SDRP Journal of Earth Sciences & Environmental Studies (ISSN: 2472-6397)

The influence of annual variation and seasonal turnover of plant communities in hybrid ecosystems on metrics of biodiversity: implications for herbaceous vegetation sampling design

Ashlee Nichter*[a], Andrew Gregory[b]

DOI: 10.25177/JESES.4.2.RA.467

Research

Received Date: 14th Feb 2019
Accepted Date: 01st Mar 2019
Published Date:07th Mar 2019

[a]Earth Source, Inc., 14921 Hand Road, Fort Wayne, IN 46814, 260.515.2011

[b]190 Overman Hall, Bowling Green State University, Bowling Green, OH 43403, 989.400.3492, Email: agregor@bgsu.edu

CORRESPONDENCE AUTHOR

Ashlee Nichter
Email: ashleennichter@gmail.com

CITATION

Ashlee Nichter, Andrew Gregory, The influence on annual variation and seasonal turnover of plant communities in hybrid ecosystems on metrics of biodiversity: implications for herbaceous vegetation sampling design(2019) SDRP Journal of Earth Sciences & Environmental Studies 4(2)

ABSTRACT

Background*:* Most researchers recognize and account for annual and seasonal turnover of herbaceous vegetation in sampling protocols, but few have evaluated and quantified these effects and even fewer have evaluated these effects in hybrid ecosystems. We analyzed annual and seasonal turnover in herbaceous vegetation diversity in grassland reserves, ditches, and field margins in northwest, Ohio.

Methods*:* We sampled 33 sites in 2016 and 61 sites in 2017 with 21 sites sampled in both years. The point-intercept method was used to identify species presence along either side of two 10 meter transects. Site similarity was characterized using the Jaccard similarity index. Annual variation was analyzed via a z-test, to test the difference of similarity from complete similarity. Seasonal variation was analyzed using repeated measures ANOVA.

Results*:* We identified 139 species in 2016 (54% native and 46% nonnative) and 154 species in 2017 (57% native and 43% nonnative). We identified 93 species (52% native and 48% nonnative) both in 2016 and in 2017. We found a significant difference in annual site similarity ($P < 0.01$), and a significant difference in seasonal turnover in 2016 and 2017 between all sampling periods ($P < 0.01$), except Spring to Summer versus Summer to Fall in 2016 ($P \geq 0.19$).

Conclusion*:* Because there is annual and seasonal turnover in species composition, sampling herbaceous vegetation should occur across multi-years and during multi-seasonal sampling bouts to characterize diversity in an ecosystem. Highest diversity levels occurred during the summer (June to July) and could be used to maximize sampling efficiency.

Keywords*:* Annual turnover, Hybrid ecosystems, Jaccard similarity index, Novel ecosystems, Seasonal turnover

INTRODUCTION

Human activities have fundamentally altered global ecology and resulted in novel sets of environmental conditions for most species, which ecologists refer to as either hybrid or novel ecosystems [1]. Hybrid ecosystems are ecosystems with community compositions that retain historic characteristics, but also contain community assemblages and species compositions not historically present [2]. Novel ecosystems are a special case of hybrid ecosystems that have been severely impacted, have no natural or historic analog, and the system cannot likely be restored to historic conditions [2-3]. Because few contemporary landscapes have not experienced substantial anthropogenic activity, hybrid and novel ecosystems are becoming the dominant ecological feature on the landscape and are becoming increasingly important in applied ecology and conservation [2, 4].

Many marginal ecosystems (e.g., roadsides and ditches) can be considered hybrid or even novel ecosystems [5]. Marginal ecosystems are anthropogenically disturbed ecosystems with many of them intentionally planted with nonnative species [6] then subsequently recolonized/colonized by native species [7]. Despite efforts to reduce invasion and non-native species establishment, most reserves are also heavily invaded; therefore reserves could also be considered hybrid ecosystems [8]. As a result, growing anthropogenic activity is increasing the threat and integrity of natural ecosystems.

A common characteristic in grassland communities is seasonal turnover of herbaceous vegetation. Thus, the species composition in the spring is different than species composition later in the growing season [9-11]. Therefore, the determination of community assemblage at a site may be conditioned upon the time of year that sampling occurs. Nonnative species take advantage of these varying life history traits when colonizing and, as a result, species seasonal turnover at a site might be contributing factor for the invasiveness of some non-native species [12]. The presence of nonnative species in hybrid and novel ecosystems exacerbates seasonal turnover of community assemblages [9-10]. In addition, sampling season may influence the determination of the invasiveness of the system based on the community dynamics and growing season of native and nonnative members of the local herbaceous vegetation community.

In recognition of this phenomena in dynamic grassland communities, most researchers will characterize diversity in ecosystems by sampling across years to account for year to year variation in plant detection and environmental conditions [13] or across seasons to account for seasonal variation in species turnover [9-11]. On the other hand, managers may not account for these annual and seasonal effects due to time constraints or limited sampling ability. Consequently, this could have ramifications on how a natural area is managed. While annual and seasonal turnover is widely understood, few have evaluated and quantified these effects, and even fewer have quantified these effects in hybrid ecosystems (i.e. the types of systems most likely to be targeted for restoration and active management). In this paper we seek to 1) quantify the degree to which herbaceous vegetation varies annually and seasonally, and 2) provide best sampling practices to maximize vegetation diversity detection.

METHODS

This study was conducted at grassland reserves and ditches of Lucas and Wood County in northwest Ohio (Figure 1). We sampled 33 sites in 2016 and 61 sites in 2017 with 21 sites sampled in both years. Each site was sampled during three sampling periods from March to August 2016 and 2017. Spring sampling occurred from 12-March to 9-June; Summer sampling occurred from 14-June to 14-July; Fall sampling occurred from 19-July to 21-August.

We assessed vegetation diversity of ditch sites along two, 10-meter transects each placed at a 20º angle from the bottom of either side of the ditch. Due to concerns regarding sampling disturbance in ground nesting bird habitat in reserves, we modified reserve site sampling to one 10-meter transect at a random bearing from a randomly selected set of GPS coordinates chosen within each grassland patch of the reserve (Karen Menard, Stewardship Supervisor of Metroparks Toledo *personal communication*). We

used the point-intercept count method to index vegetation species presence every 0.25 meters along each transect [14].

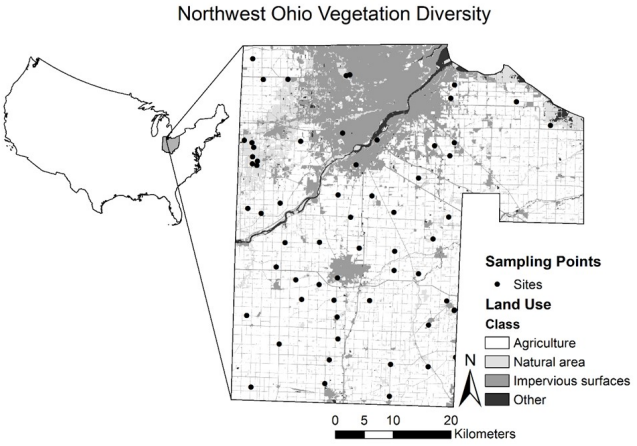

Figure 1. Locations of the 61 sampling sites in Lucas and Wood Counties in Ohio, USA.

