)	0 (0.0%)	2 (1.1%)	9 (3.3%)	5 (4.8%)	6 (5.2%)	7 (1.4%)	1 (1.3%)	0 (0.0%)	16 (2.6%)	43 (5.9%)
Canada thistle (*Cirsium arvense*)	0 (0.0%)	0 (0.0%)	1 (0.6%)	8 (2.9%)	1 (1.0%)	0 (0.0%)	5 (1.0%)	0 (0.0%)	0 (0.0%)	65 (10.4%)	92 (12.7%)
Chinaberrytree (*Melia azedarach*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Common barberry (*Berberis vulgaris*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	3 (3.3%)	9 (1.4%)	0 (0.0%)
Common buckthorn (*Rhamnus cathartica*)	2 (3.3%)	1 (4.8%)	11 (6.3%)	2 (0.7%)	8 (7.7%)	0 (0.0%)	1 (0.2%)	0 (0.0%)	16 (17.4%)	17 (2.7%)	101 (13.9%)
Common reed (*Phragmites australis*)	3 (4.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	0 (0.0%)	4 (0.6%)	1 (0.1%)
Creeping jenny (*Lysimachia nummularia*)	0 (0.0%)	0 (0.0%)	3 (1.7%)	18 (6.5%)	2 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.8%)	2 (0.3%)
Dames rocket (*Hesperis matronalis*)	0 (0.0%)	0 (0.0%)	1 (0.6%)	9 (3.2%)	1 (1.0%)	1 (0.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.8%)	0 (0.0%)
English ivy (*Hedera helix*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
European cranberrybush (*Viburnum opulus*)	0 (0.0%)	0 (0.0%)	3 (1.7%)	2 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)
European privet (*Ligustrum vulgare*)	2 (3.3%)	0 (0.0%)	0 (0.0%)	19 (6.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (8.0%)	3 (3.3%)	6 (1.0%)	0 (0.0%)
Garlic mustard (*Alliaria petiolata*)	13 (21.3%)	3 (14.3%)	31 (17.7%)	53 (19.1%)	22 (21.2%)	15 (12.9%)	0 (0.0%)	23 (30.7%)	3 (3.26%)	28 (4.5%)	6 (0.8%)
Giant knotweed (*Polygonum sachalinense*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Glossy buckthorn (*Frangula alnus*)	1 (1.6%)	0 (0.0%)	0 (0.0%)	2 (0.7%)	0 (0.0%)	0 (0.0%)	4 (0.8%)	0 (0.0%)	18 (19.6%)	14 (2.3%)	12 (1.7%)
Japanese barberry (*Berberis thunbergii*)	28 (45.9%)	2 (9.5%)	3 (1.7%)	6 (2.2%)	4 (3.9%)	0 (0.0%)	4 (0.8%)	15 (20.0%)	14 (15.2%)	10 (1.6%)	7 (1.0%)
Japanese honeysuckle (*Lonicera japonica*)	3 (4.9%)	12 (57.1%)	62 (35.4%)	87 (31.4%)	0 (0.0%)	2 (1.7%)	0 (0.0%)	29 (38.7%)	0 (0.0%)	2 (0.3%)	0 (0.0%)
Japanese knotweed (*Polygonum cuspidatum*)	1 (1.6%)	1 (4.8%)	0 (0.0%)	1 (0.4%)	1 (1.0%)	0 (0.0%)	1 (0.2%)	1 (1.3%)	1 (1.1%)	0 (0.0%)	0 (0.0%)
Japanese meadowsweet (*Spiraea japonica*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Japanese stiltgrass (*Microstegium vimineum*)	0 (0.0%)	5 (23.8%)	10 (5.7%)	83 (30.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	21 (28.0%)	3 (3.3%)	0 (0.0%)	0 (0.0%)

