

PLANT SPECIES ASSOCIATED WITH A REGIONALLY RARE HEMIPARASITIC PLANT, PEDICULARIS LANCEOLATA (OROBANCHACEAE), THROUGHOUT ITS GEOGRAPHIC RANGE Author(s): Sydne Record

Source: *Rhodora,* Vol. 113, No. 954 (Apr-Jun, 2011), pp. 125-159

Published by: New England Botanical Club, Inc.

Stable URL: https://www.jstor.org/stable/23314598

Accessed: 27-08-2020 01:42 UTC

**REFERENCES**

Linked references are available on JSTOR for this article: https://www.jstor.org/stable/23314598?seq=1&cid=pdf-reference#references\_tab\_contents You may need to log in to JSTOR to access the linked references.

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at https://about.jstor.org/terms



*New England Botanical Club, Inc.* is collaborating with JSTOR to digitize, preserve andextend access to *Rhodora*

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

RHODORA, Vol. 113, No. 954, pp. 125-159, 2011

© Copyright 2011 by the New England Botanical Club

PLANT SPECIES ASSOCIATED WITH A REGIONALLY

RARE HEMIPARASITIC PLANT, PEDICULARIS

LANCEOLATA (OROBANCHACEAE), THROUGHOUT ITS

GEOGRAPHIC RANGE

Sydne Record

University of Massachusetts, Plant Biology Graduate Program, Amherst, MA 01003

Current Address: Harvard University, Harvard Forest, 324 North Main Street,

Petersham, MA 01366

e-mail: srecord@fas.harvard.edu

abstract. Typically, non-native invasive plant species are considered a

threat to rare native plants, but this generalization may not hold true for rare parasitic plants that depend upon host plants to complete their life cycles. It is

essential to know what plant species a particular hemiparasitic species

associates with in the field, in order to determine host plant preferences and

to make broader inferences about host plants. Pedicularis lanceolata is a hemiparasite that is regionally rare in New England and the southeastern

margins of its range, but more abundant in the core of its range in the Midwest.

I sought to compare the species associated with P. lanceolata in the core and

margins of its range to determine if marginal populations have different

associates from core populations. I hypothesized that P. lanceolata may be rare in the eastern United States because it encounters fewer suitable associates, and potentially more competitive invasive species, at the margins of its range than at the center of its range. In each of 22 populations of P. lanceolata I recorded

abundances of all vascular plants growing near five focal P. lanceolata individuals. Different suites of species co-occurred with P. lanceolata in

different parts of its range, but there were no significant differences across its

range in the percent covers of natives, non-native invasives, non-native non

invasives, or species with native and non-native genotypes. These results suggest

that non-native invasive species do not pose greater threats to edge populations

of P. lanceolata than to core populations. The data suggest that candidates

for potential hosts include members of the Asteraceae and Poaceae, Cirsium discolor, Clematis virginiana, Cornus amomum, Eupatorium maculatum, E.

perfoliatum, Impatiens capensis, Lycopus uniflorus, and Vernonia gigantea. These

data provide baseline data for future manipulative studies on host-preference of

P. lanceolata.

Key Words: Pedicularis lanceolata, hemiparasitic plants, host plants, non

native plants, regionally rare plants

Approximately 4500 of the world's plants are holoparasites

(plants lacking chlorophyll and completely dependent on host

plants to survive) or hemiparasites (plants with chlorophyll that rely

125

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

126 Rhodora [Vol. 113

on host plants for supplemental resources to complete their life cycle; Heide-Jorgensen 2008). The availability of suitable hosts is

critical to rare hemiparasites, whether they are specialists utilizing a

single host species or generalists capable of parasitizing a suite of

hosts (Marvier and Smith 1997).

