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The new flora of northeastern USA: quantifying introduced plant species occupancy in forest ecosystems

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Abstract Introduced plant species have significant negative impacts in many ecosystems and are found in many forests around the world. Some factors linked to the distribution of introduced species include fragmentation and disturbance, native species richness, and climatic and physical conditions of the landscape. However, there are few data sources that enable the assessment of introduced species occupancy in native plant communities over broad regions. Vegetation data from 1,302 forest inventory plots across 24 states in northeastern and mid-western USA were used to examine and compare the distribution of introduced species in relation to forest fragmentation across ecological provinces and forest types, and to examine correlations between native and introduced species richness. There were 305 introduced species recorded, and 66 % of all forested plots had at least one introduced species. Forest edge plots had higher constancy and occupancy of introduced species than intact forest plots, but the differences varied significantly among ecological provinces and, to a lesser degree, forest types. Weak but significant positive correlations between native and introduced species richness were observed most often in intact forests. *Rosa multiflora* was the most common introduced species recorded across the region, but *Hieracium aurantiacum* and *Epipactus helleborine* were dominant in some ecological provinces. Identifying regions and forest types with high and low constancies and occupation by introduced species can help target forest stands where management actions will be the most effective. Identifying seemingly benign introduced species that are more prevalent than realized will help focus attention on newly emerging invasives.

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Abbreviations

FIA Forest Inventory and Analysis
VEG Vegetation Indicator
NRS Northern Research Station
r Pearson correlation coefficient

Introduction

Many plant species have been introduced to the USA by humans since European settlement, often deliberately and sometimes inadvertently (Mack 2003;

Reichard and White 2001). Pimentel et al. (2005) predicted that some 50,000 foreign species grow in the USA. Some have successfully escaped cultivation and become invasive, spreading and establishing new populations at distance from original populations. Not every plant that arrives on the scene becomes established, and not every established plant becomes a problem invasive. However, while many introduced plants do not exhibit invasive qualities for long periods after introduction, some reach a point of naturalization when they become invasive where they had previously been benign (Crooks 2005; Mack 2003). Once established, invasive plants can threaten the sustainability of native forest composition, structure, function, and resource productivity (Pimentel et al. 2005; Webster et al. 2006).

A number of factors can influence the pace and dynamics of plant invasions. Fragmentation is the process of site disturbance where intact natural plant communities are broken into smaller areas by human-influenced activities (e.g., roads, urban development, agriculture, or parcelization of ownership). Fragmentation alters ecosystem functions and increases the amount of edge in remnant forest patches. Conditions on forest edges are often distinct from interior portions of forests and are often conducive to the establishment of introduced species. It is well established that introduced species are more common and abundant on forest edges than in the interior of undisturbed forests (Brothers and Spingarn 1992; Kuhman et al. 2010; Meekins and McCarthy 2001; Moser et al. 2009; Schulte et al. 2011; Schulz et al. 2012; Vilà and Ibàñez 2011). However, the generality of edge effects across different regions of the country or vegetation types, in relation to numbers or dominance of introduced species, is not clear. Both historical and contemporary land uses in surrounding areas can influence the distribution of introduced species (DeGasperis and Motzkin 2007; Kuhman et al. 2010). Stohlgren et al. (1999, 2005) linked the number of introduced species to native species richness, suggesting that native species richness indicates higher resource availability which predisposes sites to invasion by introduced species. Others have shown that absolute or temporal availability of resources is important; some invasive species are known to thrive on higher productivity sites (Richardson and Pyšek 2006), spread readily when seeds are transported by flood waters (Warren et al. 2011), or take advantage of gaps in otherwise closed forest canopies (Knapp and Canham 2000). In Europe, both man-made and natural habitats subject to frequent disturbance were found to harbor more alien species (Chytrý et al. 2008). Understanding the influences and trends of introduced species distribution at both regional and local scales can assist land managers with limited resources minimize the local spread of non-native plants, and can help identify relatively pristine communities where early detection and rapid response to invasions are more likely to be successful (Pluess et al. 2012).

Many federal, state, and local natural resource agencies in the USA conduct targeted surveys of selected introduced species that have been identified as being invasive (NAWMA 2002). Results from these are available through web sites such as University of Georgia's Early Detection and Distribution Mapping System (http://www.eddmaps.org/about/). Similar efforts in Europe are available on-line via DAISIE European Invasive Alien Species Gateway (http://www.europe-aliens.org). However, few surveys can account for the full suite of introduced species regardless of invasive status and their association with native plant communities (Gray 2009). The U.S. Forest Service Forest Inventory and Analysis (FIA) Program collects data and reports vital statistics on the condition of the nation's forests (Bechtold and Patterson 2005, Woodall et al. 2011). The Forest Health Vegetation Indicator (VEG) species data include a census of all vascular plants on a subset of the FIA plots and are appropriate for regional- or national-scale reporting (Gray 2009; Heinz Center 2006; Schulz et al. 2009). Unlike opportunistic surveys, the probabilistic sample ensures that statistics on native and introduced species prevalence and abundance are applicable to the entire population of forested lands and any defined subset with an adequate sample size. VEG data have been collected discontinuously across the country since 2001; the Northern Research Station's (NRS) FIA program has collected VEG data more consistently across broader areas than other FIA regions. The NRS FIA program collects forest inventory data throughout a 24-state region in northeastern USA (Fig. 1). As of 2008, VEG data had been collected on 1,302 forest health plots by the NRS. These VEG data can be used to assess the

Fig. 1 Area of inventory with ecological provinces; see Table 1 for full ecological province names

distribution and occupancy of introduced plants in forests across the region, reported as constancy (percentage of plots where recorded), relative richness, and relative cover of introduced species (Gray 2009; Schulz et al. 2012), as suggested by Noss (1999) and anticipated by the Heinz Center (2006). These data can also be used to assess the relationship between native and introduced species richness. We use the term "introduced" in the same way Richardson et al. (2000) use the term "alien": to encompass all non-native species regardless of invasiveness or legal status.

It is not clear a priori whether regional patterns of introduced plant constancy and occupancy in forests are more strongly associated with climatic and physiographic differences or with differences in the composition of overstory trees. Partitioning the Earth into ecological regions (e.g., Kuchler 1969; Omernik 1987) provides a useful framework for evaluating the ecosystem dynamics observed over large regions by distinguishing areas with similar climate, physiographic, and vegetation features (Pregitzer et al. 2001; Zenner et al. 2010). For this analysis, the hierarchical design introduced by Bailey (1995) and refined by Cleland et al. (2005) was useful for distinguishing populations of forested plots at regional scales. Ecological provinces are used to distinguish broad climatic and physiographic zones (Bailey 1995) and are nested within divisions. Provinces are named to reflect the vegetation macrofeatures within each of the larger Divisions, which are designated by annual cycles of precipitation and temperature.

In addition to ecological regions, characterizing the forest vegetation types where introduced species occur can be helpful for forest managers. Forest vegetation types vary considerably not just in overstory tree composition, but also in stand structure and successional dynamics (Marchand and Houle 2006) which, in turn, influences their susceptibility to invasion by introduced species (Huebner and Tobin 2006; Hutchinson and Vankat 1997). A comparison of introduced species occupancy by forest type would be useful for prioritizing forest types to target for management actions. FIA crews assign areas on plots to forest types based on live tree species stocking, which are generally recognizable to forest managers.

The objectives of this paper are to (1) report the distribution and occupancy of introduced plant species in the forests of northeastern USA, (2) compare introduced plant occupancy between intact forests and forest edges across ecological provinces and forest types, and (3) explore the correlation between native and introduced species richness.

Methods

The national enhanced FIA program was composed of three phases and used standard techniques to assess and measure the forests of the USA (Bechtold and Patterson 2005). Phase one entailed the use of regional imagery to identify potentially forested locations for field measurement and to reduce the variance of estimates through post-stratification of plot data. Phase two (P2) plots, with a density of one plot per 2,428 ha, were visited on the ground, and detailed tree and forest stand data, along with topographic site information, were collected. Phase three (P3) plots were a subset of 1/16th of all phase two plots, where additional variables related to forest health were collected (one plot per 38,851 ha). Data were collected from June to August (with several plots in the more southern extent collected through mid-September) by field crews trained to collect P3 VEG.

Data were collected from 2001 to 2008 by the Northern Research Station's FIA Program on lands determined to be "forest": >0.4 ha in size, with at least 10 % cover of tree species, or that recently met the criteria and not currently managed for non-forest land uses. The 1,302 P3 plots where the VEG data were collected were used in this analysis. Data are available to the public on-line at http://apps.fs.fed.us/fiadb-downloads/datamart.html. These data are registered in the Global Index of Vegetation-Plot database (Dengler et al. 2011) as NA-US-007 (FIADB Vegetation Diversity and Structure Indicator (VEG)), and data elements are defined in Woodall et al. (2010).