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
498	56	139	67	539	22	272	688	19	61	120	306	811	6,361
26 (5.2%)	1 (1.8%)	0 (0.0%)	2 (3.0%)	7 (1.3%)	0 (0.0%)	51 (18.8%)	40 (5.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.6%)	9 (1.1%)	252 (4.0%)
27 (5.4%)	0 (0.0%)	3 (2.2%)	8 (11.9%)	20 (3.7%)	0 (0.0%)	54 (19.9%)	76 (11.0%)	0 (0.0%)	1 (1.6%)	1 (0.8%)	71 (23.2%)	14 (1.7%)	429 (6.7%)
19 (3.8%)	0 (0.0%)	0 (0.0%)	3 (4.5%)	23 (4.3%)	0 (0.0%)	59 (21.7%)	90 (13.1%)	0 (0.0%)	0 (0.0%)	3 (2.5%)	118 (38.6%)	5 (0.6%)	404 (6.4%)
4 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.9%)	1 (4.6%)	2 (0.7%)	6 (0.9%)	0 (0.0%)	8 (13.1%)	1 (0.8%)	2 (0.7%)	18 (2.2%)	136 (2.1%)
0 (0.0%)	3 (5.4%)	0 (0.0%)	3 (4.5%)	5 (0.9%)	4 (18.2%)	9 (3.3%)	11 (1.6%)	0 (0.0%)	5 (8.2%)	0 (0.0%)	1 (0.3%)	29 (3.6%)	242 (3.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.8%)	7 (1.0%)	0 (0.0%)	0 (0.0%)	6 (5.0%)	2 (0.7%)	1 (0.1%)	40 (0.6%)
2 (0.4%)	1 (1.8%)	1 (0.7%)	0 (0.0%)	102 (18.9%)	2 (9.1%)	5 (1.8%)	7 (1.0%)	2 (10.5%)	0 (0.0%)	11 (9.2%)	0 (0.0%)	126 (15.5%)	418 (6.6%)
1 (0.2%)	0 (0.0%)	0 (0.0%)	3 (4.5%)	5 (0.9%)	0 (0.0%)	3 (4.5%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	23 (0.4%)
4 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	34 (6.3%)	0 (0.0%)	17 (6.3%)	14 (2.0%)	0 (0.0%)	0 (0.0%)	3 (2.5%)	5 (1.6%)	15 (1.8%)	122 (1.9%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.5%)	12 (2.2%)	0 (0.0%)	5 (1.8%)	14 (2.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.4%)	52 (0.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.1%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	2 (0.2%)	12 (0.2%)
2 (0.4%)	0 (0.0%)	0 (0.0%)	7 (10.4%)	6 (1.1%)	0 (0.0%)	43 (15.8%)	51 (7.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (3.3%)	0 (0.0%)	155 (2.4%)
16 (3.2%)	2 (3.6%)	0 (0.0%)	14 (20.9%)	71 (13.2%)	0 (0.0%)	79 (29.0%)	161 (23.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	31 (10.1%)	55 (6.8%)	626 (9.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	6 (0.1%)
0 (0.0%)	0 (0.0%)	8 (5.8%)	0 (0.0%)	21 (3.9%)	0 (0.0%)	9 (3.3%)	11 (1.6%0	3 (15.8%)	0 (0.0%)	3 (2.5%)	1 (0.3%)	42 (5.2%)	149 (2.3%)
1 (0.2%)	0 (0.0%)	4 (2.9%)	16 (23.9%)	35 (6.5%)	0 (0.0%)	37 (13.6%)	140 (20.3%)	1 (5.3%)	0 (0.0%)	6 (5.0%)	37 (13.6%)	12 (1.5%)	382 (6.0%)
49 (9.8%)	0 (0.0%)	0 (0.0%)	19 (28.4%)	2 (0.4%)	0 (0.0%)	100 (36.8%)	59 (8.6%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	47 (15.4%)	0 (0.0%)	474 (7.5%)
1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.6%)	0 (0.0%)	0 (0.0%)	5 (0.7%)	2 (10.5%)	0 (0.0%)	1 (0.8%)	3 (1.0%)	1 (0.1%)	23 (0.4%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (2.0%)	0 (0.0%)	10 (0.2%)
2 (0.4%)	0 (0.0%)	0 (0.0%)	13 (19.4%)	6 (1.1%)	0 (0.0%)	42 (15.4%)	120 (17.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	113 (36.9%)	0 (0.0%)	418 (6.6%)

Table 6 continued on next page

Table 6. (Continued)—Number and percent of Phase 2 invasive plots each species is on observed by state, 2014