Rare native hemiparasites co-occurring with non-native, invasive species pose a management conundrum. A review of approximately 2500 imperiled or federally listed plant and animal species in the

United States concluded that competition with, or prédation by,

invasive species is the second greatest threat to imperiled species, affecting 49% of the analyzed species (Wilcove et al. 1998). As such,

the management of rare plants usually involves removing or

controlling the density of non-native invasive species co-occurring

with them. Such management, however, may not be appropriate for

rare hemiparasitic plants that have unique interactions with host

plants. If invasive plants co-occur with rare, generalist hemipar

asites and serve as alternate hosts for the hemiparasites, or if

facilitative (parasitic) interactions between hosts and hemiparasites

outweigh negative competitive interactions, it may be detrimental to

remove or control the co-occurring invasive plants. Whereas a number of studies have investigated interactions between native

host plants and native hemiparasites (e.g., Adler 2002; Gibson and

Watkinson 1989; Lawrence and Kaye 2008), interactions between non-native invasive host species and native hemiparasites remain relatively understudied. Further, the few studies addressing the

effects of non-native invasive hosts on native hemiparasites have

yielded conflicting results (Fellows and Zedier 2005; Prider et al.

2009).

Regionally rare species [i.e., Division 2 rare taxa according to Brumback et al. (1996)] that reach the edge of their geographic

range in the Northeast, and have fewer than 20 occurrences in New

England, are ideal for studies on the effects of native and non native invasive plants on native hemiparasites. Such conditions

allow for comparisons between areas where the target species are

common within their ranges and areas in which they are rare.

Regionally rare species also enable investigation into correlates of rarity because conditions in which a species is common can provide

hints as to limiting factors at the edge of the range where the species

may be rare (Kunin and Gaston 1997; Rabinowitz 1981). Finally,

data from comparisons between different areas of regionally rare

species' geographic ranges can be used to adapt management

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 127

approaches to the particular needs of core and edge populations. Such adaptive management is important because at the edge of a species' range there is greater potential for evolutionary change

(Grant and Antonovics 1978; Lesica and Allendorf 1995). For

instance, populations at the periphery of a species' range may

exhibit founder effects due to isolation from gene flow compared to

more centrally located populations (Lammi et al. 1999).

Pedicularis lanceolata Michx. is a "regionally rare" North

American generalist hemiparasite; that is, it is listed as rare in the states at the northeastern and southeastern portions of its range, but is considered secure and has more numerous populations in the geographic heart of its range in the Midwest (NatureServe 2009).

Prior studies have provided some data on interactions between P.

lanceolata and some of its host species. Foster (2003) studied the effects of P. lanceolata on three native (Chelone glabra, Juncus

effusus, and Scirpus cyperinus) and one non-native invasive

(Phalaris arundinacea) hosts in a container experiment to see if P.

lanceolata could be used as a biological control agent on P.

arundinacea. Seedlings of P. lanceolata established haustoria with

all four hosts in this study. The biomass of P. arundinacea was only

decreased when P. lanceolata was accompanied by the other native species, suggesting that competition by multiple native species was needed to depress growth of P. arundinacea (Foster 2003).

Previous studies also have provided information on potential or known hosts of Pedicularis lanceolata (i.e., species with which

P. lanceolata are known to form haustoria). Macior (1969) and Farnsworth et al. (2007) recorded a total of 73 associated species of P. lanceolata in the field in Ohio and Massachusetts, respectively,

but could not confirm if P. lanceolata formed haustorial

connections to these species (Appendix). Other studies documente

direct haustorial connections between P. lanceolata and 29 host

species through root excavations in the field (Piehl 1965), lab

experiments (Lackney 1981), and outdoor container experiments

(Foster 2003; Appendix). Only two of the 29 species with which P.

lanceolata was known to form haustoria were invasive species:

Frangula alnus Mill, and Phalaris arundinacea (Appendix). Three

quarters of these known hosts came from a study of a single site in

Michigan, the geographic center of P. lanceolata range (Piehl

1965).

