

Vegetation response to Amur honeysuckle removal along Fall Creek (2012-2015)

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Summary

1. Initial surveys from 2012, before the Lilly Day of Service (LDOS), document that there was a very heavy infestation of Amur honeysuckle along Fall Creek. Herbaceous-layer vegetation was dominated by non-native plants, especially Amur honeysuckle and winter-creeper.
2. Following one year of honeysuckle removal, the same numbers of honeysuckle plants were found in survey plots, but the area covered was significantly reduced. In 2014, two years following initial removal and with one year of additional treatment, both numbers of plants per plot and cover were significantly lower than before the 2012 LDOS. The trend continued in 2015, with numbers of plants and cover significantly lower than in 2014. This indicates significant reductions are occurring each treatment year and that the effort is being effective.
3. More plants, both native and non-native, were present in 2013 and 2014 than in 2012. Data for 2015 indicate the trend is tapering off. Overall, there has been improvement in the quality of the vegetation following Amur honeysuckle removal, but more years of data are needed to establish the significance of the trend.

Methods

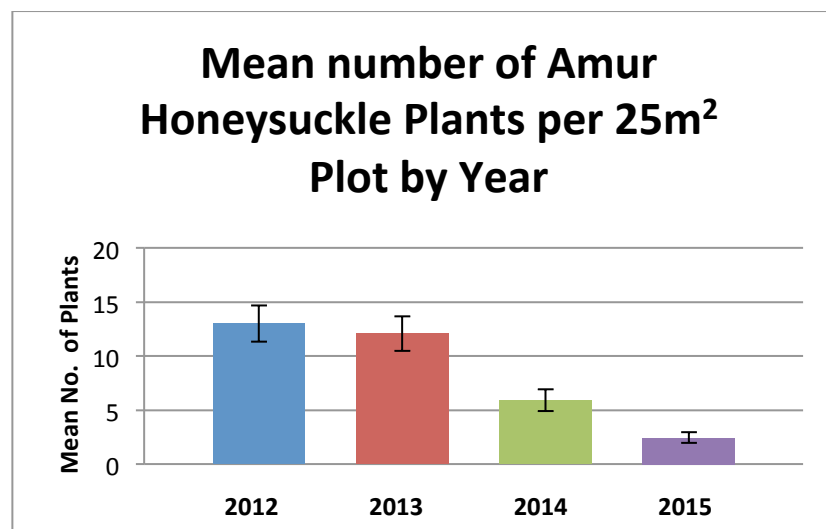
In the late summer of 2012 before the Lilly Day of Service (LDOS), we set up 100 m long transects (sample lines) at three sites between Coliseum Drive and College Ave (Figure 1). Transects were run parallel to the creek, two at the edge of the mown turf grass and one within the woody border. We counted stems of Amur honeysuckle within 25m² quadrats (subsample squares) located every 10 meters along the transects and recorded the percentage of the plot covered by honeysuckle. Cover was estimated in equal angular (arcsine square root) classes (1 = 1-7%, 2 = 8-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-93%, 6 = 94-100%). We recorded species and diameter at breast height (dbh) for all trees larger than 5 cm dbh. We also recorded the species of all smaller trees and any other plants occurring in the quadrats.

In 2013, 2014, and 2015 we resampled at the same time of year, establishing 3 more temporary transects. Note that the transects were in the same general location but that the exact same sample plots were not surveyed each year. We added information for cover class of all species, not just Amur honeysuckle, in the herb-layer (herbaceous plants or woody plant with diameter of less than 5 cm) of each 5m x 5m plot so we can see presence and abundance is changing over time for all plants. A list of all plants seen in the herbaceous layer is in the Appendix.