On plots where the VEG data were collected, all vascular plants rooted in or hanging over the four 7.32-m-radius subplots were identified (Fig. 2). Plant identifications were recorded using the nationally

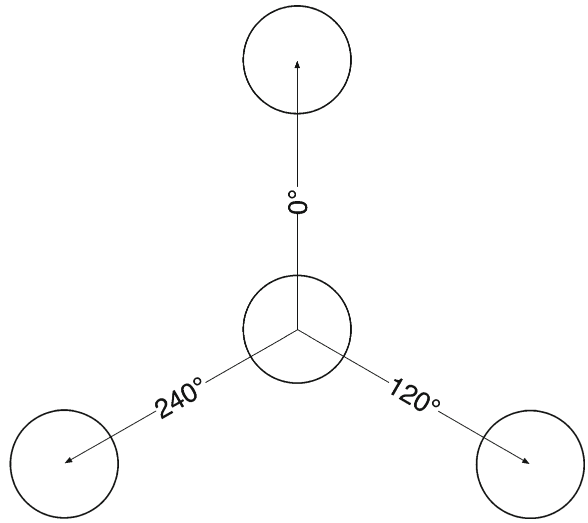

Fig. 2 Plot cluster of four circular subplots (radius of 7.3 m); three surrounding a central subplot with centers 36.6 m apart at azimuths of 0°, 120°, and 240°

standardized PLANTS database taxonomy (USDA NRCS 2000). For each species on the subplot, total percent canopy cover was estimated and recorded. Data quality for VEG has been assessed (Gartner and Schulz 2009); agreement of species identification was above 70 % for all but the smallest cover classes assessed (1 % or less subplot canopy cover), comparable to other assessments of species agreements in vegetation surveys (Gray and Azuma 2005; Scott and Hallam 2002). Unknown species were collected near the plot and identified later by an FIA vegetation specialist or submitted to a qualified herbarium (USDA 2007). Introduced species were designated using the NRCS PLANTS database (USDA NRCS 2000), with origin status of "introduced," "probably introduced," and "cultivated" and refined with local knowledge. Some plants observed on VEG plots were never identified to species due to their phenological stage at the time of plot visits. We assumed that the proportion of introduced species among the unidentified plants is similar to their proportion of all plants identified to species. The analyses of constancy, occupancy, and correlation were limited to those plants identified to species.

Forest types were assigned based on tree measurements, as part of condition classification. The systematic-random sample design of the FIA program results in some plots straddling multiple vegetation conditions defined by significant differences in land use, forest type, or stand size class, including some plots with forest and non-forest lands (Bechtold and Patterson 2005). Each plot was designated to one of three levels of fragmentation based on the number and types of condition classes assigned. If the plot was 100 % forest and was determined to be a single condition, it was designated as an "intact" stand. Plots that were 100 % forest but had more than one condition assigned were designated as "multiple condition." Plots that were less than 100 % forest were designated as "forest edge"; although only forested portions of these plots were measured, their proximity to non-forest land classes signifies their status as forest edge and potential exposure to introduced plant species that may flourish on non-forested lands. This method served as a coarse filter for fragmentation; some "intact" forest plots could be located close to forest edges or within small parcels of remnant forests, and some "edge" plots could be adjacent to naturally occurring non-forest plant communities. Further examination of plot locations with other variables collected in the inventory or supplementary data sources such as the National Land Cover Data sets (NLCD; Homer et al. 2004) could be used to further explore the influence of edge effects on the distribution of introduced plant species.

The numbers of native and introduced species per fully forested *subplot* were compiled for all plots regardless of level of fragmentation. Constancy, the presence of at least one introduced species, and measures of occupancy—relative richness and relative cover of introduced species—were computed at the plot level at the site. The relative richness is simply the number of introduced species divided by the total number of all species identified to species per plot. The relative cover of introduced species is the sum of subplot cover of all introduced species divided by the sum of subplot cover of all species.

To assess the level of occupancy of introduced species in forests *where they occur* for each category of interest (ecological provinces and forest types), only the plots where introduced species were recorded were included in the compilation of the relative richness and relative cover of introduced species. This approach is used to provide the reader with more information. Because constancy of introduced species is reported for each category, the reader knows that on (100 minus the constancy) percentage of the plots, relative richness and relative cover of introduced species are zero. If compilation of category means included zero values, the reader would not be able to assess the differences of occupancy on those plots where introduced species occurred.

Estimates and variances for each category were computed using the ratio of means methods described in Schulz et al. (2009). The effects of levels of fragmentation, ecological provinces, and forest type on introduced species occupancy were analyzed with a one-way ANOVA, and significant differences among means were determined for significant effects with Tukey's studentized range test (SAS Institute 2011). The Student's t test for two independent samples was used to test for significant differences between intact and forest edge conditions within ecological provinces or forest types. Results were considered significant if the probability of a type I error was less than 0.05. Results were compiled for different subsets of plots depending on the analyses: (1) the entire population, (2) by level of fragmentation over the entire population, (3) for intact and edge plots over ecological provinces with at least 20 intact plots, and (4) for intact and edge plots over forest types with at least 20 intact plots and 10 edge plots.

To assess the relationship between native and introduced species richness, Pearson correlation coefficients between the number of native and introduced species per subplot were calculated. Only subplots that were 100 % forested were used so that the sampled area would be consistent. A complete list of the introduced species recorded with constancies by ecological provinces was compiled. Constancies of the most commonly encountered species were compiled by level of fragmentation, as were the most common species recorded in selected forest types.

Results

Over the 1,302 plots, 55.3 % were intact, 9.2 % were multiple forest types, and 35.5 % were forest edge plots. The inventory area covered 14 ecological provinces in all or in part (Fig. 1). Nine provinces had at least 20 intact and 10 edge plots (Table 1), with the Laurentian province best represented. The proportion of intact, multiple, and forest edge plots (Table 1) varied by ecological province. Because of the disproportionally small number of multiple condition plots, only intact or forest edge plots were compared across

Table 1 Number of plots in each level of fragmentation by ecological province; underlined portions of each province name are the labels used in text, figures, and other tables

Ecological region		Level of fragmentation		
		Intact	Multiple	Forest edge
Code	Name			
210	Warm Continental Division			
211	Northeastern Mixed Forest	80	12	34
M211	Adirondack-New England Mixed Forest–Coniferous Forest–Alpine Meadow	65	12	12
212	Laurentian Mixed Forest	207	40	76
220	Hot Continental Division			
221	Eastern Broadleaf Forest	85	18	65
M221	Central Appalachian Broadleaf Forest–Coniferous Forest–Meadow	50	3	18
222	Midwest Broadleaf Forest	49	11	81
223	Central Interior Broadleaf Forest	112	14	65
230	Subtropical Division			
231	Southeastern Mixed Forest	5	0	0
232	Outer Coastal Plain Mixed Forest	28	4	33
250	Prairie Division			
251	Temperate Prairie Parkland	24	4	55
255	Subtropical Prairie Parkland-	3	1	0
330	Temperate Steppe Division			
331	Great Plains–Palouse Dry Steppe	3	0	11
332	Great Plains Steppe	5	1	9
M334	Black Hills Coniferous Forest	4	0	3

Table 2 Number of intact and forest edge plots per selected forest type and ecological province; underlined portions of each forest type name are the labels used in text, figures, and other tables

Forest type		Level of fragmentation	Ecological provinces										
Code	Name		211	M211	212	221	M221	222	223	232	251	Other[a]	Total
503	White oak/red oak/hickory	Intact	6		3	21	7	13	67	1	7	1	126
		Edge	1		3	13	1	16	24	3	10		71
504	White oak	Intact					2	1	19		1		23
		Edge	1			1	1	2	5	3	2		15
520	Mixed upland hardwoods	Intact			5			2	3	4	4	2	20
		Edge				5		9	4	4	5		27
801	Sugar maple/beech/yellow birch	Intact	28	32	30	10	9	7	1		1		118
		Edge	7	4	5	2	3	5					26
805	Hard maple/ basswood	Intact	5	1	12	3	2	3	1				27
		Edge	3		6	4		5	2		1		21
901	Aspen	Intact	1	3	47	1		1					53
		Edge	2		16	1		5					24

[a] Ecological provinces with small sample sizes include 231,255, 332, 331, and M334

ecological provinces and forest types. A total of 63 forest types were recorded on the plots where Vegetation Indicator data were collected, but only six had at least ten intact and ten forest edge plots (Table 2). These were all hardwood types and varied in distribution over the region. White oak/red oak/hickory ("oak/hickory") and sugar maple/beech/yellow birch ("sugar maple") were the most commonly sampled forest types.

A total of 305 introduced species were identified, and two native species with invasive populations were included in compilation of constancy and occupancy measures. The two native species—*Phalaris arundinacea* (reed canary grass) and *Phragmites australis* (common reed)—were included because of their highly invasive nature and likelihood that invasive populations are genetically distinct from native populations (Olson and Cholewa 2009). A complete list of all introduced species with constancy by ecological province is included in Appendix 1, in order of overall descending constancy.

Constancy of introduced species

Over the entire population of 1,302 plots, 66.4 % had at least one introduced species present. The presence of introduced species increased with level of fragmentation. Of the 720 intact plots, 421 (58.5 %) had at least one introduced species, while 81 (67.5 %) of the 120 multiple condition plots and 359 (77.8 %) of the 462 forest edge plots had introduced species.

Constancy of introduced species was lowest in the montane and northern ecological provinces (Appalachian, Adirondack, Northeastern, and Laurentian; Fig. 3), where forest edge plots usually had higher constancy than intact plots. Across ecological provinces, the difference in constancy between intact and forest edge plots decreased as intact constancy increased: The Adirondack province had the lowest constancy on intact plots and the greatest difference between intact and edge plots, while constancy on intact plots in the Temperate Prairie province was slightly higher than on edge plots. The same general trend of differences in constancy between intact and edge was observed across forest types (Fig. 4). The sugar maple forest type showed the greatest difference between intact and forest edge constancies,

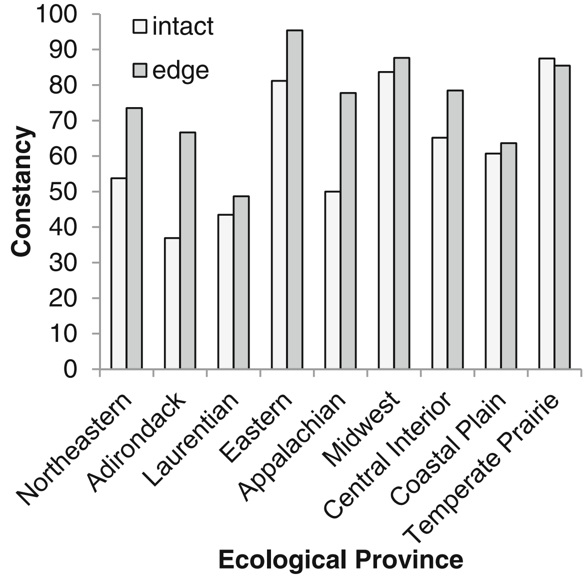

Fig. 3 Constancy of introduced species on intact and forest edge plots over nine ecological provinces

while the mixed upland type showed the least. For some ecological provinces (Eastern, Midwest, and Temperate Prairie) and forest types (mixed upland and hard maple), constancies for both intact and forest edge plots exceed the mean constancy for all edge plots (77 %).