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Leafy spurge (*Euphorbia esula*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	0 (0.0%)
Louise's swallow-wort (*Cynanchum louiseae*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.1%)	0 (0.0%)	0 (0.0%)
Morrow's honeysuckle (*Lonicera morrowii*)	3 (4.9%)	0 (0.0%)	4 (2.3%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	8 (1.6%)	3 (4.0%)	3 (3.3%)	2 (0.3%)	0 (0.0%)
Multiflora rose (*Rosa multiflora*)	27 (44.3%)	8 (38.1%)	116 (66.3%)	213 (76.9%)	63 (60.6%)	18 (15.5%)	5 (1.0%)	31 (41.3%)	18 (19.6%)	54 (8.7%)	4 (0.6%)
Non-native bush honeysuckle (*Lonicera* spp.)	7 (11.5%)	4 (19.0%)	12 (6.9%)	85 (30.7%)	25 (24.0%)	6 (5.2%)	9 (1.8%)	3 (4.0%)	9 (9.8%)	40 (6.4%)	85 (11.7%)
Norway maple (*Acer platanoides*)	6 (9.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	0 (0.0%)	4 (4.3%)	1 (0.2%)	0 (0.0%)
Oriental bittersweet (*Celastrus orbiculatus*)	28 (45.9%)	3 (14.3%)	4 (2.3%)	17 (6.1%)	1 (1.0%)	0 (0.0%)	1 (0.2%)	9 (12.0%)	21 (22.8%)	7 (1.1%)	0 (0.0%)
Princesstree (*Paulownia tomentosa*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (2.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Purple loosestrife (*Lythrum salicaria*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)
Reed canarygrass (*Phalaris arundinacea*)	1 (1.6%)	1 (4.8%)	15 (8.6%)	23 (8.3%)	43 (41.4%)	2 (1.7%)	22 (4.5%)	0 (0.0%)	3 (3.3%)	31 (5.0%)	165 (22.7%)
Russian olive (*Elaeagnus angustifolia*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	1 (1.3%)	1 (1.1%)	2 (0.3%)	1 (0.1%)
Showy fly honeysuckle (*Lonicera xbella*)	2 (3.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (3.3%)	2 (0.3%)	17 (2.3%)
Siberian elm (*Ulmus pumila*)	0 (0.0%)	0 (0.0%)	2 (1.1%)	1 (0.4%)	5 (4.8%)	10 (8.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.6%)	7 (1.0%)
Silktree (*Albizia julibrissin*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Spotted knapweed (*Centaurea stoebe* spp. *micranthos)*	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	34 (5.5%)	5 (0.7%)
Tatarian honeysuckle (*Lonicera tatarica*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)	3 (2.9%)	0 (0.0%)	1 (0.2%)	0 (0.0%)	1 (1.1%)	2 (0.3%)	14 (1.9%)
Tree-of-heaven (*Ailanthus altissima*)	1 (1.6%)	1 (4.8%)	0 (0.0%)	4 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (8.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Grand Total	**135**	**46**	**388**	**747**	**212**	**71**	**71**	**177**	**126**	**431**	**567**

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
1 (0.2%)	4 (7.1%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	2 (9.1%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (14.9%)	136 (25.2%)	0 (0.0%)	20 (7.4%)	122 (17.7%)	0 (0.0%)	0 (0.0%)	2 (1.7%)	15 (4.9%)	7 (0.9%)	336 (5.3%)
268 (53.8%)	4 (7.1%)	3 (2.2%)	24 (35.8%)	161 (29.9%)	0 (0.0%)	240 (88.2%)	326 (47.4%)	4 (21.1%)	0 (0.0%)	5 (4.2%)	175 (57.2%)	63 (7.8%)	1,830 (28.8%)
5 (1.0%)	1 (1.8%)	3 (2.2%)	0 (0.0%)	54 (10.0%)	4 (18.2%)	15 (5.5%)	27 (3.9%)	0 (0.0%)	1 (1.6%)	9 (7.5%)	29 (9.5%)	115 (14.2%)	548 (8.6%)
0 (0.0%)	0 (0.0%)	1 (0.7%)	3 (4.5%)	10 (1.9%)	0 (0.0%)	1 (0.4%)	21 (3.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	49 (0.8%)
0 (0.0%)	0 (0.0%)	6 (4.3%)	11 (16.4%)	18 (3.3%)	0 (0.0%)	22 (8.1%)	71 (10.3%)	5 (26.3%)	0 (0.0%)	3 (2.5%)	20 (6.5%)	5 (0.6%)	252 (4.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (2.6%)	0 (0.0%)	12 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.7%)	0 (0.0%)	1 (0.4%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (0.1%)
5 (1.0%)	5 (8.9%)	1 (0.7%)	0 (0.0%)	23 (4.3%)	5 (22.7%)	7 (2.6%)	4 (0.6%)	0 (0.0%)	0 (0.0%)	3 (2.5%)	0 (0.0%)	111 (13.7%)	470 (7.4%)
1 (0.2%)	2 (3.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.8%)	2 (0.3%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	17 (0.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.6%)	0 (0.0%)	9 (3.3%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.6%)	43 (0.7%)
1 (0.2%)	5 (8.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (4.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	9 (1.1%)	46 (0.7%)
1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.5%)	1 (0.2%)	0 (0.0%)	2 (0.7%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (1.0%)	54 (0.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.9%)	0 (0.0%)	4 (1.5%)	7 (1.0%)	0 (0.0%)	0 (0.0%)	2 (1.7%)	2 (0.7%)	4 (0.5%)	46 (0.7%)
3 (0.6%)	0 (0.0%)	0 (0.0%)	1 (1.5%)	5 (0.9%)	0 (0.0%)	27 (9.9%)	40 (5.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	52 (17.0%)	1 (0.1%)	142 (2.2%)
439	**28**	**30**	**139**	**787**	**19**	**874**	**1,448**	**17**	**18**	**59**	**755**	**661**	**8,245**