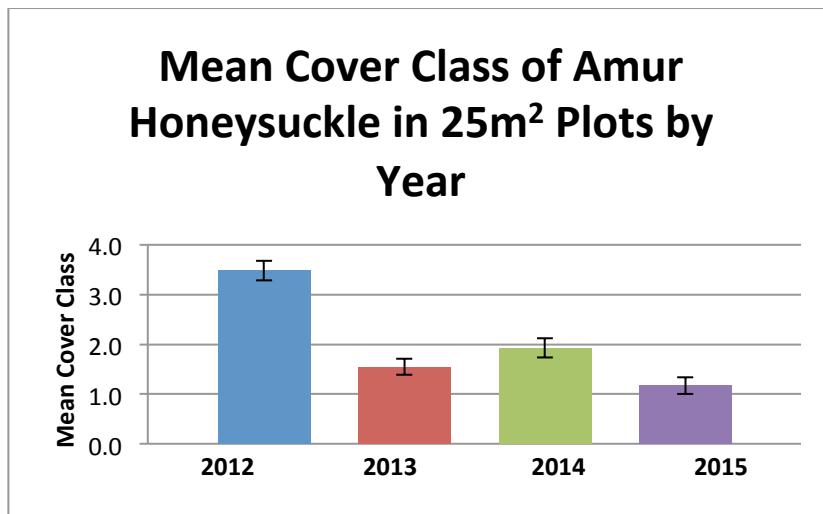
Results

Abundance of Amur honeysuckle

In 2012, before the LDOS, a mean of 13 honeysuckle plants were present in each quadrat. This equates to a density of ca. 2,000 stems per acre, generally considered a very heavy infestation. Following one year of treatment (2013), the number of plants per quadrat dropped by only one, which is not a statistically significant change from the before-treatment number. By 2014, the number of honeysuckle plants in each plot averaged 6, a significant reduction. 2015 saw a further significant reduction in the number of stems, down to an average of 2.5. So, the first year of treatment did not reduce the number of honeysuckle stems, but continual treatment in the 2nd and 3rd years each resulted in fewer stems.



Another way of looking at the abundance of honeysuckle is to consider how much of the plot was covered by the plant, not just the number of plants present. The 2012 LDOS honeysuckle removal resulted in a reduction of the mean cover class of honeysuckle from 26-50% to 8-25% per plot on average. There was a slight rebound in coverage in 2014, but still significantly less than in 2012 before the LDOS. In 2015, cover was significantly lower than in 2014 or 2013, dropping to a mean in the 1-7% coverage range. This indicated continued success in honeysuckle reduction.



(1 = 1-7%, 2 = 8-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-93%, 6 = 94-100%).

Interpretation:

From the outset it was recognized that it will take several years of treatment to effectively remove the Amur honeysuckle. The drop in numbers of plants and in coverage shows positive impact of the LDOS, with numbers of plants and coverage continuing to decline. More years of treatment and follow-up are recommended to get closer to the goal of no Amur honeysuckle.

Trees

All trees with diameter at breast height (dbh) greater than 5 cm were recorded in quadrats in 2012. Tree data were not reanalyzed in 2013, 2014 because not much was to have changed over just a few years. Data for 2015 are presented in the table below.

Importance value (I.V.), based on frequency, density, and size of species measured, reflects the overall contribution of each tree in the landscape. For Fall Creek in 2012, natives Ohio buckeye and hackberry

were the most important. Many small plants of these species were present too, indicating they are naturally regenerating. There were a few large high-wildlife-quality burr oaks present. Large Amur honeysuckles, large enough to qualify in the tree category, were also prominent.

In 2015, hackberry and Ohio buckeye were even more dominant, with native box elder, cottonwood, burr oak, and slippery elm absent from the plots. Trees not present may have died, been removed during construction of the Fall Creek Trail, or perhaps they did not occur in plots in 2015 due to transects not being placed in the exact same spot each year. Data from 2105 show a large increase in importance of non-native, invasive white mulberry.