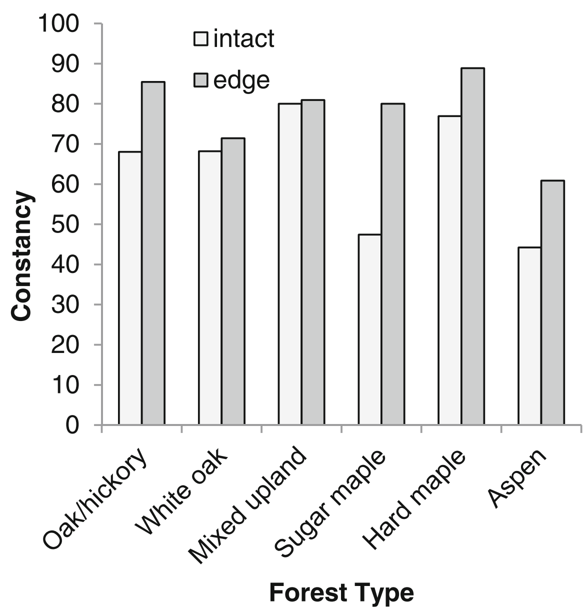

Fig. 4 Constancy of introduced species on intact and forest edge plots on selected forest types

Relative richness and cover of introduced species

Level of fragmentation and ecological province both had significant effects on both relative richness and relative cover of introduced species (Table 3). Forest type was somewhat influential, but with less confidence. Occupancy of introduced species was lowest in intact stands and greatest on forest edge plots (Fig. 5). Separation of means indicated that relative richness was significantly different at each level of fragmentation, while relative cover was similar between intact and multiple condition plots but significantly different from edge plots.

Introduced species occupancy varied significantly among ecological provinces on intact and edge plots (Table 3). On intact plots, relative richness in the Eastern and Midwest provinces was significantly greater than in the Northeastern, Adirondack, Laurentian, and Central Interior provinces (Fig. 6). On forest edge plots, relative richness in the Eastern province was significantly greater than the Laurentian, Central Interior, Coastal Plain, and Temperate Prairie provinces. Relative cover also varied significantly on intact and forest edge plots (Fig. 7). On intact plots, relative cover of introduced species was greatest in the Midwest province, significantly greater than for all but Temperate Prairie and Eastern provinces. On edge plots, it was greatest in the Eastern province, significantly greater than from Laurentian, Central Interior, and Adirondack provinces.

The differences in occupancy of introduced species between intact and forest edge plots varied across the nine ecological provinces. Significant differences in relative richness between intact and edge forests were observed in the Northeastern, Laurentian, Eastern, Central Interior, and Temperate Prairie provinces (Fig. 6). Relative cover was also greater on forest edge plots than intact plots within the same ecological provinces, significantly so for the Northeastern, Central Interior, and Eastern provinces (Fig. 7). Although some significant differences in introduced species occupancy among the adequately sampled forest types were found (Table 3), the conservative separation of means analysis did not identify significant differences in relative richness or cover among individual forest types for either intact or forest edge plots. Within forest types, however, there were significant differences in relative richness between intact and forest edge plots for the oak/hickory, white oak, mixed upland, and sugar maple forest types (Fig. 8). The difference in relative cover of introduced species between intact and edge plots was significant only for the mixed upland forest type (Fig. 9).

Comparisons of native and introduced species richness

Native species richness on fully forested plots varied among ecoregions and forest types, as did the relationship between native and introduced species richness (Table 4). Over the entire population, level of fragmentation did not affect native species richness, but it did affect the mean number of introduced species per subplot (Table 5), with each level of fragmentation significantly different from the others.

Table 3 Results of statistical analyses of factors affecting introduced species occupancy

Predictor		df	Occupancy measurement			
			Relative richness		Relative cover	
		Num/den	*F*	*p*	*F*	*p*
Level of fragmentation		2/858	61.7	<0.0001	38.58	<0.0001
Ecological province	All	8/809	16.04	<0.0001	11.27	<0.0001
	Intact	8/394	9.04	<0.0001	8.66	<0.0001
	Edge	8/327	5.03	<0.0001	4.06	0.0001
Forest type	All	5/324	2.41	0.0361	2.25	0.0492
	Intact	5/206	1.28	0.2748	2.14	0.0625
	Edge	5/112	2.33	0.0466	1.02	0.4000

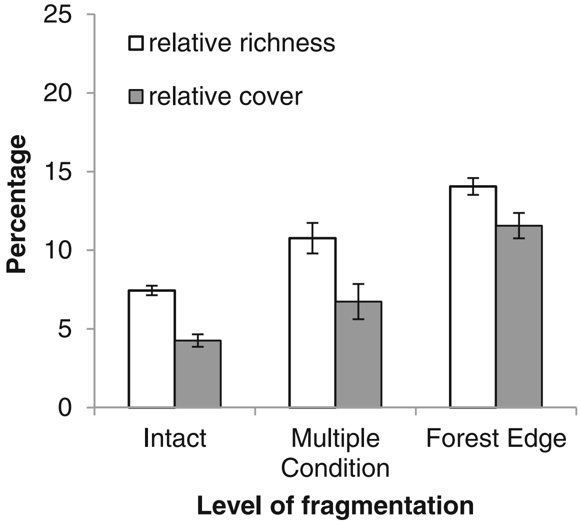

Fig. 5 Mean relative richness and relative cover on plots where introduced species were recorded by level of fragmentation; *bars* represent ±1 standard error

On intact forest subplots, both mean native and introduced species richness varied significantly across ecological provinces and forest types (Table 4). Native species richness was significantly lower in the Coastal Plain province than all others except the Appalachian

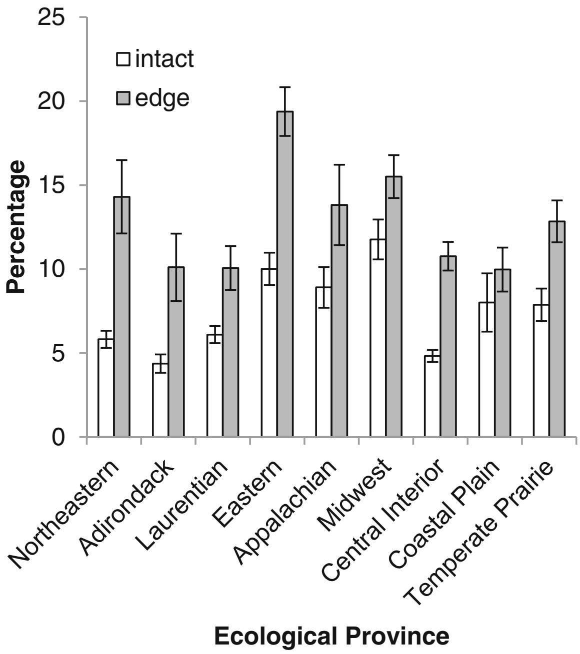

Fig. 6 Mean relative richness of introduced species where they occur on intact and forest edge plots across nine ecological provinces; *bars* represent ±1 standard error

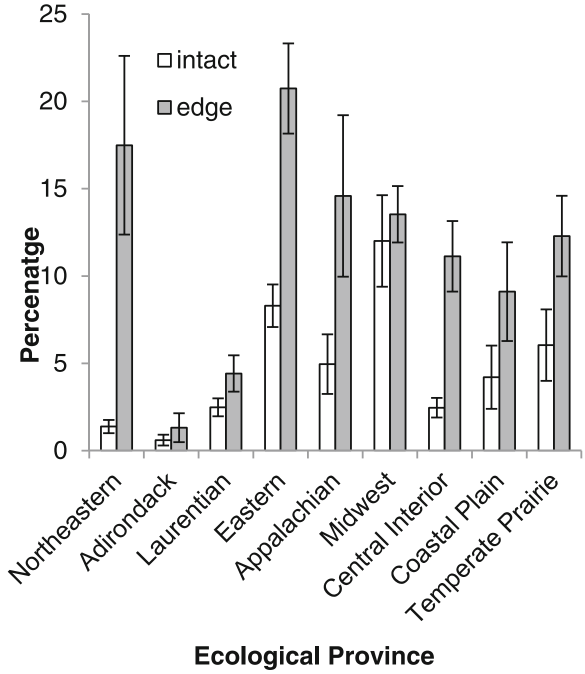

Fig. 7 Mean relative cover of introduced species where they occur on intact and forest edge plots across nine ecological provinces; *bars* represent ±1 standard error

province. The highest native richness was in the Northeastern province and was significantly greater

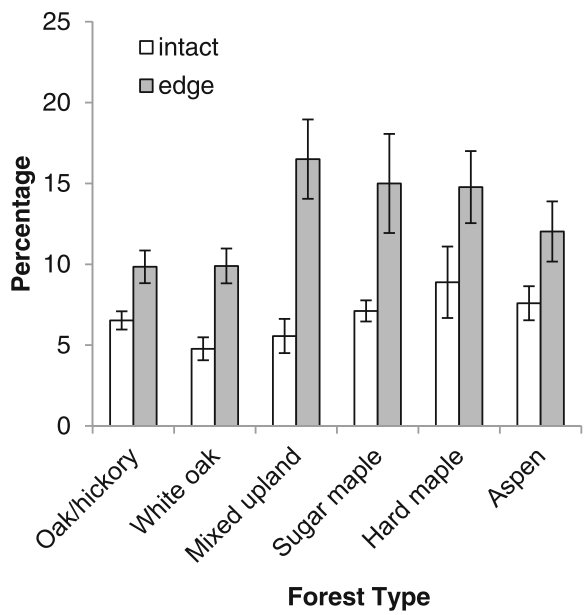

Fig. 8 Mean relative richness of introduced species where they occur on intact plots and forest edge plots for adequately sampled forest types; *bars* signify ±1 standard error