Table 7.—Number and percent of Phase 2 invasive plots each species is observed on by state, 2009

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Number of plots monitored	53	58	154	253	56	73	367	64	83	681	756
Amur honeysuckle (*Lonicera maackii*)	0 (0.0%)	3 (5.2%)	29 (18.8%)	22 (8.7%)	11 (19.6%)	3 (4.1%)	1 (0.3%)	1 (1.6%)	0 (0.0%)	5 (0.7%)	0 (0.0%)
Autumn olive (*Elaeagnus umbellata*)	1 (1.9%)	3 (5.2%)	27 (17.5%)	32 (12.6%)	4 (7.1%)	1 (1.4%)	0 (0.0%)	4 (6.3%)	1 (1.2%)	52 (7.6%)	0 (0.0%)
Black locust (*Robinia pseudoacacia*)	1 (1.9%)	0 (0.0%)	11 (7.1%)	19 (7.5%)	1 (1.8%)	1 (1.4%)	0 (0.0%)	11 (17.2%)	1 (1.2%)	6 (0.9%)	0 (0.0%)
Bohemian knotweed (*Polygonum xbohemicum*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Bull thistle (*Cirsium vulgare*)	0 (0.0%)	0 (0.0%)	1 (0.6%)	6 (2.4%)	4 (7.1%)	2 (2.7%)	8 (2.2%)	0 (0.0%)	0 (0.0%)	32 (4.7%)	22 (2.9%)
Canada thistle (*Cirsium arvense*)	1 (1.9%)	0 (0.0%)	2 (1.3%)	8 (3.2%)	1 (1.8%)	1 (1.4%)	6 (1.6%)	1 (1.6%)	0 (0.0%)	61 (9.0%)	29 (3.8%)
Common barberry (*Berberis vulgaris*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (2.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (3.1%)	2 (2.4%)	6 (0.9%)	0 (0.0%)
Common buckthorn (*Rhamnus cathartica*)	2 (3.8%)	0 (0.0%)	8 (5.2%)	1 (0.4%)	5 (8.9%)	0 (0.0%)	4 (1.1%)	2 (3.1%)	9 (10.8%)	17 (2.5%)	72 (9.5%)
Common reed (*Phragmites australis*)	0 (0.0%)	2 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	6 (0.9%)	0 (0.0%)
Creeping jenny (*Lysimachia nummularia*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (2.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	3 (0.4%)	2 (0.3%)
Dames rocket (*Hesperis matronalis*)	0 (0.0%)	0 (0.0%)	1 (0.6%)	10 (4.0%)	2 (3.6%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	0 (0.0%)
English ivy (*Hedera helix*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
European cranberrybush (*Viburnum opulus*)	0 (0.0%)	0 (0.0%)	2 (1.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	1 (0.1%)
European privet (*Ligustrum vulgare*)	3 (5.7%)	2 (3.4%)	1 (0.6%)	11 (4.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (4.7%)	1 (1.2%)	8 (1.2%)	0 (0.0%)
European swallow-wort (*Cynanchum rossicum*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Garlic mustard (*Alliaria petiolata*)	4 (7.5%)	3 (5.2%)	18 (11.7%)	46 (18.2%)	9 (16.1%)	9 (12.3%)	0 (0.0%)	19 (29.7%)	1 (1.2%)	33 (4.8%)	1 (0.1%)
Giant knotweed (*Polygonum sachalinense*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)
Glossy buckthorn (*Frangula alnus*)	0 (0.0%)	0 (0.0%)	5 (3.2%)	1 (0.4%)	0 (0.0%)	0 (0.0%)	6 (1.6%)	0 (0.0%)	11 (13.3%)	15 (2.2%)	12 (1.6%)
Japanese barberry (*Berberis thunbergii*)	16 (30.2%)	2 (3.4%)	5 (3.2%)	1 (0.4%)	3 (5.4%)	0 (0.0%)	5 (1.4%)	14 (21.9%)	12 (14.5%)	15 (2.2%)	0 (0.0%)
Japanese honeysuckle (*Lonicera japonica*)	1 (1.9%)	29 (50.0%)	32 (20.8%)	65 (25.7%)	0 (0.0%)	4 (5.5%)	0 (0.0%)	24 (37.5%)	0 (0.0%)	4 (0.6%)	0 (0.0%)