Trees in plots with Importance Values (all woody plants with dbh > 5.0 cm)

Common Name	Scientific Name	2012	2015
Box elder	<i>Acer negundo</i>	6.0	-
Norway maple*	<i>Acer platanoides</i>	7.5	10.6
Ohio buckeye	<i>Aesculus glabra</i>	20.4	23.1
Tree-of-heaven*	<i>Ailanthus altissima</i>	4.6	6.2
Catalpa	<i>Catalpa speciosa</i>	2.1	4.9
Hackberry	<i>Celtis occidentalis</i>	21.0	34.1
European spindle*	<i>Euonymus europaeus</i>	-	1.8
White ash	<i>Fraxinus americana</i>	1.9	3.3
Amur honeysuckle*	<i>Lonicera maackii</i>	9.2	-
White mulberry*	<i>Morus alba</i>	2.0	12.2
Red mulberry	<i>Morus rubra</i>	5.8	2.7
Cottonwood	<i>Populus deltoides</i>	9.7	-
Black cherry	<i>Prunus serotina</i>	1.7	1.2
Burr oak	<i>Quercus macrocarpa</i>	5.2	-
Slippery elm	<i>Ulmus rubra</i>	3.1	-

*non-native and invasive

The following trees were seen as saplings or seedlings in the herb-layer sample plots in the years indicated. They are naturally regenerating along Fall Creek.

Common Name	Scientific Name	Native	C	2012	2013	2014	2015
Boxelder	<i>Acer negundo</i>	x	1		1	11	
Norway maple	<i>Acer platanoides*</i>				1		4
Sugar maple	<i>Acer saccharum</i>	x	4		1	2	
Maple seedling	<i>Acer sp.</i>	?		5	1		
Ohio buckeye	<i>Aesculus glabra</i>	x	5		1	3	1
Tree-of-heaven	<i>Ailanthus altissima*</i>			1	4	6	3
Cigar tree	<i>Catalpa speciosa</i>	x	0	4		3	4

Common Name	Scientific Name	Native	C	2012	2013	2014	2015
Eastern redbud	<i>Cercis canadensis</i>	x	3		1	2	1
Blue ash	<i>Fraxinus quadrangulata</i>	x	7	1			1
Ash seedling	<i>Fraxinus</i> sp.	x		3	2	5	5
Honey locust	<i>Gleditsia triacanthos</i>	x	1		1		
Black walnut	<i>Juglans nigra</i>		2			1	
Eastern red cedar	<i>Juniperus virginiana</i>	x	2	1	2		1
White mulberry	<i>Morus alba</i> *			2	1		1
Mulberry seedling	<i>Morus</i> sp.	?			2	1	
Callery pear	<i>Pyrus calleryana</i> *						1
Swamp white oak	<i>Quercus bicolor</i>	x	7		1		
Northern red oak	<i>Quercus rubra</i>	x	4	1			1
Oak seedling	<i>Quercus</i> sp.	x			2	4	2
Slippery elm	<i>Ulmus rubra</i>	x	3	1			2
Siberian elm	<i>Ulmus pumila</i> *						1

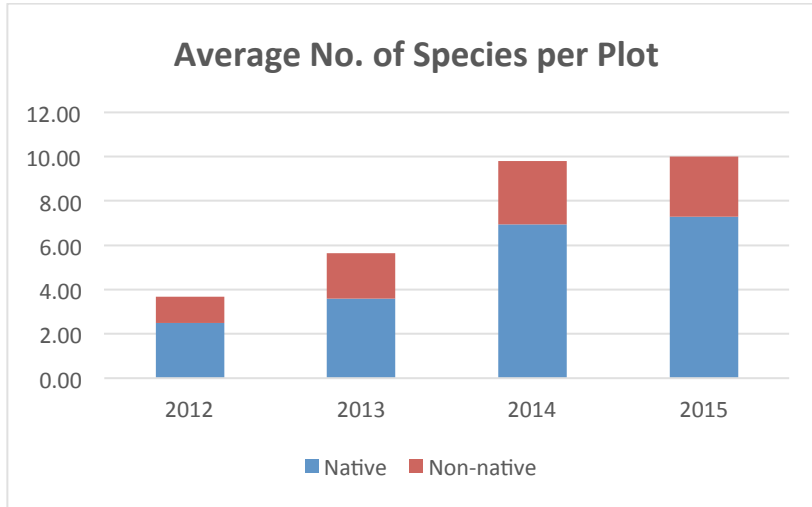
*non-native and invasive

Interpretation:

There are some mature, high quality trees characteristic of natural riparian habitat remaining along Fall Creek and some of these are naturally regenerating. Some invasive non-natives are among the most common, as well.