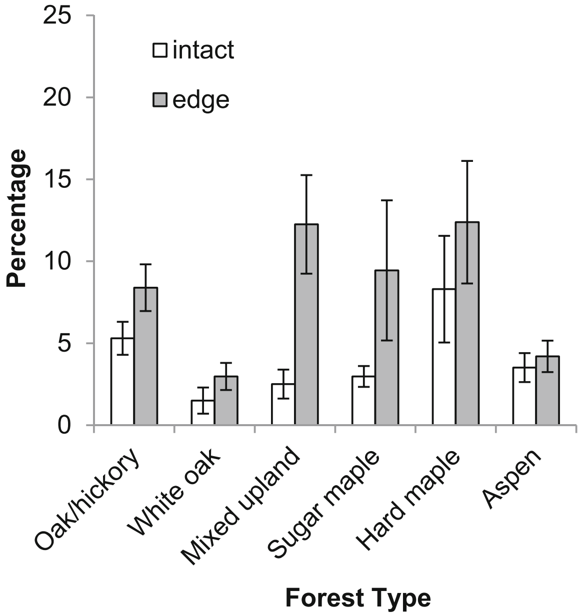

Fig. 9 Mean relative cover of introduced species where they occur on intact and forest edge plots in adequately sampled forest types; *bars* signify ±1 standard error

than all others except the Eastern, Central Interior, and Temperate Prairie provinces. Introduced species richness was lowest in Adirondack and was significantly different than Eastern, Midwest, and Temperate Prairie provinces. It was highest in Eastern—significantly different from all others except Midwest and Temperate Prairie provinces.

On forest edge subplots, the highest mean native species richness was in the Temperate Prairie; this was significantly different than those ecological provinces where the mean native species richness was less than 20. Mean number of introduced species was greatest in Eastern and significantly different than all others except Midwest and Temperate Prairie. The lowest numbers of introduced species were observed in the Adirondack, Laurentian (each with 0.6), and Coastal Plain (0.8) provinces; each of these was significantly different from Eastern, Midwest, and Temperate Prairie provinces.

Species richness of native and introduced plants also differed among forest types. Native species richness on intact forest subplots was highest in the mixed upland hardwood type (27.8) and was significantly different to all other forest types except white oak. The hard maple type was the lowest (18.7) and was significantly different from the oak/hickory, white oak, and mixed upland types. Introduced species richness was highest in the hard maple, which was significantly different from the lowest means on white oak, aspen, and sugar maple. Native species richness on edge plots ranged from 19.3 to 22 species per subplot, with no significant differences among forest types. In contrast, introduced species richness on edge plots was lowest in white oak and greatest in mixed upland hardwoods; these extremes were significantly different from each other. Introduced species richness in the mixed upland type was also significantly different from oak/hickory and aspen types.

Differences between intact vs. forest edges of the same region or forest type

Mean native species richness was usually greater on intact subplots than forest edges within a given ecological province or forest type. However, for ecological province, differences in native species richness between intact and forest edges were only significantly different for Adirondack and Central Interior provinces. Of the forest types compared, mean native species richness was significantly different between intact and forest edge subplots only for white oak and mixed upland types. Contrasting the results for native species, introduced species richness was significantly different between intact and forest edge most of the time. For ecological provinces, the exceptions were Adirondack, Laurentian, Appalachian, and the Coastal plain; for forest types, exceptions were white oak and aspen. Edge subplots always had a higher number of introduced species than their intact counterparts.

Relationship of native and introduced species richness

Correlation between native and introduced species richness was significant over the entire population of subplots and for intact and edge level of fragmentations (Table 4). Pearson correlation coefficients (r) reveal significant values over most intact forests by ecological province. On forest edge subplots, the correlation was only significant in Temperate Prairie and the Coastal Plain. Correlations between native and introduced species richness in the sufficiently sampled forest types

Table 4 Number of plots and subplots, average number of native and introduced species per subplot and their standard errors, and Pearson correlation coefficients and level of significance

	Level of fragmentation	Number of plots	Number of subplots	Mean number of native species	se	Mean number of introduced species	se	*r*	*p*
Total		1,302	4,227	20.8		1.1		0.13	<0.0001
	Intact	720	2,880	20.9	0.3	0.9	0.05	0.18	<0.0001
	Multiple	120	480	20.1	0.7	1.5	0.19	0.08	0.065
	Edge	462	869	20.2	0.4	1.9	0.12	0.11	0.0006
Ecological province									
Northeastern	Intact	80	320	20.8	1.1	0.5	0.1	0.28	<0.0001
	Edge	34	65	20.5	1.9	2	0.4	0.22	0.07
Adirondack	Intact	65	260	24.3	1	0.3	0.1	0.19	0.0014
	Edge	12	21	21.4	2.4	0.6	0.3	0.40	0.07
Laurentian	Intact	207	828	19	0.5	0.4	0.1	0.21	<0.0001
	Edge	76	168	18.6	0.8	0.6	0.1	0.04	0.59
Eastern	Intact	85	340	22.7	1.1	2	0.2	0.18	0.0009
	Edge	65	111	22.3	1.3	3.3	0.4	-0.02	0.8
Appalachian	Intact	50	200	16.7	1.3	0.7	0.1	0.33	<0.0001
	Edge	18	36	22.4	2.4	1.4	0.3	-0.13	0.4
Midwest	Intact	49	196	19.4	1.1	1.9	0.2	-0.06	0.35
	Edge	81	139	19.2	0.8	3	0.4	0.04	0.66
Central Interior	Intact	112	448	24.1	0.8	0.6	0.1	0.11	0.015
	Edge	65	128	19.6	0.9	1.6	0.2	0.10	0.25
Coastal Plain	Intact	28	112	15.7	1.4	0.7	0.2	0.28	0.002
	Edge	33	61	17.2	1.4	0.8	0.2	0.31	0.015
Temperate Prairie	Intact	24	96	24.2	1	1.6	0.1	0.39	<.0001
	Edge	55	98	23.6	1.6	2.4	0.3	0.23	0.02
Forest type									
Oak/hickory	Intact	122	488	23.1	0.8	1	0.1	0.16	0.0002
	Edge	55	119	22	1.1	1.5	0.2	0.21	0.02
White oak	Intact	22	88	24.1	1.7	0.6	0.2	0.07	0.49
	Edge	14	29	19.3	2.2	1.1	0.2	0.19	0.31
Mixed upland	Intact	20	80	27.8	2.2	1.1	0.4	0.1	0.35
	Edge	21	37	19.3	1.6	3	0.7	0.35	0.03
Sugar maple	Intact	116	464	21.2	0.8	0.7	0.1	0.23	<.0001
	Edge	25	58	19.9	1.6	2	0.6	-0.04	0.73
Hard maple	Intact	26	104	18.7	1.2	1.3	0.4	-0.09	0.34
	Edge	18	34	21.7	1.9	1.9	0.7	0.17	0.329
Aspen	Intact	52	208	21	1	0.7	0.1	0.25	0.0002
	Edge	23	49	19.3	1.5	1.3	0.3	0.26	0.07

were significant on both intact and forest edge subplots in oak/hickory, mixed upland edge subplots, and subplots of intact sugar maple and aspen. In all cases where the correlation between native and introduced species was significant, the relationship was weak. The greatest r value was 0.39 in the Temperate Prairie province, but with an r^2 of 0.15, only 15 % of the variation of one group is explained by the variation of the other value.

Table 5 Results of statistical analyses of factors affecting native and introduced species richness

Predictor		Species richness variable			
		Native		Introduced	
	df	*F*	*p*	*F*	*p*
Level of fragmentation	2, 4,227	2.15	0.1161	121.14	<0.0001
Ecological province	8, 4,090	31.31	<0.0001	102.71	<0.0001
Intact	8, 2,791	27.26	<0.0001	66.24	<0.0001
Edge	8, 818	4.94	<0.0001	18.85	<0.0001
Forest type	5, 1,936	10.01	<0.0001	13.50	<0.0001
Intact	5, 1,426	12.80	<0.0001	4.78	0.0002
Edge	5, 320	1.39	0.2286	406	0.0014

Distribution of individual species

The 40 most commonly recorded species are shown in Table 6, with overall constancy and constancy by level of fragmentation. *Rosa multiflora* (multiflora rose) was, by far, the most common introduced species; it was recorded on over one quarter of all plots (Tables 6, appendix 1). Its distribution across ecological provinces varied widely: Constancy of multiflora rose ranged from 70 % in Eastern province to zero in Adirondack province (appendix 1). This species was the first or second most common species in all other provinces except the Laurentian and was the most common species in five of six adequately sampled forest types (Table 7).

Lonicera japonica (Japanese honeysuckle) was a distant second, recorded on just over one-tenth of all plots. Number three, *Alliaria petiolata* (garlic mustard), had an overall constancy of 7 % and a high of 24 % in the Midwest province. Most introduced species were recorded with a higher constancy on edge or multiple condition plots, but there were a few exceptions: *Microstegium vimineum* (Japanese stiltgrass), *Ailanthus altissima* (tree-of-heaven), and *Epipactis helleborine* (broadleaf helleborine) were slightly more constant on intact plots (Table 6).

No single introduced species was recorded in every ecological province, but *Hypericum perforatum* (common St. Johnswort) was found in each province and division listed in appendix 1 and *Rosa multiflora*, *Lonicera maackii* (Amur honeysuckle), and *Rumex crispus* (curly dock) were recorded in each division. The most common species recorded in the Adirondack province was *Epipactis helleborine*, a lily species originally introduced to northeastern USA in the 1800s and recently recognized as a "watch" species (Swearingen et al. 2010). *Hieracium aurantiacum* (orange hawkweed) was the most common species in the Laurentian province. Orange hawkweed was also the most common introduced species recorded on aspen forest type plots (Table 7), which occurred most often in the Laurentian province (Table 2).