The first objective of this study was to document plant species growing with Pedicularis lanceolata in populations in the center of

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

128 Rhodora [Vol. 113

its range in the Midwest where the species is common (henceforth,

the "core") and at the margins of its range in the Northeast and

Southeast where the species is rare (henceforth, the "edge"). While

some habitats, such as stream banks, are common to different regions where P. lanceolata occurs, other habitats are unique to

certain portions of its range, such as prairies in the Midwest or tidal wetlands along the east coast. As such, I hypothesized that marginal

populations of P. lanceolata in the northeastern and southeastern

states would establish associations with different species from those

associated with populations of P. lanceolata in the Midwest.

The second objective of this study was to determine whether the

types and relative abundances of native and invasive species

associated with Pedicularis lanceolata differed among core and

edge geographic areas. I hypothesized that P. lanceolata in the edge of its range, where it is considered as rare, occurs more frequently

with invasive species that are potentially suboptimal hosts or

stronger competitors for resources, than in the Midwest. I predicted

that the proportions of invasive species associated with P.

lanceolata would be higher in eastern populations, if populations

along the eastern coast of the United States where P. lanceolata is

considered rare occur more frequently with less suitable associates

(i.e., invasive species) than populations in the Midwest, where the

species is considered common. Alternatively, I predicted that the

relative abundances of native and invasive species would not differ

between midwestern and eastern populations of P. lanceolata

throughout its geographic range, if those populations are similarly associated with invasive species. To identify finer-scale differences

in associated species due to latitudinal variation, I compared edge

populations at the regional level (i.e., Northeast, Southeast). I was

not able to confirm the hosts utilized by P. lanceolata or whether or

not interactions with associated species were competitive or

beneficial, but the data presented here do help to identify a suite of potential host plant species.

MATERIALS AND METHODS

Study species. Laboratory studies show that Pedicularis lan

lata is an obligate hemiparasite: seedlings become chlorotic an when grown without a host (Lackney 1981). In observational

studies and laboratory and outdoor container experiment

lanceolata acts as a generalist, forming haustorial connections

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata

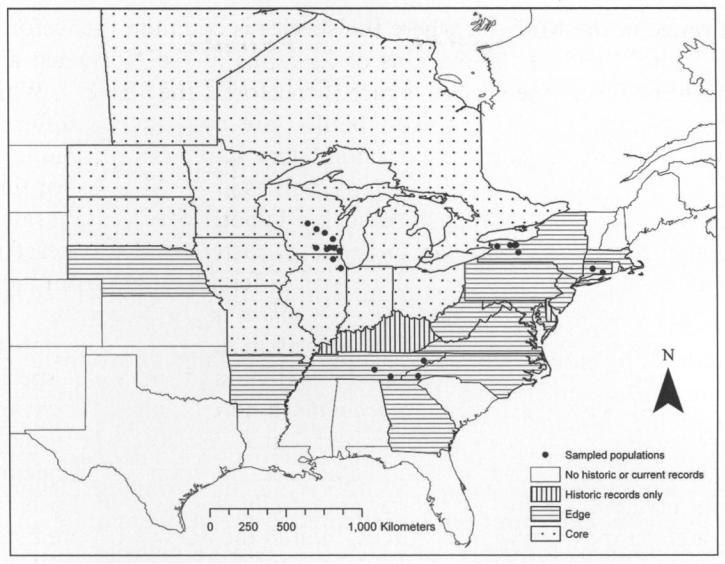


Figure 1. Range map of Pedicularis lanceolata's global distribution showing

locations of sample populations. The fill of each state or province reflects

whether there are historic records or the state is considered as being in the "core" or "edge" of the species' geographic range. White fill denotes states or

provinces with no historic or current records of P. lanceolata. Kentucky is the

sole state with historic records only and has a fill of vertical lines. States or

provinces filled with horizontal lines are considered to be "edge" of range and

have state (USA) or provincial (Canada) statuses of critically imperiled (SI),

imperiled (S2), or vulnerable (S3; NatureServe 2009). Stippled fill shows areas in

the "core" of the range with state or provincial statuses that are apparently secure (S4) or are not ranked.

a number of species to obtain water and mineral nutrients (Foster

2003; Lackney 1981; Piehl 1965; Appendix).