Overall habitat quality

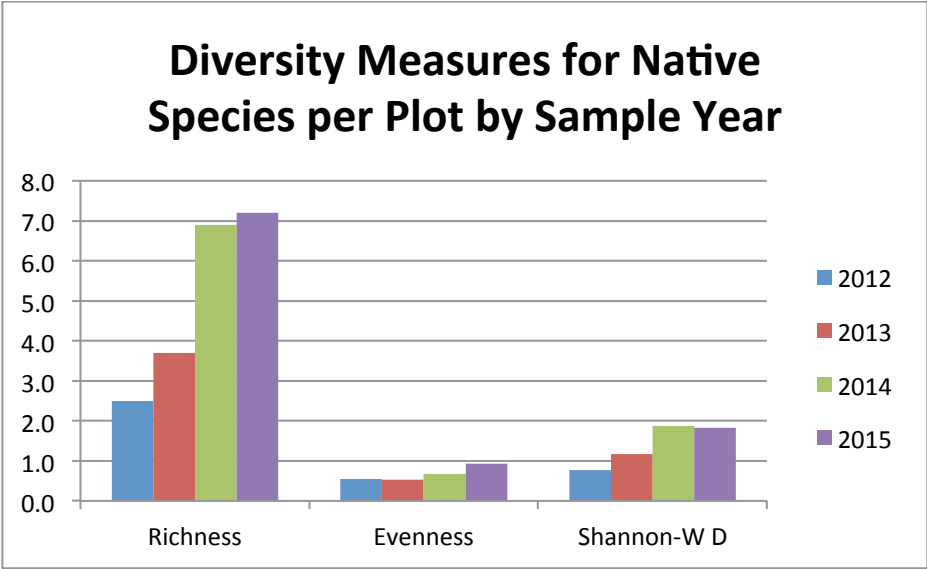
Species lists from the herbaceous-layer quadrats reveal how the vegetation changed after three years of Amur honeysuckle removal. Compiling data from all quadrats, both the total number of species per plot and the number of native species per plot increased in 2013 and 2014 over numbers present in 2012 before any Amur honeysuckle removal. The trend of increasing numbers of species following honeysuckle removal appears to be leveling off based on 2015 data.



All species found in our herb-layer surveys are listed in the Appendix, with those considered invasive in the state indicated. In 2015, invasive Callery Pear and Siberian elm were seen for the first time in plots along Fall Creek. The pear, especially, can spread quickly and should be eradicated before it becomes more established. The open habitat created by honeysuckle removal may be providing an opening for other invasive, something to keep an eye out for.

The most common native species in all years were hackberry and poison ivy. The most common non-natives were Amur honeysuckle and winter-creeper. From the outset of this project it was recognized 3 – 5 years of treatment would be needed to eradicate the honeysuckle. Bottlebrush grass, planted after the first LDOS, had established in 15 plots by 2015.

One way ecologists evaluate overall habitat quality is by looking at measures of diversity. Generally, more diverse ecosystems, in terms of numbers of species and in terms of evenness or distribution of species across a landscape, are thought to be more stable and healthier. The following chart presents three indicators of diversity for native plants growing along Fall Creek. Trends in each of the measures show improved habitat quality over time. Richness, or the number of native species in each sample plot, has more than doubled since the 2012 LDOS. The data show trends of increasing diversity each year following honeysuckle removal, with the trend tapering off in 2015.