The majority of the most common species recorded in the sampled forest types had similar constancies on intact and forest edge plots (Table 7). Species that were more constant on edge plots include *Alliaria petiolata* (garlic mustard) on oak/hickory forests and hard maple, *Hypericum perforatum* (St. Johnswort) in sugar maple, and *Phleum pretense* (timothy), and *Trifolium pretense* (red clover) in the aspen forest type. Conversely, *Microstegium vimineum* (Japanese stiltgrass) was more constant in intact oak/hickory plots than on forest edges of the same type.

Discussion

This study indicates that forests with entirely native flora are not the norm in northeastern USA. With 305 introduced species found in this sample, two-thirds of the plots had at least one introduced species, where they represented 5–20 % of the species present and up to 20 % of the plant cover—and those proportion calculations include

Table 6 Forty most commonly recorded introduced species with constancy by level of fragmentation

Species	Level of fragmentation (number of plots)			
	All (1,302)	Intact (720)	Multiple (120)	Edge (462)
Rosa multiflora	27.5	23.9	30.0	32.5
Lonicera japonica	10.1	9.0	10.0	11.7
Alliaria petiolata	7.1	4.0	6.7	11.9
Daucus carota	6.0	2.1	10.0	11.0
Glechoma hederacea	5.0	3.6	8.3	6.3
Phleum pratense	4.9	2.5	6.7	8.2
Phalaris arundinacea	4.8	2.6	3.3	8.7
Hieracium aurantiacum	4.5	4.3	10.8	3.0
Leucanthemum vulgare	4.5	3.1	12.5	4.5
Berberis thunbergii	4.4	4.0	2.5	5.4
Polygonum convolvulus	4.2	2.9	5.8	5.8
Polygonum persicaria	4.1	4.0	5.8	3.9
Dactylis glomerata	4.1	1.7	5.0	7.6
Trifolium pratense	3.9	2.9	6.7	4.8
Trifolium repens	3.8	2.4	6.7	5.2
Elaeagnus umbellata	3.5	3.2	3.3	3.9
Solanum dulcamara	3.3	2.8	4.2	3.9
Rhamnus cathartica	3.2	3.1	2.5	3.7
Morus alba	3.2	2.1	4.2	4.8
Arctium minus	3.2	1.7	2.5	5.8
Hypericum perforatum	3.1	2.4	5.0	3.9
Lonicera maackii	3.0	1.3	3.3	5.6
Microstegium vimineum	2.9	3.2	2.5	2.6
Rumex acetosella	2.8	2.4	6.7	2.4
Ailanthus altissima	2.7	3.2	1.7	2.2
Poa compressa	2.4	1.1	4.2	3.9
Lolium pratense	2.4	0.8	3.3	4.5
Medicago lupulina	2.3	1.1	2.5	4.1
Anthoxanthum odoratum	2.2	1.7	6.7	1.9
Melilotus officinalis	2.2	1.3	2.5	3.7
Potentilla recta	2.2	2.1	5.0	1.5
Agrostis gigantea	2.2	1.8	3.3	2.4
Epipactis helleborine	2.1	2.6	2.5	1.1
Lonicera morrowii	2.1	1.1	4.2	3.0
Frangula alnus	2.0	0.6	5.0	3.5
Celastrus orbiculata	1.9	1.9	0.0	2.4
Plantago lanceolata	1.9	1.1	4.2	2.6
Verbascum thapsus	1.9	1.1	1.7	3.2
Lysimachia nummularia	1.9	0.8	3.3	3.2
Rumex crispus	1.9	0.7	1.7	3.9

Table 7 Constancy of the three to five most common introduced species for adequately sampled forest types over all, intact, and forest edge plot

Forest type	Species	All	Intact	Edge
Oak/hickory	*Rosa multiflora*	45.8	45.9	45.5
	Lonicera japonica	13.6	13.9	12.7
	Alliaria petiolata	9.0	6.6	14.5
	Daucus carota	6.2	4.9	9.1
	Microstegium vimineum	6.2	7.4	3.6
White oak	*Rosa multiflora*	30.6	31.8	28.6
	Lonicera japonica	13.9	9.1	21.4
	Lolium pratense	8.3	9.1	7.1
	Poa annua	8.3	9.1	7.1
Mixed upland	*Rosa multiflora*	39.0	35.0	42.9
	Lonicera japonica	17.1	15.0	19.0
	Glechoma hederacea	12.2	10.0	14.3
Sugar maple	*Rosa multiflora*	14.9	13.8	20.0
	Epipactis helleborine	7.8	7.8	8.0
	Hypericum perforatum	6.4	2.6	24.0
Hard maple	*Rosa multiflora*	34.1	34.6	33.3
	Alliaria petiolata	20.5	11.5	33.3
	Leucanthemum vulgare	11.4	11.5	11.1
	Lonicera japonica	11.4	11.5	11.1
Aspen	*Hieracium aurantiacum*	17.3	15.4	21.7
	Phleum pratense	13.3	7.7	26.1
	Phalaris arundinacea	8.0	7.7	8.7
	Rosa multiflora	5.3	5.8	4.3
	Trifolium pratense	5.3	1.9	13.0

the overstory trees, which are primarily native species. Constancy and occupancy of introduced species varied regionally with ecosystem and vegetation type and with proximity to non-forest conditions. These findings could prove valuable for prioritizing efforts to control and eradicate introduced plant species.

Regional prevalence of introduced species

Recent multiregional or large-scale assessments of introduced plant species distribution include three climatic regions in Europe (Chytrý et al. 2008) and county-level data from across the USA (Stohlgren et al. 2005). These relied on data that included both native and introduced species from various sources, habitats, and collection techniques. Stohlgren et al. (1999) spanned a number of habitat types and used standard methods, but had only a few replicates of several forested ecosystems. Moser et al. (2009) reported from many forest inventory plots in the upper mid-west, and Ibáñez et al. (2009) summarized findings from invasive plant surveys in New England, but these surveys focused on a few selected invasive plants with no measurements of native species composition. Gray (2009) compared results using two types of FIA surveys used in the Pacific Northwest (a full census of vascular species and a short list of invasive species) and demonstrated the utility of each. He found that the constancy of introduced species on VEG plots was 63 %, and the constancy of a short list of species on the more numerous standard inventory plots was 26 %. This is very similar to the differences in constancy in this analysis (66 %, over all) and that reported by Moser et al. (2009) (25 %) using a short list of species on P2 plots.

Each approach provides a unique perspective and addresses specific information needs concerning the population dynamics of introduced plants at regional or multiregional scales. Plant invasion dynamics are controlled at multiple scales: Regionally, climate and physiographic characteristics are important; at the landscape scale, habitat type and surrounding land use—past and present—are influential; at the local scale, existing plant community composition and structure, and disturbance are important.

The Forest Inventory and Analysis Vegetation Indicator database (Schulz et al. 2009; Woodall et al. 2010) provides the ability to report on introduced and native species richness in forests for a large area of the USA as well as subsets defined by ecological regions, forest types, and levels of fragmentation. The full census of vascular plants collected using consistent methods with a statistically sound sampling design removes potential ambiguity that results from analyses that combine different plot sizes and sampling intensities (Gray 2009). Data collection on permanent inventory plots also enables the use of forest structure and age information calculated from standard tree measurements and data on management and disturbance history. Future remeasurement of these plots with the Vegetation Indicator could provide valuable information on the rate of change of introduced species and the conditions enabling those changes.

Levels of fragmentation and introduced species distribution

Increased occurrence of introduced plant species on forest edges is well established. In their review of the effects of the composition and configuration of the landscape on the distribution of introduced species, Vilà and Ibàñez (2011) confirmed that there are more alien species at habitat edges than in the interior of fragments, and in numerous localized studies, proximities to other land uses are important factors that contribute to higher incidence of introduced species invasions (Chen et al. 2010; Meekins and McCarthy 2001; Moser et al. 2009; Ohlemüller et al. 2006; Schulte et al. 2011; Yates et al. 2004). In Europe, those habitats with the greatest proportion of alien species were either man-made or those subject to frequent disturbance by flooding (Chytrý et al. 2008).

In this regional-scale assessment of all forest lands, forest edge plots had higher constancy and significantly higher relative richness and relative cover of introduced species than intact plots. There were varying degrees of fragmentation over the study area as indicated by the proportion of intact, multiple, and forest edge plots encountered in each ecological region and as reported by Riitters et al. (2002). Ecological provinces with more intact forests have lower constancies of introduced species. In contrast, ecological regions with a higher proportion of fragmented forests—either due to human activity or naturally sparse forest habitats—have higher constancies and fewer differences between intact and edge plots. Much of the natural plant communities in the Midwest and Temperate Prairie ecological provinces (where there were more forest edges than intact plots) have been cleared for agriculture or urban development (McNab et al. 2005). New England encompasses portions of the Eastern, Northeastern, and Adirondack provinces and is characterized by secondary forest growth following agricultural abandonment (Ibáñez et al. 2009). This portion of the country has had the longest steady exposure to intentional plant introductions (Mack 2003; Reichard and White 2001). The Eastern and Northeastern provinces had the highest relative richness and cover of introduced species on forest edge plots—significantly more so than intact forest plots. However, the montane Adirondack province had the lowest occupancy of introduced species on plots where they occur on both intact and forest edges, indicating conditions that are less favorable for invading species, including fewer entry points due to fewer roads and other human-induced disturbances.

Constancy of introduced species also varied between intact and forest edges for the adequately sampled forest types. Forest types with a higher proportion of edge plots (mixed upland, hard maple, and white oak) had higher constancies overall, with a little difference between intact and forest edge plots, but there were significant differences between intact and forest edge plots for relative richness for these three forest types. The mixed upland type also showed a significant difference in relative cover between intact and edge plots. This may indicate that although there are similar proportions of plots with introduced species, the interior of these forests are less conducive to abundant growth of introduced plants. It could also mean that although these forests are minimally occupied now, introduced species are present and small changes or pulses of resources (nutrients, water, or light) could tip the scale and encourage the lurking sleeper species to become more abundant. Although it is difficult to extrapolate results from small-scale studies to larger regions, localized studies reveal important dynamics of specific species in local forest plant communities. Site-specific assessments within the regional perspective are key to successful management strategies.