Pedicularis lanceolata grows in habitats that are periodically

inundated, such as wet meadows, prairies, swamps, freshwater tidal

marshes, and stream sides and other early-successional habitats (Allard 2001). The global conservation status of P. lanceolata is

secure (G5), but it is listed as historic, endangered, threatened, or a

species of concern in 15 of the 25 states in which it occurs in the

United States (NatureServe 2009; Figure 1). Most of the states in which P. lanceolata is considered rare are along the eastern coast

of the United States, with the exception of Kentucky, where the species is possibly extinct and is known only from historic records

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

130 Rhodora [Vol. 113

(NatureServe 2009). Pedicularis lanceolata is most secure (S4)

along the northern edge of its range in Manitoba and Ontario

(NatureServe 2009).

Field methods. In July and August of 2007, I sampled 11 populations of Pedicularis lanceolata in Illinois and Wisconsin

where the species was classified by the state as common, and 11

populations in Connecticut, New York, North Carolina, and

Tennessee where the species was state-listed as rare. In the states where P. lanceolata was considered rare, there were 2-17 extant

populations per state, with population sizes varying from three to hundreds of individuals. Populations were defined as groups of co

occurring organisms of the same species that were likely to

interbreed. Macior (1969) showed that P. lanceolata is an obligate

outcrossing species pollinated by bumblebees (Bombus spp.),

particularly Bombus vagans Smith. While the foraging distances

of B. vagans have not been investigated in detail, there are data on foraging ranges for other species in the genus. Knight et al. (2005) conservatively estimated the maximal foraging range for the genus

as 758 m in the United Kingdom, based on studies that used

molecular markers. Thus, each site in this study was considered a separate population because all sites were further than 10 km away

from one another.

I selected sampling sites based upon the most recently updated

state Natural Heritage and Endangered Species Program field

forms for states where Pedicularis lanceolata was classified as rare,

and on herbarium specimens dating back to 1990 for locations

where the species was considered common. I did not seek to sample similar types of habitats in each of the three sectors because one

objective of this study was to see if P. lanceolata occurred with different species at core and edge sites. For this same reason, I

sampled along a broader latitudinal gradient in the edge than in the

core, in order to capture any differences in associated species and potential hosts due to climatic and other differences between the southeastern and northeastern margins of the range. Despite the greater aggregation of sites in the Midwest, the habitats sampled

were variable (e.g., fens, stream sides, prairies, lake shores, city

parks), so the closer proximities of sites in the Midwest should not

have biased the results in regards to habitat types. Logistical

constraints and differences in the numbers of extant populations in

different states resulted in an imbalanced design, with seven

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 131

populations in the Midwest, four in the Southeast, and seven in the

Northeast.

At each site, I set up a transect through the center of the

population and used random numbers to select plants based on

their positions relative to the transect (Haahr 2006). Abundances in

six cover classes (< 1%, 2-5%, 6-25%, 26-50%, 51-75%, and 76

100%) of all vascular plant species were recorded within half-meter

radius circular plots centered on five focal Pedicularis lanceolata

plants per population. The scarcity of P. lanceolata in many of the

edge, and some of the core, populations limited the number of focal

plants sampled in each population to five. I chose the size of the

plots based upon my previous root excavations of five plants in the

midwestern United States, which revealed that the roots of P.

lanceolata extended approximately one-half meter from the base of

an individual. Thus, I assumed that associated vascular species

occurring within one-half meter of the focal P. lanceolata plant were

available as potential hosts. Also, associated plants within one-half meter of P. lanceolata were the most likely to compete with it for light. I did not collect data on the species pool at the sites, beyond the sampling that I did around the focal P. lanceolata individuals.