Another way to look at changes in the flora is to use Floristic Quality Assessment. The Floristic Quality Index (FQI) measures the overall quality of the habitat as indicated by the native species present. In this approach, native species have been assigned numbers, C- values, from 0 – 10 that indicate their perceived fidelity to high quality habitats. FQI for a site is derived from these values for the species present. Greater numbers indicate greater natural habitat integrity. FQI with non-natives indicates the influence non-native plants have in reducing habitat quality. Fall Creek vegetation as a whole (considering tree and herb-layer data for all plots together each year) is, in general, trending in the right direction. However, the signal is not as strong as that indicated by the diversity statistics above.

Sites with high natural area quality would be expected to have FQI values of 35 or greater. Sites like Fall Creek that are actively undergoing restoration would be expected to have much lower values. The absolute value is not as important as how the number changes through time, with an increase indicating better site quality from an ecological perspective. Values for Fall Creek have not changed much following honeysuckle removal. It may be that natural recolonization of the site by high quality native plants will take more years to occur, or it may be that native seed sources are simply not available. Use of Floristic Quality Indexes is fairly new in Indiana, so there is not much context in which to interpret these values.

Trait	2012	2013	2014	2015
Total sp.	35	60	67	69
No. native sp.	27	43	46	46
No. non-native	8	17	21	23
Percent native	77%	72%	69%	67%
Native FQI	15.0	16.3	16.5	14.9
FQI with non-natives	13.2	13.8	13.7	12.5

Most new natives appearing in 2013, 2014 and 2015 are disturbance loving plants with C-values in the 0-2 range (Appendix), indicating they are not specialists of stabilized habitat. Joe-pye weed, with a C-value = 5, is a new naturally occurring native seen in 2013 that indicates improved habitat quality; Maryland blacksnake root (C=5) was a new native present for the first time in 2014; Maryland figwort (C=5) increased in 2015. Winter-creeper, an invasive non-native woody ground-cover also targeted for herbicide treatment 2013-2015, while still present in 22 plots in 2013, 21 plots in 2014 and 24 plots in 2015, has had its cover reduced from 26-50% to 8-25% of a plot on average.

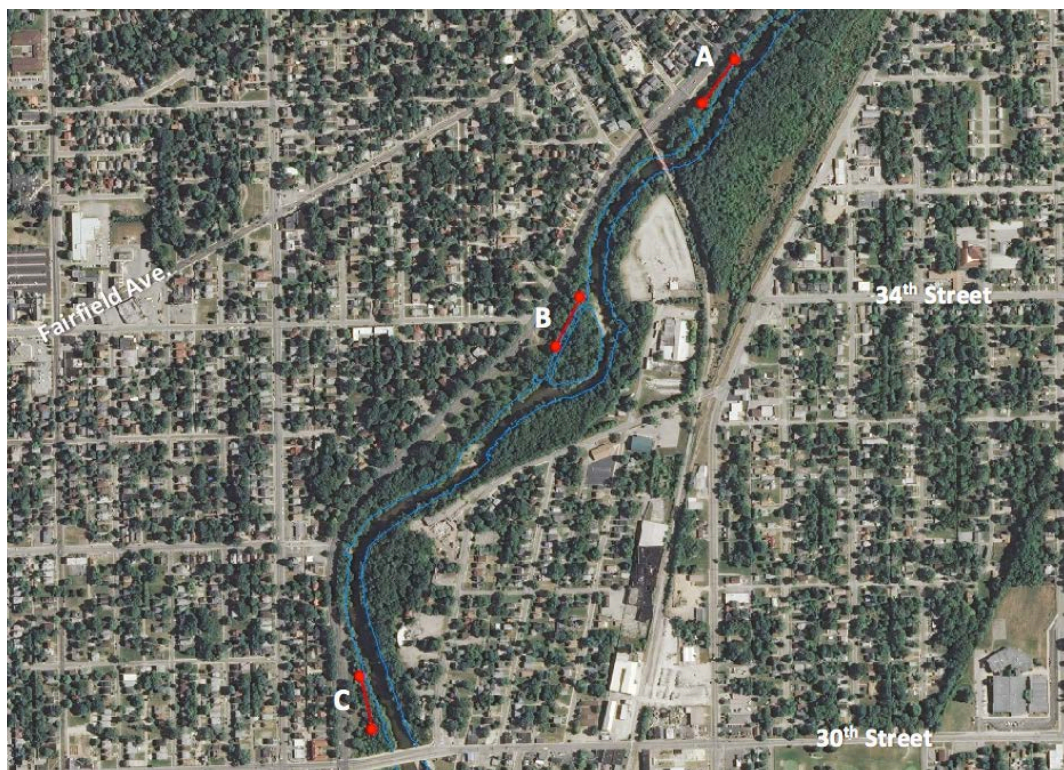
Interpretation:

Fall Creek vegetation is trending in the right direction toward higher habitat quality following removal of Amur honeysuckle during the 2012 LDOS and three additional years of treatment and removal. 2015 results indicated the trend may be tapering off.

Acknowledgments

This work was funded by Reconnecting to Our Waterways (www.reconnectingtoourwaterways.org). Prior years' work was funded by Keep Indianapolis Beautiful and Butler University. Field assistance was provided by Kelly Harris of Current-Consulting and Butler University undergraduate student assistants Brandon Euen and Jenna Kresak. The map was made by Kelly Harris.

Figure 1. Location of 100 m transects along Fall Creek.



Appendix. Entire species list for all plants seen in herb-layer plots each sample year. Species found in 10 or more plots have frequencies in bold.

Common Name	Scientific Name	Native	Invasive	C	Growth Form	# plots 2012	# plots 2013	# plots 2014	# plots 2015
Three-seeded mercury	<i>Acalypha virginica</i>	x		0	annual forb		3	12	8
Boxelder	<i>Acer negundo</i>	x		1	tree	2	5	12	6
Norway maple	<i>Acer platanoides</i>		***		tree		5	1	4
Sugar maple	<i>Acer saccharum</i>	x		4	tree	7	1	2	
Ohio buckeye	<i>Aesculus glabra</i>	x		5	tree	8	7	3	1
White snakeroot	<i>Ageratina altissima</i>	x		2	perennial forb		1	1	9
Tree-of-heaven	<i>Ailanthus altissima</i>		***		tree	3	8	15	3
Garlic mustard	<i>Alliaria petiolata</i>		***		biennial forb	3	13	12	7
Giant ragweed	<i>Ambrosia trifida</i>	x		0	annual forb		1		
Common burdock	<i>Arctium minus</i>				biennial forb		1	2	3
Spanish needles	<i>Bidens bipinnata</i>	x		0	annual forb			1	3
Common beggar's ticks	<i>Bidens frondosa</i>	x		1	annual forb			1	
Common wood sedge	<i>Carex blanda</i>	x		1	perennial sedge				10
Cigar tree	<i>Catalpa speciosa</i>	x		0	tree	4	4	6	4
Oriental bittersweet	<i>Celastrus orbiculata</i>		***		woody vine	1			
Hackberry	<i>Celtis occidentalis</i>	x		3	tree	13	17	23	26
Eastern redbud	<i>Cercis canadensis</i>	x		3	tree		1	2	1
Southern wild chervil	<i>Chaerophyllum tainturieri</i>	x		1	annual forb				1
Lamb's quarters	<i>Chenopodium album</i>				annual forb			5	
Chicory	<i>Cichorium intybus</i>				perennial forb			1	
Field thistle	<i>Cirsium arvense</i>				perennial forb		1		
Autumn virgin's bower	<i>Clematis terniflora</i>		c		woody vine	1	2	1	1
Common day flower	<i>Commelina communis</i>				annual forb		1	1	
Mistflower	<i>Conoclinium coelestinum</i>	x		2	perennial forb			1	
Horseweed	<i>Conza canadensis</i>	x		0	annual forb			2	3
Sand vine	<i>Cynanchum laeve</i>	x		1	woody vine		1	2	
Queen Anne's lace	<i>Daucus carota</i>		**		biennial forb		3	3	2