Correlation between native and introduced species

Historically, it was assumed that alien species were more likely to invade "wastelands" or nutrient poor areas where few native species would grow (Stohlgren et al. 1999). However, this relationship between native and introduced species richness has been debated in recent years. Especially at larger spatial scales, a number of investigators have found that the best predictor for alien species richness has been native species richness (Chen et al. 2010; Huebner and Tobin 2006; Stohlgren et al. 1999, 2005). The long European history of phytosociological work allowed Chytrý et al. (2008) to classify species as natives, archaeophytes (species introduced over 1,500 years before present), and neophytes (species introduced in the past 1,500 years). These authors analyzed the relationship between archaeophytes and neophytes rather than natives and found that archaeophyte richness was the single best predictor for neophyte richness across the 33 habitat types they examined. Others have found no evidence of a relationship between native and introduced species (Ohlemüller et al. 2006) or found that it does not hold true at the smallest scales (Chen et al. 2010). Most studies surmise that positive correlations between native and introduced species richness indicate more about resource availability to all plant species, especially pulses of resources or short-term changes in resources—flooding, light (canopy gaps), temperature regimes, and events that alter soil nutrients (Chytrý et al. 2008)

Our analyses showed a positive, significant relationship between native and introduced species richness over the entire population of forested lands and for most intact forests over the various ecological provinces. However, the strengths of the positive correlations were weak. For forest edge plots by ecological province and for both intact and edge plots by forest type, there were fewer significant correlations between native and introduced species richness (Table 4), suggesting that other factors may provide better predictions for introduced species richness, such as proximity to plant propagules, density of roads and human population, size of forest parcels, and frequency of disturbance. It is interesting to note that the ecological province with the highest mean native species richness on intact plots (Adirondack) had the lowest mean introduced species richness and the forest type with the lowest mean native species (hard maple) also had the highest mean introduced species richness on intact plots (Table 4).

Distribution of individual introduced species

Surveys for invasive plants are becoming more sophisticated, and up-to-date results from many surveys are available via public web sites, providing fantastic sources of information on the distribution on many species. However, a complete census of both native and introduced species allows for analysis of the distribution and potential impact of any introduced species on the native plant communities where they occur. Inventories limited to a list of species are less versatile, and results may be interpreted inappropriately. For example, Moser et al. (2009) suggested that forbs may less likely survive in northern Minnesota, Wisconsin, and Michigan, but that analysis was limited to a short list of species. Using the full inventory of vascular plants revealed that this was not the case; most of the introduced species found in the Laurentian province were forbs or graminoids (appendix 1).

In this assessment, it was possible to examine which species were most prominent across the entire inventory area and then to determine the differences in composition by ecological region and forest type. Although none of the ten most commonly recorded species was on the Federal Noxious and Invasive species list (USDA NRCS 2000), all but *Phleum pratense* (timothy) are considered noxious in one or more states. *Rosa multiflora* was, by far, the most common species recorded, but its constancy varied widely in different ecoregions (appendix 1). Multiflora rose is much less prominent in the Warm Continental Division: Although it is the most common species recorded in the Northeastern province, it was present on less than 12 % of the plots and only on 2 % of plots in the Laurentian province and was not recorded in Adirondack forests. In this province, *Epipactis helleborine* was the most common introduced species. Although introduced to the region in the 1800s, only recently was it observed becoming invasive on dry, gravely soils in forests and woodland edges (Swearingen et al. 2010). *Hieracium aurantiacum* was most common in the Laurentian province: This species is listed as a noxious weed in five western states, it is recognized in Wisconsin as a potentially invasive species (USDA NRCS), and it was identified as a species becoming more abundant in northern forests over the past 50 years (Wiegmann and Waller 2006). Neither species is listed in the FIA programs new invasive species inventory for the Northern Research Station, in which a short list of species is developed for each inventory unit to target (Olson and Cholewa 2009). Gray (2009) also reported that some of the most commonly recorded introduced species on VEG plots in the Pacific Northwest were not on any agencies' invasive plant lists.

Although many of the most common species recorded are known invasives and found most often on edge or multiple condition plots, several species were found more commonly on intact forest plots. The land manager charged with invasive species control could be well served to concentrate on early detection and rapid response in forests that remain relatively pristine. Areas heavily occupied by introduced species are likely to stay that way, although there may be hope of eliminating problem species in small areas of high value.

Conclusions

It is well established that introduced plant species are common in the forests of northeastern USA and are more abundant on forest edges than forest interiors. This analysis quantifies the extent to which this is true; 66 % of all plots visited had at least one introduced plant species present; *Rosa multiflora* alone was present on over 27 % of plots in the inventory. The differences between intact and forest edge forest stands varied across ecological provinces—highlighting the potential influences of climate, historical land use, and forest fragmentation on the distribution of introduced species. In the ecological provinces with highly fragmented forests, there is less difference in constancy between intact and forest edge plots; in provinces with harsher winter conditions, relative cover of introduced species is low on both intact and forest edge plots. Further analyses should include a more detailed examination of the forest edge effect by employing both additional variables collected by FIA and ancillary data sets such as NLCD (Homer et al. 2004).

Large- and small-scale point-in-time studies and long-term monitoring are necessary to reveal invasion dynamics. Full census allows analyses of relationships to native and introduced species—long-term monitoring would aid the understanding of the complexities of these relationships. Although not all introduced species become invasive, there are many naturalized species that have the potential of becoming invasive in the future. This study is a point-in–time assessment, but with data collected on established FIA plots, there is the potential to remeasure in the future and determine changes in occupancy for individual species, forest types, or ecological provinces.

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Appendix 1

Table 8 Recorded introduced species in order of descending total constancy with constancy by ecological region

	Ecological region codes (number of plots)										
	Provinces							Divisions			Total
Species	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Rosa multiflora	11.90	0.00	2.17	70.24	29.58	45.39	41.36	17.14	47.13	2.78	27.50
Lonicera japonica	0.00	0.00	0.00	23.21	7.04	9.93	19.90	48.57	1.15	0.00	10.06
Alliaria petiolata	6.35	0.00	0.00	17.86	12.68	24.11	2.62	0.00	6.90	0.00	7.07
Daucus carota	3.17	0.00	1.24	11.31	5.63	12.06	10.99	0.00	10.34	0.00	5.99
Glechoma hederacea	3.17	0.00	0.62	16.67	2.82	15.60	0.52	1.43	5.75	0.00	4.99
Phleum pratense	6.35	6.74	3.72	8.33	0.00	12.06	0.00	0.00	8.05	0.00	4.92
Phalaris arundinacea	5.56	1.12	3.41	4.17	0.00	13.48	1.57	0.00	14.94	5.56	4.84
Hieracium aurantiacum	3.97	3.37	10.84	1.19	0.00	7.09	1.57	0.00	0.00	0.00	4.45
Leucanthemum vulgare	4.76	5.62	3.10	11.31	4.23	5.67	1.57	1.43	3.45	0.00	4.45
Berberis thunbergii	3.97	2.25	0.31	19.05	12.68	3.55	0.52	1.43	1.15	0.00	4.38
Polygonum convolvulus	0.79	0.00	4.33	4.76	5.63	4.96	2.62	0.00	16.09	5.56	4.22
Polygonum persicaria	3.97	1.12	0.00	18.45	5.63	1.42	2.62	4.29	3.45	0.00	4.15
Dactylis glomerata	3.17	0.00	0.62	11.90	5.63	7.09	2.09	0.00	9.20	2.78	4.07
Trifolium pratense	3.17	0.00	3.10	8.33	2.82	7.80	2.62	0.00	5.75	0.00	3.92
Trifolium repens	2.38	1.12	1.86	7.74	2.82	4.96	3.14	0.00	8.05	11.11	3.76
Elaeagnus umbellata	1.59	0.00	0.62	5.95	15.49	4.26	5.76	1.43	2.30	0.00	3.46
Solanum dulcamara	7.14	1.12	4.33	1.19	0.00	11.35	0.52	0.00	0.00	0.00	3.30
Arctium minus	5.56	0.00	0.62	3.57	0.00	8.51	1.57	0.00	9.20	11.11	3.23
Morus alba	0.00	0.00	0.00	2.98	0.00	3.55	4.71	2.86	17.24	16.67	3.23
Rhamnus cathartica	2.38	3.37	1.55	5.36	0.00	10.64	0.00	1.43	6.90	0.00	3.23
Hypericum perforatum	3.17	2.25	3.10	4.76	1.41	4.26	2.62	4.29	1.15	2.78	3.15
Lonicera maackii	0.79	0.00	0.00	2.38	1.41	9.22	5.24	2.86	8.05	2.78	3.00
Microstegium vimineum	3.17	0.00	0.00	5.36	15.49	0.71	3.14	8.57	1.15	0.00	2.92
Rumex acetosella	3.17	2.25	4.64	3.57	0.00	3.55	0.00	4.29	1.15	0.00	2.76
Ailanthus altissima	0.00	0.00	0.00	12.50	11.27	2.13	0.52	2.86	0.00	0.00	2.69
Lolium pratense	0.00	0.00	0.00	2.98	4.23	2.84	5.24	0.00	8.05	5.56	2.38
Poa compressa	0.79	0.00	3.10	1.19	1.41	4.26	2.09	0.00	2.30	13.89	2.38
Medicago lupulina	0.79	0.00	1.55	0.60	1.41	2.13	2.62	0.00	9.20	16.67	2.30
Anthoxanthum odoratum	10.32	0.00	0.00	7.14	2.82	0.71	0.00	1.43	0.00	0.00	2.23
Melilotus officinalis	0.00	0.00	0.62	2.38	1.41	5.67	1.05	0.00	5.75	19.44	2.23
Agrostis gigantea	0.79	3.37	3.10	3.57	0.00	3.55	0.00	0.00	2.30	2.78	2.15
Potentilla recta	0.79	2.25	0.31	8.93	0.00	4.96	0.52	0.00	1.15	0.00	2.15
Epipactis helleborine	10.32	12.36	0.31	0.60	0.00	0.71	0.00	0.00	0.00	0.00	2.07
Lonicera morrowii	9.52	0.00	0.31	5.36	2.82	2.13	0.00	0.00	0.00	0.00	2.07
Frangula alnus	4.76	1.12	0.93	3.57	0.00	7.09	0.00	0.00	0.00	0.00	2.00
Celastrus orbiculata	3.17	0.00	0.00	6.55	4.23	3.55	0.52	1.43	0.00	0.00	1.92
Lysimachia nummularia	0.00	0.00	0.31	6.55	0.00	7.80	1.05	0.00	0.00	0.00	1.92
Plantago lanceolata	0.79	0.00	1.86	1.79	1.41	5.67	0.52	0.00	4.60	2.78	1.92