Other studies on hemiparasitic species have done this, and analyzed the data with an association analysis to see if the hemiparasite was

correlated with certain associated species. However, Gibson and

Watkinson (1989) showed that an association analysis of Rhi

nanthus minor L. only revealed two potential hosts, whereas direct

examination of the plants' roots showed that the plants were

forming haustorial connections with 20 species. Further, at none of the 22 sites was there great variation in species present in areas

with or without P. lanceolata. As such, I chose to sample more

populations, only recording information from plots with P.

lanceolata present, rather than visiting fewer populations while

sampling plots with and without P. lanceolata. All vascular plants were identified to species using Gleason and Cronquist (1991), with the exception of some Carex species for which positive identifica

tion was not possible because perigynia were undeveloped at the time of sampling. Unidentifiable Carex species were treated as different un-named taxa based on gross morphology. Nomencla

ture follows the Integrated Taxonomic Information System (2010). Voucher specimens were housed in the herbaria of the Universities

of Massachusetts (mass), Tennessee (tenn), and Wisconsin (wis;

Appendix).

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

132 Rhodora [Vol. 113

Data analysis. To visualize differences in the species associated with Pedicularis lanceolata throughout its range, I analyzed the

abundance data of all species encountered. I used non-metric

multidimensional scaling (NMDS), using Bray's distance measure and two dimensions to plot an ordination showing relationships

between species and sites (McGarigal et al. 2000). Non-metric

multidimensional scaling was employed rather than correspondence analysis (CA) or detrended correspondence analysis (DCA) because, as a non-parametric procedure, NMDS was less sensitive to outliers

and made no assumption that the species' distributions along

the underlying gradient exhibited unimodal or linear responses

(McGarigal et al. 2000). To determine whether population-level

differences in associated species were due to the greater latitudinal gradient sampled in the edge, I overlaid ellipses onto the ordination

plot showing the standard deviations of the point scores for species

within each portion of the range (core or edge) and region

(Midwest, Northeast, or Southeast) using the 'ordi.ellipse' function from the Vegan package in R statistical software (R Development

Core Team 2005).

All co-occurring plant species were categorized into the following

groups: natives, non-native invasives, non-native non-invasives,

and non-invasive species having co-occurring native and non-native

genotypes (Appendix). Classifications of species by origin and

invasiveness in the United States Department of Agriculture

PLANTS database (USDA, NRCS 2009) were inconsistent with individual state classifications, so associated non-native species

were only considered invasive in a state when they were listed as invasive by the U.S.D.A. and at least one other source. References

for individual states were: Connecticut (Mehrhoff et al. 2003),

Illinois (Howe et al. 2008), North Carolina (Smith 2008), New York

(Invasive Plant Council of New York State 2005; O'Neill 2008),

Tennessee (Franklin et al. 2004; Miller 2003), and Wisconsin (Howe et al. 2008; Reinartz 2003). Species with both non-native and native genotypes included: Achillea millefolium, Poa pratensis, Ranunculus acris, Rubus idaeus, Taraxacum officinale, and Phalaris arundinacea

(USDA, NRCS 2009). Phalaris arundinacea (Gifford et al. 2002)

was one of the most abundant co-occurring species at many of the

study sites, suggesting that the non-native genotype may have been

at the sites studied. Thus, I performed two separate analyses where

P. arundinacea was either treated as non-native invasive or as a

species with native and invasive genotypes. I confirmed that none of

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 133

the unknown Carex species were considered non-native invasive

based on comparisons of vegetative characters with known invasive

Carex species.