We defined native diversity as defined by the Ohio Invasive Plants Council as species that were documented in the region prior to 1800. Species that did not fit this requirement were deemed nonnative [15; Supplementary File 1]. Species with no conclusive native or nonnative classification were excluded from the analysis (N = 1).

We used the Jaccard similarity index to compare year to year and seasonal variation in community assemblages. Jaccard similarity index is defined as:

$$\text{Jaccard} = \frac{M}{(M+N)}$$

where M is the total number of shared taxa and N is the total number of taxa not shared [16]. In this context, the Jaccard similarity index can be viewed as an indication of the percent shared species between sites out of the total species pool sampled among sites or time periods. We used the vegan package (Oksanen et al. 2017) in R (version 3.4, R Core Team, Vienna, AT) to calculate the Jaccard similarity index. The vegan package calculates the Jaccard dissimilarity, so we subtracted one from all values to obtain the Jaccard similarity index (Oksanen et al. 2017).

To compare year to year variation, we used a *z*-test to test significant deviation from one (complete similarity) to see if species assemblages differ between years using the PASWR package (Arnholt 2012) in R (version 3.4, R Core Team, Vienna, AT). For seasonal variation, we used a repeated measures ANOVA to compare similarity measures between sites from Spring to Summer, Summer to Fall, and Spring to Fall. We calculated a linear mixed model using package nlme (Pinheiro and Bates 2017) in R and used ANOVA to obtain the repeated measures ANVOA results. We used *post hoc* paired *t*-tests to test for significant differences among paired sampling periods. We compared seasonal variation for 2016 and 2017 in a separate analyses.

RESULTS

In 2016, 54% of the species were native and 46% of the species were nonnative (139 total species). In 2017, 57% of the species were native and 43% of the species were nonnative (154 total species). Between 2016 and 2017, 52% native and 48% nonnative species (93 total species) were the same. The average site similarity from 2016 to 2017 was 0.24. We found a significant difference in site similarity between 2016 and 2017 ($P < 0.01$; Supplementary File 2). For all sites collectively, only 47% of the species between 2016 and 2017 occurred at sites in both years.

In 2016, we identified 77 species in the Spring (52% native and 48% nonnative species), 84 species in the Summer (55% native and 45% nonnative species), and 74 species in the Fall (50% native and 50% nonnative species). In 2017, we identified 136 species in the Spring (60% native and 40% nonnative species), 152 species in the Summer (63% native and 37% nonnative species), and 114 species in the Fall (63% native and 37% nonnative species). We found a significant difference among sampling period Jaccard similarities in 2016 ($P < 0.01$; Supplementary File 3). Specifically, we found a significant differences from Spring to Fall versus Summer to Fall ($P < 0.01$) and Spring to Summer versus Spring to Fall ($P < 0.02$).

We did not find a significant difference in similarities of Spring to Summer versus Summer to Fall ($P \geq 0.19$). We also found significant differences among sampling period similarities in 2017 ($P < 0.01$; Supplementary File 3). Specifically, we found significant differences among all period similarity comparisons from Spring to Fall versus Summer to Fall ($P < 0.01$), Spring to Summer versus Spring to Fall ($P < 0.04$), and Spring and Summer versus Summer and Fall ($P < 0.01$).

Table 1. Mean and standard deviations for seasonal Jaccard similarities.

Period Comparison	2016	2017
Spring and Summer	0.2 ± 0.14	0.2 ± 0.1
Summer and Fall	0.24 ± 0.14	0.34 ± 0.2
Spring and Fall	0.14 ± 0.10	0.17 ± 0.1

CONCLUSION

Our data suggest on average only about 25% of the species recorded at a site were present both years sampled. Although similarity is low between years, this can be attributed to the increase in total diversity, specifically the number of species, during the last year (61 species). The observed increase in diversity from 2016 to 2017, or turnover in diversity among years could be driven by climatic variations (e.g., temperature and precipitation) [11, 17] and phenological and life form classification (e.g., perennial, biennial, and annual) differences among species [11, 18]. Specifically, Schultz et al. [11] observed that drought conditions in one year resulted in lower site diversity and delayed phenological events $\geq$1 growing year after the observed drought period. Although we did not specifically measure precipitation during our study, we did have significantly more rainfall during the second year of our study and observed higher native species community composition during the 2017 field season.

Although the similarities among the seasons were not significant in 2016, seasonal site similarity was very low. Between Spring and Summer only 20% of the species were the same and only 24% were the same between Summer and Fall. Similarities were even lower when comparing Spring to Fall. Seasonal turnover in 2017 was significant and, like 2016, was low. Between Spring and Summer only 20% of the species were present in both seasons and 34% of the species were present in Summer and Fall. Similar to 2016, the lowest similarity was between Spring and Fall. As a result, there is likely high species turnover occurring during the Summer (June to July). This can be partially attributed to phenological differences of germination and senescence [11, 18] and the amount of system-wide disturbance. In northwest Ohio, disturbance in ditches and field margins can almost solely be attributed to frequent mowing by Ohio Department of Transportation. This influences species composition because only species adapted to frequent disturbance can survive. Moreover, mowing influences species detection depending on the timing of the survey related to the timing of mowing.

While we detected low similarities in diversity across years, further research beyond two years may confirm the influence of climatic and phenological variations on inter-annual diversity [11]. Also, while we fully characterized diversity at our sites, we did not conduct exhaustive searches. Species may have been missed that did not occur along the sampling transect or were too young to be accurately identified to the species level.

Because of the observed inter-annual and seasonal variability of hybrid ecosystems, sampling efforts to characterize diversity should be determined by management goals; thus, defining when and how frequently to sample each site. Hybrid ecosystems, specifically the ditch network, in northwest Ohio are a highly interconnected network. If the goal was to characterize diversity of the hybrid ecosystems as a whole, sampling should occur across multiple years and seasons, but each site may only need to be sampled once. On the other hand, ditches are privately and publically owned and, while ditches are physically connected they are not functionally connected [4], each ditch should be treated as its own hybrid ecosystem. Therefore, each site should be sampled across multiple years and seasons.