Common Name	Scientific Name	Native	Invasive	C	Growth Form	# plots 2012	# plots 2013	# plots 2014	# plots 2015
Fuller's teasel	<i>Dipsacus follonum</i>		***		biennial forb				1
Indian strawberry	<i>Duchesnea indica</i>				perennial forb				2
Bottlebrush grass ^P	<i>Elymus hystrix</i>	x		5	perennial grass		3	13	15
Annual fleabane	<i>Erigeron annuus</i>	x		0	biennial forb			2	3
Winged euonymus	<i>Euonymus alata</i>		**		shrub		1		1
Winter-creeper	<i>Euonymus fortunei</i>		***		shrub	17	22	21	24
Japanese spindle tree	<i>Euonymus hamiltoniana</i>				tree				1
Purple joe-pye weed	<i>Eupatoriadelphus purpureus</i>	x		5	perennial forb		1		
Tall boneset	<i>Eupatorium altissimum</i>	x		1	perennial forb	1	4	1	3
Climbing false buckwheat	<i>Fallopia scandens v. scandens</i>	x		0	herbaceous vine	1	2	1	2
White ash	<i>Fraxinus americana</i>	x		4	tree	4	3	2	5
Green ash	<i>Fraxinus pennsylvanica</i>	x		1	tree		1		
Blue ash	<i>Fraxinus quadrangulata</i>	x		7	tree	1	1		1
Ground ivy	<i>Glechoma hederacea</i>				perennial forb			2	
White avens	<i>Geum canadense</i>	x		1	perennial forb			1	2
Honey locust	<i>Gleditsia triacanthos</i>	x		1	tree		1		
Eastern red cedar	<i>Juniperus virginiana</i>	x		2	tree	1	2		1
Blue lettuce	<i>Lactuca floridana</i>	x		5	biennial forb			1	
Prickly lettuce	<i>Lactuca serriola</i>				biennial forb			1	2
Canada wood nettle	<i>Laportea canadensis</i>	x		2	perennial forb		1		1
Rice cut grass	<i>Leersia oryzoides</i>	x		2	perennial grass				1
Motherwort	<i>Leonurus cardiaca</i>				perennial forb		3	4	1
Border privet	<i>Ligustrum obtusifolium</i>		***		perennial forb			1	
Tulip poplar	<i>Liriodendron tulipifera</i>	x		4	tree		1		
Japanese honeysuckle	<i>Lonicera japonica</i>		***		woody vine	2			
Amur honeysuckle	<i>Lonicera maackii</i>		***		shrub	28	27	27	19
Common water horehound	<i>Lycopus americanus</i>	x		3	perennial forb		1		
Moonseed	<i>Menispermum canadense</i>	x		3	woody vine	2	1	2	3