Japanese knotweed (*Polygonum cuspidatum*)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	1 (1.6%)	1 (1.2%)	1 (0.1%)	0 (0.0%)
Japanese meadowsweet (*Spiraea japonica*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
379	39	109	49	383	17	197	337	30	48	109	259	755	5,309
10 (2.6%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	5 (1.3%)	0 (0.0%)	25 (12.7%)	21 (6.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.9%)	10 (1.3%)	152 (2.9%)
5 (1.3%)	0 (0.0%)	1 (0.9%)	4 (8.2%)	9 (2.3%)	0 (0.0%)	23 (11.7%)	34 (10.1%)	2 (6.7%)	0 (0.0%)	0 (0.0%)	49 (18.9%)	10 (1.3%)	262 (4.9%)
7 (1.8%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	13 (3.4%)	0 (0.0%)	49 (24.9%)	44 (13.1%)	1 (3.3%)	0 (0.0%)	1 (0.9%)	94 (36.3%)	7 (0.9%)	268 (5.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
7 (1.8%)	2 (5.1%)	0 (0.0%)	0 (0.0%)	10 (2.6%)	2 (11.8%)	3 (1.5%)	9 (2.7%)	0 (0.0%)	7 (14.7%)	1 (0.9%)	6 (2.3%)	21 (2.8%)	143 (2.7%)
2 (0.5%)	4 (10.3%)	0 (0.0%)	0 (0.0%)	7 (1.8%)	4 (23.5%)	12 (6.1%)	1 (0.3%)	0 (0.0%)	7 (14.6%)	0 (0.0%)	4 (1.5%)	24 (3.2%)	175 (3.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	1 (0.5%)	3 (0.9%)	0 (0.0%)	0 (0.0%)	5 (4.6%)	3 (1.2%)	0 (0.0%)	29 (0.5%)
2 (0.5%)	1 (2.6%)	2 (1.8%)	1 (2.0%)	62 (16.2%)	1 (5.9%)	3 (1.5%)	3 (0.9%)	0 (0.0%)	1 (2.1%)	3 (2.8%)	1 (0.4%)	90 (11.9%)	290 (5.5%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	4 (1.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	15 (0.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	22 (5.7%)	0 (0.0%)	12 (6.1%)	3 (0.9%)	0 (0.0%)	0 (0.0%)	2 (1.8%)	3 (1.2%)	5 (0.7%)	43 (1.1%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12 (3.1%)	0 (0.0%)	2 (1.0%)	5 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)	7 (0.9%)	43 (0.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
0 (0.0%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (1.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.5%)	12 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (6.1%)	9 (2.3%)	0 (0.0%)	31 (15.7%)	14 (4.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (2.3%)	0 (0.0%)	92 (1.7%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
2 (0.5%)	1 (2.6%)	0 (0.0%)	10 (20.4%)	49 (12.8%)	0 (0.0%)	54 (27.4%)	76 (22.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	21 (8.1%)	39 (5.2%)	395 (7.4%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
0 (0.0%)	0 (0.0%)	4 (3.7%)	1 (2.0%)	14 (3.7%)	0 (0.0%)	4 (2.0%)	3 (0.9%)	4 (13.3%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	34 (4.5%)	115 (2.2%)
0 (0.0%)	0 (0.0%)	3 (2.8%)	11 (22.4%)	25 (6.5%)	0 (0.0%)	23 (11.7%)	75 (22.3%)	2 (6.7%)	0 (0.0%)	4 (3.7%)	24 (9.3%)	15 (2.0%)	255 (4.8%)
12 (3.2%)	0 (0.0%)	0 (0.0%)	19 (38.8%)	0 (0.0%)	0 (0.0%)	58 (29.4%)	26 (7.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	33 (12.7%)	2 (0.3%)	309 (5.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.3%)	0 (0.0%)	1 (0.5%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (1.2%)	0 (0.0%)	15 (0.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (2.7%)	0 (0.0%)	10 (0.2%)