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Rumex crispus	1.59	0.00	0.62	4.76	0.00	5.67	1.05	1.43	1.15	2.78	1.92
Verbascum thapsus	1.59	2.25	1.24	1.79	0.00	2.13	1.57	0.00	3.45	13.89	1.92
Lonicera tatarica	2.38	0.00	0.31	7.14	2.82	3.55	0.00	0.00	1.15	0.00	1.84
Cirsium arvense	3.17	0.00	0.31	2.38	0.00	3.55	0.52	0.00	3.45	13.89	1.77
Elymus repens	1.59	0.00	1.86	0.60	0.00	4.96	0.52	0.00	1.15	13.89	1.77
Cirsium vulgare	1.59	2.25	2.17	0.00	1.41	3.55	0.52	0.00	1.15	8.33	1.69
Poa trivialis	3.17	1.12	2.79	2.38	0.00	1.42	0.00	0.00	0.00	2.78	1.61
Ligustrum vulgare	0.00	0.00	0.31	7.14	1.41	3.55	0.00	1.43	0.00	0.00	1.54
Lolium arundinaceum	0.00	0.00	0.00	1.79	1.41	0.71	0.52	0.00	14.94	2.78	1.54
Prunus avium	2.38	0.00	1.24	2.38	2.82	4.26	0.52	0.00	0.00	0.00	1.54
Torilis arvensis	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.00	16.09	2.78	1.46
Dianthus armeria	1.59	0.00	0.00	3.57	2.82	1.42	0.52	1.43	4.60	0.00	1.38
Vicia cracca	4.76	5.62	1.55	0.60	0.00	0.71	0.00	0.00	0.00	0.00	1.38
Hieracium caespitosum	7.94	3.37	0.62	0.00	0.00	1.42	0.00	0.00	0.00	0.00	1.31
Lactuca serriola	0.00	0.00	0.31	0.00	0.00	0.71	3.66	0.00	4.60	11.11	1.31
Tussilago farfara	2.38	2.25	0.31	2.98	4.23	2.13	0.00	0.00	0.00	0.00	1.31
Pinus sylvestris	1.59	0.00	0.93	4.17	1.41	1.42	0.52	0.00	0.00	0.00	1.23
Tragopogon dubius	0.79	0.00	0.93	0.60	0.00	1.42	0.00	0.00	0.00	25.00	1.23
Commelina communis	0.00	0.00	0.62	1.19	0.00	1.42	2.09	2.86	3.45	0.00	1.15
Hieracium lachenalii	1.59	1.12	1.24	0.00	0.00	4.96	0.00	0.00	0.00	0.00	1.08
Holcus lanatus	0.79	0.00	0.00	4.17	5.63	1.42	0.00	0.00	0.00	0.00	1.08
Nepeta cataria	0.00	0.00	0.31	0.00	0.00	2.84	0.00	0.00	4.60	13.89	1.08
Rumex obtusifolius	1.59	0.00	0.93	4.76	1.41	0.00	0.00	0.00	0.00	0.00	1.08
Trifolium aureum	0.79	4.49	0.93	0.60	0.00	1.42	0.00	2.86	1.15	0.00	1.08
Rubus phoenicolasius	1.59	0.00	0.00	3.57	7.04	0.00	0.00	0.00	0.00	0.00	1.00
Bromus japonicus	0.00	0.00	0.00	0.60	0.00	0.00	0.52	0.00	3.45	16.67	0.84
Cerastium fontanum ssp. vulgare	0.79	0.00	0.93	1.19	0.00	2.13	0.52	1.43	0.00	0.00	0.84
Hesperis matronalis	1.59	0.00	0.00	1.79	1.41	3.55	0.00	0.00	0.00	0.00	0.84
Ipomoea purpurea	0.00	0.00	0.93	0.00	0.00	0.71	2.09	2.86	1.15	0.00	0.84
Leonurus cardiaca	0.00	0.00	0.31	0.00	0.00	3.55	0.00	0.00	2.30	8.33	0.84
Lespedeza cuneata	0.00	0.00	0.00	0.60	0.00	0.00	3.14	1.43	3.45	0.00	0.84
Poa annua	0.00	0.00	0.93	0.00	0.00	0.00	3.66	0.00	1.15	0.00	0.84
Polygonum hydropiper	0.00	0.00	0.31	0.00	0.00	0.71	2.09	5.71	1.15	0.00	0.84
Sonchus oleraceus	0.00	0.00	0.62	0.60	0.00	2.13	2.09	1.43	0.00	0.00	0.84
Stellaria media	0.00	0.00	0.31	2.98	1.41	1.42	0.52	0.00	1.15	0.00	0.84
Barbarea vulgaris	0.79	0.00	0.00	1.19	1.41	1.42	0.00	0.00	4.60	0.00	0.77
Centaurea biebersteinii	1.59	0.00	1.55	0.00	1.41	1.42	0.00	0.00	0.00	0.00	0.77
Coronilla varia	0.00	0.00	0.00	2.98	1.41	0.00	0.52	0.00	3.45	0.00	0.77
Duchesnea indica	0.00	0.00	0.00	5.36	0.00	0.71	0.00	0.00	0.00	0.00	0.77
Elaeagnus angustifolia	0.00	0.00	0.00	4.76	0.00	0.00	0.00	0.00	0.00	5.56	0.77

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Linaria vulgaris	1.59	0.00	0.31	1.19	2.82	1.42	0.52	0.00	0.00	0.00	0.77
Lonicera x xylosteoides	0.00	0.00	2.48	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.77
Lotus corniculatus	2.38	1.12	0.93	0.60	0.00	0.00	0.00	0.00	2.30	0.00	0.77
Polygonum cespitosum	0.00	0.00	0.00	2.98	7.04	0.00	0.00	0.00	0.00	0.00	0.77
Trifolium hybridum	0.00	1.12	0.00	0.00	1.41	2.84	2.09	0.00	0.00	0.00	0.77
Cerastium fontanum	0.79	0.00	1.24	1.19	0.00	1.42	0.00	0.00	0.00	0.00	0.69
Galium mollugo	3.97	1.12	0.00	1.19	0.00	0.71	0.00	0.00	0.00	0.00	0.69
Impatiens balsamina	3.17	1.12	0.00	1.19	0.00	1.42	0.00	0.00	0.00	0.00	0.69
Phragmites australis	0.79	0.00	0.62	0.60	0.00	2.13	0.00	2.86	0.00	0.00	0.69
Picea abies	3.97	0.00	0.00	1.79	0.00	0.71	0.00	0.00	0.00	0.00	0.69
Acer platanoides	0.79	0.00	0.00	3.57	0.00	0.71	0.00	0.00	0.00	0.00	0.61
Carduus nutans	0.00	0.00	0.00	0.00	0.00	0.00	1.57	0.00	3.45	5.56	0.61
Malus pumila	0.79	1.12	0.62	1.19	0.00	1.42	0.00	0.00	0.00	0.00	0.61
Tanacetum vulgare	0.00	0.00	0.31	0.00	0.00	3.55	1.05	0.00	0.00	0.00	0.61
Typha angustifolia	1.59	0.00	0.93	1.19	0.00	0.71	0.00	0.00	0.00	0.00	0.61
Arctium lappa	0.00	0.00	0.31	0.00	0.00	4.26	0.00	0.00	0.00	0.00	0.54
Convolvulus arvensis	0.00	0.00	0.93	0.00	0.00	0.71	0.00	1.43	1.15	2.78	0.54
Galeopsis tetrahit	1.59	3.37	0.31	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.54
Hieracium pilosella	0.79	3.37	0.62	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.54
Medicago sativa	0.00	0.00	0.31	0.00	0.00	2.13	0.00	0.00	1.15	5.56	0.54
Setaria viridis	0.00	0.00	0.00	0.00	0.00	0.71	0.52	0.00	3.45	5.56	0.54
Trifolium campestre	0.00	0.00	0.00	1.19	0.00	2.84	0.52	0.00	0.00	0.00	0.54
Agrostis capillaris	1.59	1.12	0.00	0.60	2.82	0.00	0.00	0.00	0.00	0.00	0.46
Allium vineale	0.00	0.00	0.00	1.79	1.41	0.71	0.52	0.00	0.00	0.00	0.46
Amaranthus caudatus	0.00	0.00	0.62	0.00	0.00	2.84	0.00	0.00	0.00	0.00	0.46
Bromus tectorum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.45	8.33	0.46
Cannabis sativa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.60	5.56	0.46
Conium maculatum	0.00	0.00	0.00	0.00	0.00	0.71	1.05	0.00	1.15	5.56	0.46
Dipsacus fullonum ssp. sylvestris	0.00	0.00	0.00	1.79	0.00	1.42	0.52	0.00	0.00	0.00	0.46
Melilotus alba	0.00	0.00	0.31	1.19	0.00	1.42	0.00	0.00	1.15	0.00	0.46
Sorghum halepense	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	2.30	8.33	0.46
Tragopogon pratensis	0.00	0.00	1.24	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.46
Ulmus pumila	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30	11.11	0.46
Veronica arvensis	1.59	0.00	0.31	1.19	0.00	0.00	0.00	0.00	0.00	2.78	0.46
Berberis vulgaris	0.00	1.12	0.62	0.00	1.41	0.71	0.00	0.00	0.00	0.00	0.38
Chelidonium majus	0.00	0.00	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.00	0.38
Cichorium intybus	0.00	0.00	0.00	0.60	0.00	1.42	0.52	0.00	1.15	0.00	0.38
Echinochloa crus-galli	0.00	0.00	0.00	0.60	0.00	0.00	1.05	2.86	0.00	0.00	0.38
Euonymus alata	0.79	0.00	0.00	1.19	0.00	0.00	0.00	2.86	0.00	0.00	0.38
Lonicera xylosteum	0.79	0.00	0.31	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.38