Failing to account for inter-annual and seasonal variability could bias results and lead to the mismanagement of hybrid ecosystems. Multiple sampling year effort is advised regardless of the number of sampling periods used as sampling all sites and characterizing the entire system in 2016 could account for a downward bias of up to 31% or in this case missing 61 total species (23% or 46 species for 2017). Therefore, if the goal is to characterize diversity on a site by site basis and happens to occur in a dry year, diversity may be underrepresented. Given that under most climate change scenarios we anticipate a greater frequency of extreme weather event years, this propensity to underestimate diversity with a singular annual survey could prove detrimental to core management and restoration objectives for some grassland systems.

Sampling to characterize the entire ecosystem during the peak turnover or Summer (June to July) would account for 65% of the species identified in 2016 and 70% identified in 2017, but, similar to inter-annual variation, would be much lower on a site by site basis. Moreover, this observed level of turnover from inter-annual and seasonal variation is sufficient to change our inference about overall ecosystem integrity. For example, depending on the season and year sampled, we would infer that between 37% and 50% of the herbaceous vegetative community at a site was comprised of non-native species. In addition, comparing restoration success from sites sampled in different time periods from different years could bias the effectiveness of the results leading to improper site management.

While inter-annual and seasonal variations in vegetation diversity is well known, few have quantified these changes. We demonstrated that site similarity across years and seasons is low, and therefore, to properly and fully characterize diversity researchers and managers should sample across multiple years and seasons.

AUTHOR CONTRIBUTIONS

Ashlee Nichter contributed to the design, data collection, analysis, and writing.

Andrew Gregory contributed to acquiring funding, design, data collection, analysis, and writing.

ACKNOWLEDGEMENTS

We thank Hannah Olenik, Andy Dolan, Jordyn Hutchinson, Kaylee Luke, Mist Peavler, Casey Stephens, and Mitchell Woodruff who were technicians on this project. We also thank all private land owners, Bowling Green Parks and Recreation, Metroparks Toledo, Ottawa National Wildlife Refuge, and Wood County Parks District for access to their property to conduct this research. We also thank Bowling Green State University Center for Undergraduate Research and Scholarship, Bowling Green State University Department of Geology, and Ohio Environmental Protection Agency for support. Partial support for A. Gregory and A. Nichter was provided by Bowling Green State University.

FUNDING/FINANCIAL DISCLOSURE

Partial funding for this study was provided by Bowling Green State University Center for Undergraduate Research and Scholarship and Ohio EPA.

REFERENCES

[1] Ellis, E.C., and N. Ramankutty. 2008. Putting people in the map: Anthropogenic biomes of the world. Frontiers in Ecology and the Environment 6:439-447. View Article

[2] Hobbs, R.J., E. Higgs, and J.A. Harris. 2009. Novel ecosystems: Implications for conservation and restoration. Trends in Ecology and Evolution 24:599–605. PMid:19683830 View Article PubMed/NCBI

[3] Kasari, L., L. Saar, F. de Bello, K. Takkis, and A. Helm. 2016. Hybrid ecosystems can contribute to local biodiversity conservation. Biodiversity and Conservation 25 3023–3041. View Article

[4] Nichter, A.N. 2017. Population dynamics of hybrid ecosystems: Implications for conservation and management. (Electronic Thesis or Dissertation). Retrieved from View Article

[5] Arenas, J.M., A. Escudero, and I. Mota. 2017. Roadsides: An opportunity for biodiversity conservation. Journal of Applied Vegetation Science 20:527-537. View Article

[6] Mayer, P.M., S.K. Reynolds, and T.J. Canfield. 2005. Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of

current science and regulations. Cincinnati, Ohio: National Risk Management Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. View Article

[7] Kiss, J., K. Penksza, T. Toth, and F. Kadar. 1997. Evaluation of fields and field margins in nature production capacity with special regard to plant protection. Agriculture Ecosystems and Environment 63:227–232. 00018-2 View Article

[8] Collinge, S.K. 2009. Ecology of fragmented landscapes. Johns Hopkins University Press, Baltimore, MD. View Article

[9] Teeri, J.A., and L.G. Stowe. 1976. Climatic patterns and the distribution of C4 grasses in North America. Oecologia 3:1–12. PMid:28309208 View Article PubMed/NCBI

[10] Cochrane, T.S., and H.H. Iltis. 2000. Atlas of the Wisconsin prairie and savanna flora. Department of Natural Resources, University of Wisconsin. Technical Bulletin No. 191. View Article

[11] Schultz, N.L., N. Reid, G. Lodge, and J.T. Hunter. 2014. Seasonal and interannual variation in vegetation composition: Implications for survey design and data interpretation. Austral Ecology 39(7):755-766. View Article

[12] Lockwood, J.L., M.F. Hoopes, and M.P. Marchetti. 2007. Invasion Ecology. Wiley-Blackwell. View Article

[13] Barbour, M.G., J.H. Burk, and W.D. Pitts. 1987. Method of sampling the plant community. Pp. 210-239. Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam, and M.W. Schwarts. Terrestrial Plant Ecology. Benjamin/Cummings Publishing Co., Menlo Park, CA. PMCid:PMC260699

[14] Caratti, J.F. 2006. Point Intercept (PO): Sampling method. U.S. Forest Service. View Article

[15] Ohio Invasive Plants Council. Ohio Invasive Plant Assessment Protocol. Accessed 10 September 2017 from View Article

[16] Hammer, Ø., and D.A.T. Harper. 2006. Paleontological data analysis. Blackwell Pub, Malden. View Article

[17] Pitt M.D., and H.F. Heady. 1978. Responses of annual vegetation to temperature and rainfall patterns in northern California. Ecology 59:336–50. View Article

[18] Rathcke, B., and E.P. Lacey. 1985. Phenological patterns of terrestrial plants. Annual Review of Ecology and Systematics 16(1):179-214. View Article

Supplementary File 1. List of websites for taxonomic classification and native or nonnative classification[1].

Website	URL
Illinois Wildflowers	http://www.illinoiswildflowers.info/
Minnesota Wildflowers	https://www.minnesotawildflowers.info/
Ohio Division of Natural Areas and Preserves	http://naturepreserves.ohiodnr.gov/natural-features-of-ohio/ohio-wildflowers/species-profiles
Ohio Invasive Plant Council	https://www.oipc.info/
USDA Natural Resource Conservation Service	https://plants.usda.gov/java/

[1]This is not an exhaustive list of websites and sources

Supplementary File 2. Year to year variation in species turnover. This table is organized alphabetically by scientific name and by native and nonnative species. Species found in both years are organized first, secondly species only found in 2016, and lastly by species only found in 2017.