Table 7 continued on next page

Table 7. (Continued)—Number and percent of Phase 2 invasive plots each species is observed by state, 2009

State	CT	DE	IL	IN	IA	KS	ME	MD	MA	MI	MN
Japanese stiltgrass (*Microstegium vimineum*)	1 (1.9%)	6 (10.3%)	19 (12.3%)	51 (20.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	14 (21.9%)	1 (1.2%)	0 (0.0%)	0 (0.0%)
Leafy spurge (*Euphorbia esula*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	1 (0.1%)
Louise's swallow-wort (*Cynanchum louiseae*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.2%)	0 (0.0%)	0 (0.0%)
Morrow's honeysuckle (*Lonicera morrowii*)	4 (7.5%)	0 (0.0%)	5 (3.2%)	0 (0.0%)	4 (7.1%)	0 (0.0%)	6 (1.6%)	2 (3.1%)	1 (1.2%)	3 (0.4%)	11 (1.5%)
Multiflora rose (*Rosa multiflora*)	16 (30.2%)	12 (20.7%)	72 (46.8%)	173 (68.4%)	29 (51.8%)	13 (17.8%)	4 (1.1%)	23 (35.9%)	10 (12.0%)	72 (10.6%)	0 (0.0%)
Non-native bush honeysuckle (*Lonicera* spp.)	0 (0.0%)	4 (6.9%)	5 (3.2%)	44 (17.4%)	3 (5.4%)	0 (0.0%)	8 (2.2%)	1 (1.6%)	6 (7.2%)	21 (3.1%)	11 (1.5%)
Norway maple (*Acer platanoides*)	5 (9.4%)	2 (3.4%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	2 (3.1%)	3 (3.6%)	1 (0.1%)	0 (0.0%)
Oriental bittersweet (*Celastrus orbiculatus*)	9 (17.0%)	3 (5.2%)	2 (1.3%)	9 (3.6%)	1 (1.8%)	1 (1.4%)	5 (1.4%)	5 (7.8%)	13 (15.7%)	5 (0.7%)	0 (0.0%)
Princesstree (*Paulownia tomentosa*)	0 (0.0%)	1 (1.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Purple loosestrife (*Lythrum salicaria*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	3 (0.4%)
Reed canarygrass (*Phalaris arundinacea*)	0 (0.0%)	0 (0.0%)	12 (7.8%)	19 (7.5%)	21 (37.5%)	2 (2.7%)	10 (2.7%)	0 (0.0%)	0 (0.0%)	69 (10.1%)	67 (8.9%)
Russian olive (*Elaeagnus angustifolia*)	1 (1.9%0	0 (0.0%)	1 (0.6%)	2 (0.8%)	0 (0.0%)	2 (2.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (1.0%)	0 (0.0%)
Saltcedar (*Tamarix ramosissima*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Showy fly honeysuckle (*Lonicera xbella*)	1 (1.9%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	2 (3.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (2.4%)	8 (1.2%)	7 (0.9%)
Siberian elm (*Ulmus pumila*)	0 (0.0%)	0 (0.0%)	3 (1.9%)	0 (0.0%)	3 (5.4%)	3 (4.1%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	3 (0.4%)	1 (0.1%)
Silktree (*Albizia julibrissin*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Spotted knapweed (*Centaurea stoebe* spp. *micranthos*)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)	1 (1.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	23 (3.4%)	1 (0.1%)
Tatarian honeysuckle (*Lonicera tatarica*)	0 (0.0%)	1 (1.7%)	10 (6.5%)	10 (4.0%)	1 (1.8%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	0 (0.0%)	21 (3.1%)	17 (2.2%)
Tree-of-heaven (*Ailanthus altissima*)	0 (0.0%)	3 (5.2%)	2 (1.3%)	4 (1.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (7.8%)	0 (0.0%)	2 (0.3%)	0 (0.0%)
Grand Total	**67**	**76**	**275**	**547**	**105**	**44**	**66**	**141**	**76**	**506**	**258**