Common Name	Scientific Name	Native	Invasive	C	Growth Form	# plots 2012	# plots 2013	# plots 2014	# plots 2015
White mulberry	<i>Morus alba</i>		***		tree	1	7	8	1
Red mulberry	<i>Morus rubra</i>	x		4	tree	2	2	1	
Evening primrose	<i>Oenothera biennis</i>	x		0	biennial forb			1	1
Hop hornbeam	<i>Ostrya virginiana</i>	x		5	tree	1			
Tall wood sorrel	<i>Oxalis stricta</i>	x		0	perennial forb		1	14	6
Prairie switch grass ^p	<i>Panicum virgatum</i>	x		4	perennial grass		1		1
Pennsylvania pellitory	<i>Parietaria pensylvanica</i>	x		1	annual forb		1		
Virginia creeper	<i>Parthenocissus quinquefolia</i>	x		2	woody vine	4	5	13	10
Lady's thumb	<i>Persicaria vulgaris</i>				annual forb			1	1
Ground cherry	<i>Physalis heterophylla</i>	x		3	perennial forb			8	
Pokeweed	<i>Phytolacca americana</i>	x		0	perennial forb		4	18	9
Canada clearweed	<i>Pilea pumila</i>	x		2	annual forb		1	4	
English plantain	<i>Plantago lanceolata</i>				perennial forb				1
Common plantain	<i>Plantago major</i>				perennial forb			2	
Sycamore	<i>Platanus occidentalis</i>	x		3	tree		1		
Annual bluegrass	<i>Poa annua</i>				annual grass				1
Solomon's seal	<i>Polygonatum biflorum</i>	x		4	perennial forb			2	1
Pale leafcup	<i>Polymnia canadensis</i>	x		3	perennial forb		1	1	2
Eastern cottonwood	<i>Populus deltoides</i>	x		1	tree	1	1	1	
Lion's foot	<i>Prenanthes alba</i>	x		5	perennial forb			1	
Black cherry	<i>Prunus serotina</i>	x		1	tree	1			
Smooth wafer ash	<i>Ptelea trifoliata</i>	x		4	shrub	2		2	1
Callery pear	<i>Pyrus calleryana</i>		***		tree				1
Swamp white oak	<i>Quercus bicolor</i>	x		7	tree		2		
Burr oak	<i>Quercus macrocarpa</i>	x		5	tree	2	1		2
Northern red oak	<i>Quercus rubra</i>	x		4	tree	1			1
Common blackberry	<i>Rubus allegheniensis</i>	x		2	shrub		2		
Black willow	<i>Salix nigra</i>	x		3	tree		1		

Common Name	Scientific Name	Native	Invasive	C	Growth Form	# plots 2012	# plots 2013	# plots 2014	# plots 2015
Common elderberry	<i>Sambucus nigra</i>	x		2	shrub	1			
Black snakeroot	<i>Sanicula marilandica</i>	x		5	perennial forb			5	
Late figwort	<i>Scrophularia marilandica</i>	x		5	perennial forb			1	4
Bristly green brier	<i>Smilax hispida</i>	x		3	woody vine	10	14	8	17
Cat brier	<i>Smilax rotundifolia</i>	x		4	woody vine		2	4	3
Bittersweet nightshade	<i>Solanum dulcamara</i>				woody vine		1	4	1
Canada goldenrod	<i>Solidago canadensis</i>	x		0	perennial forb	3	3	3	5
Prickly sow thistle	<i>Sonchus asper</i>				annual forb		1	6	
Hairy aster	<i>Symphyotrichum pilosum</i>	x		0	perennial forb	3		2	2
Common dandelion	<i>Taraxacum officinale</i>				perennial forb	4	1	12	1
Virginia knotweed	<i>Tovara virginiana</i>	x		3	perennial forb		3	2	3
Poison ivy	<i>Toxicodendron radicans</i>	x		1	woody vine	11	11	19	21
Siberian elm	<i>Ulmus pumila</i>		**		tree				1
Slippery elm	<i>Ulmus rubra</i>	x		3	tree	1			2
Woolly mullein	<i>Verbascum thapsus</i>				biennial forb		1	1	
Blue vervain	<i>Verbena hastata</i>	x		3	perennial forb		1	1	
Wingstem	<i>Verbesina alternifolia</i>	x		3	perennial forb		2	2	4
Purple violet	<i>Viola sororia</i>	x		1	perennial forb		3	3	4
Cream white violet	<i>Viola striata</i>	x		4	perennial forb		1	1	
Riverbank grape	<i>Vitis riparia</i>	x		1	woody vine	8	7	8	12

Official IISC Invasive Plant List

Indiana Invasive Species Council
<http://www.entm.purdue.edu/iisc/invasiveplants.php>

*** high

** medium

c caution

P - planted