Scientific Name	Common Name	Nativeness	2016	2017
Achillea millefolium	Common yarrow	Native	X	X
Alliaria petiolata	Garlic mustard	Nonnative	X	X
Allium oleraceum	Field garlic	Nonnative	X	X
Ambrosia trifida	Giant ragweed	Native	X	X
Apocynum cannabinum	Common dogbane	Native	X	X
Asclepias incarnata	Swamp milkweed	Native	X	X
Asclepias syriaca	Common milkweed	Native	X	X
Asparagus officinalis	Wild asparagus	Nonnative	X	X
Barbarea vulgaris	Common wintercress	Nonnative	X	X
Bromus inermis	Smooth brome	Nonnative	X	X
Bromus japonicus	Japanese brome	Nonnative	X	X
Bromus tectorum	Cheatgrass	Nonnative	X	X
Calystegia sepium	Hedge bindweed	Native	X	X
Carex lacustris	Common lake sedge	Native	X	X
Carex scoparia	Pointed broom sedge	Native	X	X
Carex cristatella	Crested sedge	Native	X	X
Cichorium intybus	Common chicory	Nonnative	X	X
Cirsium arvense	Canada thistle	Nonnative	X	X
Conium maculatum	Poison hemlock	Nonnative	X	X
Convolvulus arvensis	Field bindweed	Nonnative	X	X
Conyza canadensis	Horseweed	Native	X	X
Cornus sericea	Red osier dogwood	Native	X	X
Daucus carota	Wild carrot	Nonnative	X	X
Deschampsia flexuosa	Wavy hairgrass	Nonnative	X	X
Dipsacus fullonum	Common teasel	Nonnative	X	X
Dipsacus laciniatus	Cut-leaved teasel	Nonnative	X	X
Echinochloa crus-galli	Barnyard grass	Nonnative	X	X
Elaeagnus umbellata	Autumn olive	Nonnative	X	X
Elymus repens	Couch grass	Nonnative	X	X
Elymus virginicus	Virginia wildrye	Native	X	X
Equisetum arvense	Field horsetail	Native	X	X
Erigeron philadelphicus	Philadephia fleabane	Native	X	X
Festuca pratensis	Fescue (meadow)	Nonnative	X	X
Fragaria virginiana	Wild strawberry	Native	X	X
Galium aparine	Cleavers	Native	X	X
Geum canadense	White avens	Native	X	X
Geum macrophyllum	Large leaf avens	Native	X	X
Glechoma hederacea	Ground ivy	Nonnative	X	X
Ipomoea pandurata	Wild potato vine	Native	X	X
Juncus tenuis	Path rush	Native	X	X
Juncus effusus	Common rush	Native	X	X

Lactuca serriola	Prickly lettuce	Nonnative	X	X
Lamium purpureum	Purple dead nettle	Nonnative	X	X
Leersia oryzoides	Rice cutgrass	Native	X	X
Lepidium campestre	Field peppergrass	Nonnative	X	X
Linaria vulgaris	Yellow toadflax	Nonnative	X	X
Lolium arundinaceum	Tall fescue	Nonnative	X	X
Melilotus officinalis	Yellow sweet clover	Nonnative	X	X
Melitotus alba	White sweet clover	Nonnative	X	X
Morus alba	White mulberry	Nonnative	X	X
Pancium leibergii	Leibergs panicgrass	Native	X	X
Parthenocissus quinquefolia	Virginia creeper	Native	X	X
Pascopyrum smithii	Western wheatgrass	Native	X	X
Pastinaca sativa	Wild parsnip	Nonnative	X	X
Phalaris arundinacea	Reed canarygrass	Nonnative	X	X
Phytolacca americana	American pokeweed	Native	X	X
Plantago lanceolata	English plantain	Nonnative	X	X
Plantago major	Broadleaf plantain	Nonnative	X	X
Poa pratensis	Kentucky bluegrass	Nonnative	X	X
Polygonum pensylvanicum	Pennsylvania smartweed	Native	X	X
Pycnanthemum pilosum	Hairy mountain mint	Native	X	X
Ranunculus hispidus	Hispid buttercup	Native	X	X
Rhus glabra	Smooth sumac	Native	X	X
Robinia pseudoacacia	Black locust	Native	X	X
Rorippa nasturtium-aquaticum	Mountain watercress	Nonnative	X	X
Rubus allegheniensis	Blackberry	Native	X	X
Rubus idaeus	Red raspberry	Nonnative	X	X
Rubus occidentalis	Black raspberry	Native	X	X
Rudbeckia laciniata	Cutleaf coneflower	Native	X	X
Rumex obtusifolius	Broadleaf dock	Nonnative	X	X
Rumex occidentalis	Western dock	Native	X	X
Rumex crispus	Curlydock	Nonnative	X	X
salix nigra	Black willow	Native	X	X
Setaria glauca	Yellow foxtail	Nonnative	X	X
Silene latifolia	White campion	Nonnative	X	X
Silphium terebinthinaceum	Prairie dock	Native	X	X
Solidago altissima	Tall goldenrod	Native	X	X
Solidago canadensis	Canada goldenrod	Native	X	X
Solidago speciosa	Showy goldenrod	Native	X	X
Sorghastrum nutans	Indian grass	Native	X	X
Symphyotrichum pilosum	Frost aster	Native	X	X
Taraxacum officinale	Dandelion	Native	X	X
Thalictrum dasycarpum	Tall meadow rue	Native	X	X
Toxicodendron vernix	Poison Sumac	Native	X	X
Toxicodendron radicans	Eastern poison ivy	Native	X	X

Tragopogon pratensis	Meadow salsify	Nonnative	X	X
Trifolium pratense	Red clover	Nonnative	X	X
Trifolium repens	White clover	Nonnative	X	X
Typha angustifolia	Narrow-leaved cattail	Nonnative	X	X
Typha latifolia	Common cattail	Native	X	X
Urtica dioica	Stinging nettle	Native	X	X
Verbascum thapsus	Common mullein	Nonnative	X	X
Vitis riparia	River bank grape	Nonnative	X	X
Acer rubrum	Red maple	Native	X	-
Adiantum pedatum	Maidenhair fern	Native	X	-
Agrostis stolonifera	Creeping bentgrasss	Nonnative	X	-
Allium canadense	Wild onion	Native	X	-
Amaranthus retroflexus	Redroot pigweed	Nonnative	X	-
Ambrosia artemisiifolia	Common ragweed	Native	X	-
Andropogon gerardii	Big bluestem	Native	X	-
Asclepias verticillata	Whorled milkweed	Native	X	-
Asclepias viridiflora	Green milkweed	Native	X	-
Bidens polylepis	Tickseed sunflower	Native	X	-
Carex intumescens	Greater bladder sedge	Native	X	-
Cornus amomum	Silky dogwood	Native	X	-
Coronilla varia	Crown vetch	Nonnative	X	-
Dipsacus pilosus	Small teasel	Nonnative	X	-
Duchesnea indica	Mock strawberry	Nonnative	X	-
Erysimum cheiranthoides	Wormseed mustard	Nonnative	X	-
Glycine max	Soybeans	Nonnative	X	-
Helianthus grosseserratus	Saw tooth sunflower	Native	X	-
Hemerocallis fulva	Common day-lily	Nonnative	X	-
Hesperis matronalis	Dame's violet	Nonnative	X	-
Iodanthus pinnatifidus	Purple rocket	Native	X	-
Lonicera maackii	Amur honeysuckle	Nonnative	X	-
Medicago lupulina	Black medic	Nonnative	X	-
Mentha arvensis	Wild mint	Native	X	-
Morus rubra	Red mulberry	Native	X	-
Muscari armeniacum	Grape hyacinth	Nonnative	X	-
Oligoneuron rigidum	Stiff goldenrod	Native	X	-
Onoclea sensibilis	Sensitive fern	Native	X	-
Oxalis acetosella	Wood sorrel	Native	X	-
Panicum capillare capillare	Witchgrass	Native	X	-
Panicum virgatum	Switchgrass	Native	X	-
Potentilla reptans	Five finger grass	Nonnative	X	-
Pycnanthemum virginianum	Virginia mountain mint	Native	X	-
Pyrus calleryana	Callery pear tree	Nonnative	X	-
Quercus rubra	Red oak	Native	X	-
Ranunculus acris	Tall buttercup	Nonnative	X	-
Setaria faberi	Giant foxtail	Nonnative	X	-