MO	NE	NH	NJ	NY	ND	OH	PA	RI	SD	VT	WV	WI	Total
7 (1.8%)	0 (0.0%)	0 (0.0%)	12 (24.5%)	6 (1.6%)	0 (0.0%)	23 (11.7%)	51 (15.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	75 (29.0%)	0 (0.0%)	266 (5.0%)
1 (0.3%)	1 (2.6%)	0 (0.0%)	1 (2.0%)	0 (0.0%)	2 (11.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	2 (0.8%)	0 (0.0%)	10 (0.2%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
5 (1.3%)	0 (0.0%)	0 (0.0%)	5 (10.2%)	77 (20.1%)	0 (0.0%)	6 (3.0%)	44 (13.1%)	1 (3.3%)	0 (0.0%)	1 (0.9%)	17 (6.6%)	12 (1.6%)	204 (3.8%)
179 (47.2%)	2 (5.1%)	2 (1.8%)	23 (46.9%)	108 (28.2%)	0 (0.0%)	164 (83.2%)	154 (45.7%)	6 (20.0%)	0 (0.0%)	4 (3.7%)	137 (52.9%)	51 (6.8%)	1,254 (23.6%)
1 (0.3%)	0 (0.0%)	3 (2.8%)	2 (4.1%)	30 (7.8%)	1 (5.9%)	4 (2.0%)	15 (4.5%)	0 (0.0%)	0 (0.0%)	7 (6.4%)	15 (5.8%)	61 (8.1%)	242 (4.6%)
0 (0.0%)	0 (0.0%)	1 (0.9%)	3 (6.1%)	10 (2.6%)	0 (0.0%)	2 (1.0%)	4 (1.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	37 (0.7%)
1 (0.3%)	0 (0.0%)	2 (1.8%)	7 (14.3%)	4 (1.0%)	0 (0.0%)	11 (5.6%)	23 (6.8%)	7 (23.3%)	0 (0.0%)	0 (0.0%)	6 (2.3%)	6 (0.8%)	120 (2.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (4.2%)	0 (0.0%)	14 (0.3%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.3%)	0 (0.0%)	1 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (0.2%)
3 (0.8%)	4 (10.3%)	0 (0.0%)	1 (2.0%)	22 (5.7%)	1 (5.9%)	3 (1.5%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (1.2%)	157 (20.8%)	396 (7.5%)
3 (0.8%)	2 (5.1%)	0 (0.0%)	1 (2.0%)	0 (0.0%)	1 (5.9%)	7 (3.6%)	7 (2.1%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0 (0.0%)	3 (0.4%)	38 (0.7%)
0 (0.0%)	1 (2.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.5%)	0 (0.0%)	10 (5.1%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	24 (3.2%)	58 (1.1%)
0 (0.0%)	6 (15.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0 (0.0%)	2 (0.3%)	24 (0.5%)
1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (1.0%)	0 (0.0%)	2 (1.0%)	5 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (0.8%)	43 (0.8%)
0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	11 (2.9%)	1 (5.9%)	3 (1.5%)	10 (3.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (0.9%)	94 (1.8%)
4 (1.1%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	3 (0.8%)	0 (0.0%)	21 (10.7%)	8 (2.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	42 (16.2%)	1 (0.1%)	96 (1.8%)
252	**24**	**19**	**109**	**531**	**13**	**561**	**647**	**23**	**18**	**29**	**568**	**601**	**5,556**

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Appendix

Conversion factors for units of measure

Temperature
(9/5 °C) + 32 converts °C to °F
5/9 (°F – 32) converts °F to °C

Length
Multiply by .621 to convert km to mi
Multiply by 1.609 to convert mi to km
Multiply by .394 to convert cm to in
Multiply by 2.54 to convert in to cm

Area
Multiply by 2.47 to convert ha to acres
Multiply by .405 to convert acres to ha

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