Table 8 (continued)

Species	Ecological region codes (number of plots)										
	Provinces							Divisions			Total
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Lythrum salicaria	0.00	0.00	0.00	1.79	0.00	0.71	0.00	0.00	0.00	2.78	0.38
Pastinaca sativa	0.00	0.00	0.31	0.60	0.00	0.71	0.52	0.00	0.00	2.78	0.38
Polygonum cuspidatum	0.79	0.00	0.00	1.79	1.41	0.00	0.00	0.00	0.00	0.00	0.38
Silene vulgaris	1.59	1.12	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38
Sonchus arvensis	1.59	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.38
Artemisia absinthium	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	8.33	0.31
Cirsium palustre	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Hieracium piloselloides	0.00	1.12	0.62	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.31
Hypochaeris radicata	0.00	0.00	0.31	0.60	1.41	0.71	0.00	0.00	0.00	0.00	0.31
Impatiens glandulifera	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Kummerowia stipulacea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.60	0.00	0.31
Kummerowia striata	0.00	0.00	0.00	0.60	0.00	0.00	0.52	0.00	2.30	0.00	0.31
Lamium amplexicaule	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.00	0.00	0.00	0.31
Paulownia tomentosa	0.00	0.00	0.00	1.19	2.82	0.00	0.00	0.00	0.00	0.00	0.31
Ranunculus repens	2.38	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.31
Rosa rugosa	0.00	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Salsola tragus	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	8.33	0.31
Solanum nigrum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	4.29	0.00	0.00	0.31
Stellaria graminea	1.59	0.00	0.00	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Berteroa incana	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Buglossoides arvensis	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	5.56	0.23
Calystegia sepium ssp. sepium	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	1.15	0.00	0.23
Campanula rapunculoides	0.79	1.12	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Celastrus orbiculatus	0.00	0.00	0.00	1.19	1.41	0.00	0.00	0.00	0.00	0.00	0.23
Chaenorhinum minus	0.00	0.00	0.00	0.00	0.00	0.00	1.57	0.00	0.00	0.00	0.23
Euonymus fortunei	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	2.30	0.00	0.23
Euphorbia esula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30	2.78	0.23
Hylotelephium telephium ssp. telephium	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Ipomoea coccinea	0.00	0.00	0.00	0.60	0.00	0.00	1.05	0.00	0.00	0.00	0.23
Lamium purpureum	0.00	0.00	0.00	1.19	0.00	0.00	0.52	0.00	0.00	0.00	0.23
Malva moschata	0.79	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.23
Malva neglecta	0.00	1.12	0.00	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.23
Mentha x piperita	0.00	0.00	0.00	1.19	0.00	0.00	0.52	0.00	0.00	0.00	0.23
Myosotis scorpioides	0.00	0.00	0.31	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Pinus nigra	0.79	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.23
Potentilla argentea	0.00	0.00	0.62	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.23
Triticum aestivum	0.00	0.00	0.31	0.00	0.00	0.00	0.52	0.00	1.15	0.00	0.23
Zea mays	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	1.15	0.00	0.23
Abutilon theophrasti	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	1.15	0.00	0.15
Alopecurus pratensis	0.00	0.00	0.31	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.15

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Amaranthus retroflexus	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.15
Anagallis arvensis	0.00	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Arctium tomentosum	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.15
Arenaria serpyllifolia	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.15
Avena fatua	0.00	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Brassica juncea	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	1.15	0.00	0.15
Brassica rapa	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Bromus commutatus	0.00	0.00	0.00	0.60	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Capsella bursa-pastoris	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.15
Carex acutiformis	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Crepis capillaris	0.00	0.00	0.31	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Cynodon dactylon	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	1.15	0.00	0.15
Digitaria ischaemum	0.79	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Dioscorea oppositifolia	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.15
Epilobium hirsutum	0.00	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Erysimum cheiranthoides	0.79	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Euphorbia davidii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	2.78	0.15
Galinsoga parviflora	0.00	0.00	0.31	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Galium verum	0.79	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Hibiscus syriacus	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.15
Ipomoea hederacea	0.00	0.00	0.00	0.00	0.00	0.71	0.00	1.43	0.00	0.00	0.15
Lepidium campestre	0.00	0.00	0.31	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Melilotus altissimus	0.00	0.00	0.31	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Mentha spicata	0.79	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Perilla frutescens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	1.15	0.00	0.15
Ranunculus ficaria	0.79	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Salix alba	0.79	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Secale cereale	0.00	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Setaria faberi	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	1.15	0.00	0.15
Setaria pumila	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	2.78	0.15
Silene latifolia ssp. alba	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.15
Sisymbrium officinale	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.15
Sonchus asper	0.00	0.00	0.00	0.60	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Symphytum officinale	0.00	0.00	0.31	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Thlaspi arvense	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.15
Torilis japonica	0.00	0.00	0.31	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Trifolium arvense	0.00	0.00	0.00	0.60	0.00	0.00	0.00	1.43	0.00	0.00	0.15
Trifolium dubium	0.00	0.00	0.00	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.15
Urtica dioica ssp. dioica	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Valeriana officinalis	0.79	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Veronica chamaedrys	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Veronica persica	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Vicia sativa	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Vinca minor	0.00	0.00	0.00	0.60	0.00	0.00	0.52	0.00	0.00	0.00	0.15
Acacia sophorae	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Acer ginnala	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Achillea millefolium var. millefolium	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Achillea ptarmica	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Aegopodium podagraria	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Agropyron cristatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Agrostemma githago	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Ajuga reptans	0.00	0.00	0.00	0.00	1.41	0.00	0.00	0.00	0.00	0.00	0.08
Allium ampeloprasum	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Allium schoenoprasum	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Ampelopsis aconitifolia	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.08
Ampelopsis brevipedunculata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Anthemis arvensis	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Anthoxanthum aristatum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Anthriscus cerefolium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Aquilegia vulgaris	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Aristolochia clematitis	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Arrhenatherum elatius	0.00	0.00	0.00	0.00	1.41	0.00	0.00	0.00	0.00	0.00	0.08
Asparagus officinalis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Bothriochloa bladhii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Brassica nigra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Bromus erectus	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Bromus inermis ssp. inermis var. inermis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Bromus racemosus	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Bromus secalinus	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.08
Bromus squarrosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Camelina sativa	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Caragana arborescens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Cardaria draba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Carum carvi	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Cerastium glomeratum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Chenopodium glaucum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Clematis terniflora	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Cnicus benedictus	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Consolida ajacis	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Cymbalaria muralis	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Cyperus serotinus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Dactylis glomerata ssp. glomerata	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Datura stramonium	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Digitaria violascens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Diplotaxis muralis	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Dipsacus sativus	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Eragrostis cilianensis	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Eragrostis curvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Eriochloa villosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Euonymus europaea	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Fagopyrum esculentum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Forsythia suspensa	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Galeopsis bifida	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Geranium molle	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Hemerocallis fulva	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Hibiscus lunariifolius	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Hibiscus trionum	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Hordeum vulgare	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Hyssopus officinalis	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Iris pumila	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Juncus compressus	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Juncus inflexus	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Knautia arvensis	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Lamium album	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Lamium maculatum	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Lappula squarrosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Ligustrum obtusifolium	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Ligustrum sinense	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Linum perenne	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.08
Lithospermum officinale	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Logfia arvensis	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Lolium perenne ssp. multiflorum	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Lonicera x bella	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Lychnis coronaria	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Macleaya cordata	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Matricaria discoidea	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Pachysandra terminalis	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Panax ginseng	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08

Table 8 (continued)

Species	Ecological region codes (number of plots)										Total
	Provinces							Divisions			
	211 (126)	M211 (89)	212 (323)	221 (168)	M221 (71)	222 (141)	223 (191)	230 (70)	250 (87)	330 (36)	(1,302)
Pennisetum glaucum	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Polygonatum hirsutum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Polygonum arenastrum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Polygonum convolvulus var. convolvulus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Polygonum perfoliatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Populus alba	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.08
Pyrus communis	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Ranunculus bulbosus	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Raphanus raphanistrum	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Ribes nigrum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Ribes rubrum	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Ribes uva-crispa var. sativum	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Rosa eglanteria	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Rubus laciniatus	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Salix pentandra	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Saponaria officinalis	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.08
Senecio vulgaris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Setaria pumila ssp. pallidifusca	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.08
Silene latifolia	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Silene noctiflora	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Sisymbrium loeselii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.08
Smyrnium olusatrum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08
Sorghum bicolor ssp. bicolor	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Spiraea japonica	0.00	0.00	0.00	0.00	1.41	0.00	0.00	0.00	0.00	0.00	0.08
Syringa vulgaris	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Tradescantia fluminensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.08
Valerianella locusta	0.00	0.00	0.00	0.00	1.41	0.00	0.00	0.00	0.00	0.00	0.08
Veronica filiformis	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Viburnum opulus var. opulus	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Vicia sativa ssp. nigra	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Vinca major	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.08

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