Symphyotrichum ericoides	White heath aster	Native	X	-
Thlaspi arvense	Water pennycress	Nonnative	X	-
Vernonia altissima	Tall ironweed	Native	X	-
Vernonia fasciculata	Ironweed	Native	X	-
Veronica peregrina	Hairy purslane speedwell	Native	X	-
Vicia americana	American vetch	Native	X	-
Vicia villosa	Hairy vetch	Nonnative	X	-
Viola renifolia	Kidney leaved violet	Native	X	-
Zea mays	Corn	Nonnative	X	-
Agrostis scabra	Rough bentgrass	Native	-	X
Ailanthus altissima	Tree of heaven	Nonnative	-	X
Alisma triviale	Large water plantain	Native	-	X
Amaranthus hybridus	Smooth pigweed	Native	-	X
Arctium minus	Common burdock	Nonnative	-	X
Aronia melanocarpa	Black chokecherry	Native	-	X
Barbarea vulgaris arcuata	Yellow rocket	Nonnative	-	X
Boehmeria cylindrica	False nettle	Native	-	X
Brachypodium sylvaticum	False brome	Nonnative	-	X
Carex radiata	Star sedge	Native	-	X
Carex vulpinoidea	Foxtail barley	Native	-	X
Celastrus scandens	American bittersweet	Native	-	X
Cicuta maculata	Water hemlock	Native	-	X
Cirsium altissimum	Tall thistle	Native	-	X
Cirsium vulgare	Bull thistle	Nonnative	-	X
Cornus florida	Flowering dogwood	Native	-	X
Dianthus armeria	Deptford Pink	Nonnative	-	X
Echinacea pallida	Pale purple coneflower	Native	-	X
Equisetum hyemale	Scouring rush	Native	-	X
Fallopia scandens	Climbing false buckwheat	Native	-	X
Fissidens adianthoides	Maidenhair split toothed moss	Native	-	X
Fraxinus americana	White ash	Native	-	X
Galium pilosum	Hairy bedstraw	Native	-	X
Geum rivale	Purple avens	Native	-	X
Hordeum jubatum	Fringed loosestrife	Native	-	X
Ipomoea hederacea	Ivy leaf morning glory	Nonnative	-	X
Lamium album	White dead nettle	Nonnative	-	X
Lamium amplexicaule	Henbit dead nettle	Nonnative	-	X
Leptochloa fascicularis	Bearded sprangletop	Native	-	X
Lonicera morrowii	Morrow's honeysuckle	Nonnative	-	X
Lysimachia ciliata	Fox sedge	Native	-	X
Lysimachia nummularia	Moneywort	Nonnative	-	X
Monarda fistulosa	Wild bergamot	Native	-	X
Monarda media	Purple bergamot	Native	-	X
Nepata cataria	Catnip	Nonnative	-	X
Oxalis stricta	Yellow wood sorrel	Native	-	X

Phleum pratense	Timothy grass	Nonnative	-	X	
Phragmites australis	Reed phragmites	Nonnative	-	X	
Rhus copallinum	Prairie flame sumac	Native	-	X	
Rosa multiflora	Multiflora rose	Nonnative	-	X	
Rudbeckia hirta	Black-eyed susan	Native	-	X	
Rumex acetosella	Field sorrel	Nonnative	-	X	
Rumex maritimus	Golden dock	Native	-	X	
sabatia angularis	Common pink rose	Native	-	X	
Sambucus nigra ssp. canadensis	American Elder	Native	-	X	
Schizachyrium scoparium	Little blue stem	Native	-	X	
Scirpus atrovirens	Dark green bulrush	Native	-	X	
Setaria viridis	Green foxtail	Nonnative	-	X	
Smilax rotundifolia	Round leaved greenbrier	Native	-	X	
Solanum carolinense	Horse nettle	Native	-	X	
Solidago gigantea	Late goldenrod	Native	-	X	
Solidago nemoralis	Field goldenrod	Native	-	X	
Solidago rugosa	Wrinkle leaved goldenrod	Native	-	X	
Solidago odora	Sweet goldenrod	Native	-	X	
Sonchus avrensis	Perennial sowthistle	Nonnative	-	X	
Symphyotrichum laeve	Smooth blue aster	Native	-	X	
Symphyotrichum novae-angliae	New england aster	Native	-	X	
Tragopogon dubius	Western salsify	Nonnative	-	X	
Trifolium campestre	Low hop clover	Nonnative	-	X	
Verbena hastata	Blue vervain	Native	-	X	
Veronica arvensis	Corn speedwell	Nonnative	-	X	

Supplementary File 3. Seasonal variation in species organized alphabetically and by native or nonnative classification. Sp = Spring, Su = Summer, and F = Fall.

			2016			2017		
Scientific Name	Common Name	Nativeness	Sp	Su	F	Sp	Su	F
Acer rubrum	Red maple	Native	X	-	-	-	-	-
Achillea millefolium	Common yarrow	Native	-	X	-	X	X	X
Adiantum pedatum	Maidenhair fern	Native	-	-	X	-	-	-
Agrostis scabra	Rough bentgrass	Native	-	X	X	X	-	X
Alisma triviale	Large water plantain	Native	-	-	-	-	-	X
Amaranthus hybridus	Smooth pigweed	Native	-	-	-	X	-	-
Ambrosia artemisiifolia	Common ragweed	Native	X	X	-	X	X	-
Ambrosia trifida	Giant ragweed	Native	X	X	X	X	X	X
Andropogon gerardii	Big bluestem	Native	-	-	X	X	-	X
Apocynum cannabinum	Common dogbane	Native	-	-	-	X	X	X
Arabis glabra	Tower rockcress	Native	-	-	-	X	-	-
Aronia melanocarpa	Black chokecherry	Native	-	-	-	-	X	X
Asclepias incarnata	Swamp milkweed	Native	-	X	X	-	X	X
Asclepias syriaca	Common milkweed	Native	X	X	X	X	X	X

Asclepias verticillata	Whorled milkweed	Native	-	-	-	X	X	-
Asclepias viridiflora	Green milkweed	Native	X	-	-	-	-	-
Bidens polylepis	Tickseed sunflower	Native	X	-	-	-	-	-
Boehmeria cylindrica	False nettle	Native	-	-	-	-	X	-
Calystegia sepium	Hedge bindweed	Native	-	X	X	X	X	X
Carex bebbii	Bebb's sedge	Native	-	-	-	-	X	-
Carex conoidea	Open fieldsedge	Native	-	-	-	X	X	-
Carex intumescens	Greater bladder sedge	Native	X	-	-	-	-	-
Carex lacustris	Common lake sedge	Native	X	X	X	X	X	X
Carex molesta	Troublesome sedge	Native	-	-	-	-	X	-
Carex perglobosa	Globe sedge	Native	-	-	-	-	-	X
Carex radiata	Star sedge	Native	-	-	-	X	-	-
Carex scoparia	Pointed broom sedge	Native	X	X	-	X	X	X
Carex vulpinoidea	Foxtail barley	Native	-	-	-	-	X	X
Carex comosa	Bristly sedge	Native	X	X	X	-	-	-
Carex cristatella	Crested sedge	Native	X	X	X	-	X	X
Celastrus scandens	American bittersweet	Native	-	-	-	-	X	X
Celtis occidentalis	Hackberry	Native	-	-	-	-	X	-
Chamaecrista fasciculata	Partridge pea	Native	-	-	-	-	-	X
Cicuta bulbifera	Bulbet-bearing water hemlock	Native	-	-	-	-	X	-
Cicuta maculata	Water hemlock	Native	-	-	-	-	X	-
Cirsium altissimum	Tall thistle	Native	-	-	-	-	X	-
Comptonia peregrina	Sweet fern	Native	X	-	-	-	-	-
Conyza canadensis	Horseweed	Native	X	X	X	X	X	-
Coreopsis lanceolata	Lanceleaf coreposis	Native	-	-	-	-	X	-
Cornus florida	Flowering dogwood	Native	-	-	-	X	X	X
Cornus obliqua	Pale dogwood	Native	-	-	-	-	X	X
Cornus racemosa	Gray dogwood	Native	-	-	-	X	-	X
Cornus sericea	Red osier dogwood	Native	-	-	-	X	X	X
Cyperus lupulinus	Great plains flat-sedge	Native	-	-	-	-	X	X
Dianthus deltoides	Maiden pink	Native	-	-	-	-	X	-
Digitaria cognata	Fall witchgrass	Native	-	-	-	-	X	-
Echinacea pallida	Pale purple coneflower	Native	-	-	-	X	X	-
Elymus virginicus	Virginia wildrye	Native	-	-	X	-	X	X
Epilobium ciliatum ssp. Glandulosum	Northern willowherb	Native	-	-	-	X	X	-
Equisetum arvense	Field horsetail	Native	X	X	X	X	X	X
Equisetum hyemale	Scouring rush	Native	-	-	-	X	X	-
Erigeron philadelphicus	Philadephia fleabane	Native	-	-	X	X	X	-
Erigeron strigosus	Daisy fleabane	Native	-	-	-	-	-	X

Fallopia scandens	Climbing false buckwheat	Native	-	-	-	-	X	-
Fissidens adianthoides	Maidenhair split toothed moss	Native	-	-	-	X	-	-
Fragaria virginiana	Wild strawberry	Native	X	X	X	X	X	X
Fraxinus americana	White ash	Native	-	-	-	-	X	X
Galium aparine	Cleavers	Native	X	X	-	X	X	X
Galium pilosum	Hairy bedstraw	Native	-	-	-	X	-	-
Geranium carolinianum	Carolina cranesbill	Native	-	-	-	-	X	-
Geum aleppicum	Yellow avens	Native	-	-	-	X	-	-
Geum canadense	White avens	Native	-	X	X	-	X	X
Geum macrophyllum	Large leaf avens	Native	-	-	-	X	-	-
Geum rivale	Purple avens	Native	-	-	-	-	X	X
Helenium autumnale	Sneezeweed	Native	-	-	-	-	X	-
Hibiscus moscheutos	Crimson eyed-rose mallow	Native	-	-	-	X	-	-
Hieracium longipilum	Hairy hawkweed	Native	-	-	-	X	-	-
Hordeum jubatum	Fringed loosestrife	Native	-	-	-	X	-	-
Hypericum perforatum	St. johnwort	Native	-	X	-	-	-	-
Iodanthus pinnatifidus	Purple rocket	Native	X	-	-	-	-	-
Ipomoea pandurata	Wild potato vine	Native	X	X	-	X	X	X
Iris versicolor	North blue flag iris	Native	X	-	-	-	-	-
Juncus tenuis	Path rush	Native	-	X	-	-	X	X
Juncus effusus	Common rush	Native	X	X	-	-	X	-
Juniperus virginiana	Eastern red cedar	Native	-	-	-	X	X	-
Krigia virginica	Dwarf dandelion	Native	-	-	-	X	-	-
Leersia oryzoides	Rice cutgrass	Native	-	X	X	-	X	X
Leptochloa fascicularis	Bearded sprangletop	Native	-	-	-	X	-	-
Lupinus perennis	Wild lupine	Native	-	-	-	X	-	-
Lysimachia ciliata	Fox sedge	Native	-	-	-	-	X	-
Lysimachia quadrifolia	Whorled loosestrife	Native	-	-	-	X	-	-
Maianthemum stellatum	Star flowered solomon seal	Native	-	-	-	X	-	-
Mentha arvensis	Wild mint	Native	-	X	-	X	-	-
Monarda fistulosa	Wild bergamot	Native	-	-	X	X	X	X
Monarda media	Purple bergamot	Native	-	-	-	X	X	X
Oligoneuron ohioense	Ohio goldenrod	Native	-	-	-	-	X	-
Oligoneuron rigidum	Stiff goldenrod	Native	X	-	-	-	-	-
Onoclea sensibilis	Sensitive fern	Native	X	X	X	-	-	-
Opuntia humifusa	Eastern prickly pear	Native	-	-	-	-	X	-

Osmundastrum cinn -amomeum	Cinnamon fern	Native	-	-	-	-	X	X
Oxalis acetosella	Wood sorrel	Native	-	X	-	-	-	-
Oxalis stricta	Yellow wood sorrel	Native	-	-	-	-	X	-
Pancium leibergii	Leibergs panicgrass	Native	X	X	X	X	X	X
Panicum capillare	Witchgrass	Native	X	X	X	-	X	-
Panicum virgatum	Switchgrass	Native	-	X	-	-	X	X
Parthenocissus quin- quefolia	Virginia creeper	Native	X	-	X	X	X	X
Pascopyrum smithii	Western wheatgrass	Native	X	X	-	-	X	-
Phytolacca america- na	American pokeweed	Native	-	-	-	X	-	X
Polygonum pensyl- vanicum	Pennsylvania smartweed	Native	X	-	X	-	X	-
Populus deltoides	Eastern cottonwood	Native	X	X	X	-	-	-
Pycnanthemum pi- losum	Hairy mountain mint	Native	-	X	-	-	-	-
Pycnanthemum ten- uifolium	Narrow leaved mountain mint	Native	-	-	-	-	X	X
Pycnanthemum vir- ginianum	Virginia mountain mint	Native	-	X	-	-	-	-
Quercus alba	White oak	Native	-	-	-	X	-	-
Quercus rubra	Red oak	Native	X	-	-	-	-	-
Ranunculus hispidus	Hispid buttercup	Native	X	-	-	X	-	-
Ratibida pinnata	Gray headed coneflower	Native	-	-	-	X	-	X
Rhus copallinum	Prairie flame sumac	Native	-	-	-	X	X	-
Rhus glabra	Smooth sumac	Native	-	-	-	X	X	X
Robinia pseudoaca- cia	Black locust	Native	-	X	-	X	-	X
Rosa arkansana	Prairie rose	Native	-	-	-	X	X	X
Rubus allegheniensis	Blackberry	Native	X	X	X	X	X	X
Rubus occidentalis	Black raspberry	Native	-	X	-	X	X	X
Rudbeckia hirta	Black-eyed susan	Native	-	-	X	X	X	X
Rudbeckia laciniata	Cutleaf coneflower	Native	-	-	X	X	X	X
Rumex maritimus	Golden dock	Native	-	-	-	X	X	-
Rumex occidentalis	Western dock	Native	-	-	X	-	X	-
Sabatia angularis	Common pink rose	Native	-	-	-	-	-	X
Salix nigra	Black willow	Native	-	X	X	X	X	X
Sambucus nigra ssp. Canadensis	American Elder	Native	-	-	-	-	X	X
Schizachyrium sco- parium	Little blue stem	Native	-	-	-	X	X	X
Scirpus atrovirens	Dark green bulrush	Native	-	-	-	-	X	-
Silphium terebin- thinaceum	Prairie dock	Native	-	-	-	X	X	X
Smilax rotundifolia	Round leaved greenbrier	Native	-	-	-	X	-	-
Solanum carolinense	Horse nettle	Native	-	-	-	-	X	-

Solidago altissima	Tall goldenrod	Native	-	X	X	X	X	X
Solidago canadensis	Canada goldenrod	Native	-	-	X	X	X	X
Solidago gigantea	Late goldenrod	Native	-	-	-	X	X	X
Solidago hispida	Hairy goldenrod	Native	-	-	-	-	X	X
Solidago juncea	Early goldenrod	Native	-	-	-	-	-	X
Solidago nemoralis	Field goldenrod	Native	-	-	-	X	X	-
Solidago rugosa	Wrinkle leaved goldenrod	Native	-	-	-	X	X	X
Solidago speciosa	Showy goldenrod	Native	X	X	-	X	-	X
Solidago erecta	Slender goldenrod	Native	-	-	-	X	-	-
Solidago odora	Sweet goldenrod	Native	-	-	-	X	-	-
Sorghastrum nutans	Indian grass	Native	X	X	X	X	X	X
Stachys palustris arenicola	Hairy hedge nettle	Native	-	-	-	-	X	-
Symphyotrichum laeve	Smooth blue aster	Native	-	-	-	-	X	X
Symphyotrichum novae-angliae	New england aster	Native	-	-	-	X	X	X
Symphyotrichum pilosum	Frost aster	Native	-	-	-	-	X	-
Symphyotrichum rac -emosum	Small white aster	Native	-	-	-	X	-	-
Symplocarpus foeti-dus	Skunk cabbage	Native	-	-	-	X	-	-
Taraxacum officinale	Dandelion	Native	X	X	X	X	X	X
Thalictrum dasycarpum	Tall meadow rue	Native	-	X	-	-	X	-
Toxicodendron di-versilobum	Poison oak	Native	-	-	-	-	-	X
Toxicodendron ver-nix	Poison Sumac	Native	-	X	-	-	X	X
Toxicodendron radi-cans	Eastern poison ivy	Native	X	X	X	X	X	X
Tracaulon sagitta-tum	Arrowleaf tearthumb	Native	-	-	-	X	-	-
Typha latifolia	Common cattail	Native	X	X	X	X	X	X
Urtica dioica	Stinging nettle	Native	X	X	X	X	X	X
Verbena hastata	Blue vervain	Native	-	-	X	-	X	X
Vernonia altissima	Tall ironweed	Native	X	X	-	X	-	-
Vernonia fasciculata	Ironweed	Native	X	X	-	-	-	-
Veronica peregrina	Purslane speedwell	Native	-	-	-	X	-	-
Veronica peregrina	Hairy purslane speedwell	Native	X	-	-	-	-	-
Vicia americana	American vetch	Native	-	-	-	-	-	X
Ailanthus altissima	Tree of heaven	Nonnative	-	-	X	-	X	X
Alliaria petiolata	Garlic mustard	Nonnative	X	X	X	X	X	-
Allium oleraceum	Field garlic	Nonnative	-	X	-	X	X	X
Allium vineale	Wild garlic	Nonnative	-	-	X	-	X	X
Alopecurus praten-sis	Meadow foxtail	Nonnative	-	-	-	X	-	-

Amaranthus retroflexus	Redroot pigweed	Nonnative	-	-	X	X	-	-
arctium lappa	Great burdock	Nonnative	-	-	-	-	-	X
Arctium minus	Common burdock	Nonnative	-	-	-	X	-	X
Artemisia vulgaris	Mugwort	Nonnative	-	-	-	X	-	-
Asparagus officinalis	Wild asparagus	Nonnative	-	X	X	X	X	X
Astragalus purshii	Wooly pod milkvetch	Nonnative	-	-	-	X	-	-
Barbarea verna	American wintercress	Nonnative	-	-	-	X	-	-
Barbarea vulgaris	Common wintercress	Nonnative	X	-	-	X	-	-
Barbarea vulgaris arcuata	Yellow rocket	Nonnative	-	-	-	X	X	-
Brachypodium sylvaticum	False brome	Nonnative	-	-	-	X	-	-
Bromus inermis	Smooth brome	Nonnative	X	X	X	X	X	X
Bromus japonicus	Japanese brome	Nonnative	X	X	X	-	X	X
Bromus tectorum	Cheatgrass	Nonnative	X	X	-	X	X	X
Cichorium intybus	Common chicory	Nonnative	-	X	X	-	X	X
Cirsium arvense	Canada thistle	Nonnative	-	X	X	X	X	X
Cirsium vulgare	Bull thistle	Nonnative	-	-	-	X	-	X
Conium maculatum	Poison hemlock	Nonnative	X	X	X	-	X	X
Convolvulus arvensis	Field bindweed	Nonnative	-	-	X	X	X	X
Coronilla varia	Crown vetch	Nonnative	-	X	-	-	X	X
Daucus carota	Wild carrot	Nonnative	X	X	X	X	X	-
Deschampsia flexuosa	Wavy hairgrass	Nonnative	-	X	-	-	-	-
Dipsacus pilosus	Small teasel	Nonnative	X	-	-	-	-	-
Dipsacus fullonum	Common teasel	Nonnative	X	X	X	X	X	X
Dipsacus laciniatus	Cut-leaved teasel	Nonnative	-	X	X	-	X	X
Duchesnea indica	Mock strawberry	Nonnative	-	X	X	-	-	-
Echinacea purpurea	Purple coneflower	Nonnative	-	-	-	X	-	-
Echinochloa crus-galli	Barnyard grass	Nonnative	X	-	-	X	X	-
Elaeagnus umbellata	Autumn olive	Nonnative	X	X	X	X	-	-
Elymus repens	Couch grass	Nonnative	X	-	X	-	X	X
Erysimum cheiranthoides	Wormseed mustard	Nonnative	X	X	X	-	-	-
Festuca pratensis	Fescue (meadow)	Nonnative	X	X	X	X	X	X
Glechoma hederacea	Ground ivy	Nonnative	X	-	X	X	-	X
Glycine max	Soybeans	Nonnative	-	-	X	-	-	-
Hemerocallis fulva	Common day-lily	Nonnative	-	-	X	-	-	-
Hesperis matronalis	Dame's violet	Nonnative	X	-	-	-	-	-
Hippocrepis comosa	Horseshoe vetch	Nonnative	-	-	-	-	X	X
Ipomoea hederacea	Ivy leaf morning glory	Nonnative	-	-	-	-	X	X
Lactuca serriola	Prickly lettuce	Nonnative	-	-	X	-	X	X
Lamium album	White dead nettle	Nonnative	X	-	-	-	-	X
Lamium amplexicaule	Henbit dead nettle	Nonnative	-	-	-	X	-	-
Lamium purpureum	Purple dead nettle	Nonnative	X	-	-	X	X	-
Lepidium campestre	Field peppergrass	Nonnative	-	-	-	X	X	-
Linaria vulgaris	Yellow toadflax	Nonnative	X	X	-	X	-	-

Lolium arundinaceum	Tall fescue	Nonnative	X	X	X	X	X	X
Lonicera maackii	Amur honeysuckle	Nonnative	-	-	-	-	X	-
Lonicera morrowii	Morrow's honeysuckle	Nonnative	-	-	-	X	-	-
Lysimachia nummularia	Moneywort	Nonnative	-	X	-	X	X	-
Lythrum salicaria	Purple loosestrife	Nonnative	-	X	-	-	-	-
Malva neglecta	Common mallow	Nonnative	-	-	-	X	-	-
Medicago sativa	Alfalfa	Nonnative	-	-	-	X	-	-
Medicago lupulina	Black medic	Nonnative	X	-	-	-	-	-
Melilotus officinalis	Yellow sweet clover	Nonnative	-	X	-	X	X	X
Melitotus alba	White sweet clover	Nonnative	-	-	X	X	X	-
Morus alba	White mulberry	Nonnative	-	-	-	-	X	-
Muscari armeniacum	Grape hyacinth	Nonnative	-	X	-	-	-	-
Nepata cataria	Catnip	Nonnative	-	-	-	X	X	X
Pastinaca sativa	Wild parsnip	Nonnative	-	-	-	-	X	-
Persicaria maculosa	Spotted ladysthumb	Nonnative	-	-	-	-	-	X
Phalaris arundinacea	Reed canarygrass	Nonnative	X	X	X	X	X	X
Phleum pratense	Timothy grass	Nonnative	-	-	-	-	X	X
Phragmites australis	Reed phragmites	Nonnative	-	-	-	X	-	-
Plantago lanceolata	English plantain	Nonnative	X	X	X	X	X	X
Plantago major	Broadleaf plantain	Nonnative	X	X	X	X	-	-
Poa pratensis	Kentucky bluegrass	Nonnative	X	X	X	X	X	X
Potentilla reptans	Five finger grass	Nonnative	X	X	-	-	-	-
Pyrus calleryana	Callery pear tree	Nonnative	X	-	-	-	-	-
Ranunculus acris	Tall buttercup	Nonnative	-	X	-	-	-	-
Rorippa nasturtium-aquaticum	Mountain watercress	Nonnative	-	-	-	-	X	-
Rosa multiflora	Multiflora rose	Nonnative	-	-	-	-	X	-
Rubus idaeus	Red raspberry	Nonnative	-	-	-	X	X	-
Rumex acetosella	Field sorrel	Nonnative	-	-	-	X	X	-
Rumex obtusifolius	Broadleaf dock	Nonnative	X	X	-	X	X	-
Rumex crispus	Curlydock	Nonnative	-	X	X	X	X	X
Setaria faberi	Giant foxtail	Nonnative	-	-	-	-	X	-
Setaria viridis	Green foxtail	Nonnative	-	-	-	X	-	-
Silene latifolia	White campion	Nonnative	X	-	-	-	X	X
Sonchus avrensis	Perennial sowthistle	Nonnative	-	-	-	-	X	X
Thlaspi arvense	Water pennycress	Nonnative	X	X	-	-	X	-
Tragopogon dubius	Western salsify	Nonnative	-	-	-	X	X	X
Tragopogon pratensis	Meadow salsify	Nonnative	X	X	X	X	X	X
Trifolium campestre	Low hop clover	Nonnative	-	-	-	X	-	-
Trifolium pratense	Red clover	Nonnative	X	X	X	X	X	X
Trifolium repens	White clover	Nonnative	X	-	X	X	X	X
Typha angustifolia	Narrow-leaved cattail	Nonnative	-	X	X	X	X	X
Verbascum blattaria	Moth mullein	Nonnative	-	-	X	-	-	-
Verbascum thapsus	Common mullein	Nonnative	X	X	X	X	X	X
Veronica arvensis	Corn speedwell	Nonnative	X	-	-	X	X	-
Vicia villosa	Hairy vetch	Nonnative	X	-	-	-	X	-
Vitis riparia	River bank grape	Nonnative	X	X	X	X	X	X