To determine whether there were regional or subregional

differences in the percent covers of natives, non-native invasives,

non-native non-invasives, and species with native and non-native

genotypes associated with Pedicularis lanceolata, I performed four

nested analyses of variance (ANOVAs). I averaged the relative

abundances of all species in a category (i.e., natives, non-native invasives, non-native non-invasives, and species with native and

non-native genotypes) over the five independently sampled plants in each population to emphasize population-level rather than plot

level differences. Since relative abundances were recorded as

percent cover classes, the averages were based on the median value

for the range of values in a cover class (e.g., for the cover class ranging from 1% to 5%, I used 3% to calculate the average). The

response variables in the four ANOVAs were these population-level

averages for the percent covers of natives, non-native invasives, non-native non-invasives, or species with native and non-native

genotypes. Plot-level averages were arcsine square-root transformed

to meet the model assumptions of residual normality and

homogeneity of variance. I tested the response of either average

cover of natives, non-native invasives, non-native non-invasives, or

species with native and non-native genotypes to two predictor

variables: part of range (i.e., core, edge), and region nested within

part of range (i.e., Northeast and Southeast nested within edge;

Midwest nested within core). Region was included to test for any

effects due to latitudinal differences in the species pools of associated species in the populations sampled. All statistical

analyses were performed using R statistical software version 2.10.1.

RESULTS

Pedicularis lanceolata co-occurred with a total of 265 different

species representing 66 families across the 22 sites sampled

(Appendix). The families with the most representatives were the

Asteraceae and the Poaceae. Lycopus uniflorus occurred most

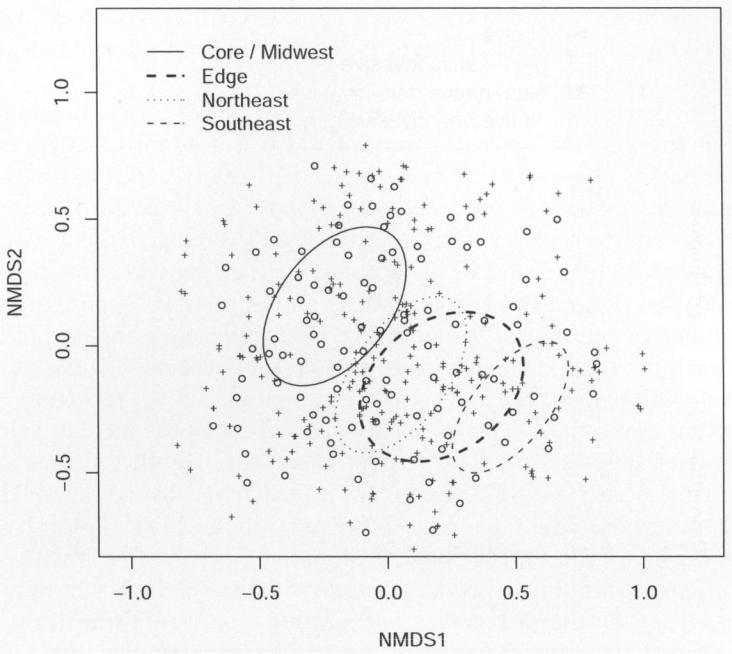
frequently in all three regions. Of the 265 species documented, 155 species were found in the Midwest (including 70 species only found in this region), 154 in the Northeast (62 unique to this region), and

81 in the Southeast (32 unique to this region; Appendix). None of

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

Rhodora [Vol.



Core / Midwest

Edge

Northeast

Southeast

I 1 1 I r

-1.0 -0.5 0.0 0.5 1.0

NMDS1

Figure 2. Ordination projection of all associated species encountered with Pedicularis lanceolata, generated using Nonmetric Multidimensional Scaling. Species are open circles, and crosses are plots within sites. Ellipses depict the

standard deviations of point scores from the covariance matrix for each region:

Core/Midwest (solid line), Edge (bold dashed line), Northeast (dotted line), and

Southeast (dashed line).

the species occurred at all 22 sites. Nine percent of the plots

sampled at the 22 sites did not contain any of the hosts known to form haustoria with P. lanceolata (Foster 2003; Lackney 1981; Piehl 1965). The ordination showed that the standard deviations of the

species' ordination scores for the core and edge overall did not overlap, although the standard deviations of the Midwest and Northeast regions' species' ordination scores overlapped. The

Midwest and Northeast regions shared more co-occurring species than either did with the Southeast region (Figure 2).

The average proportion of native species was much greater than

the average proportion of non-native invasive or non-native non

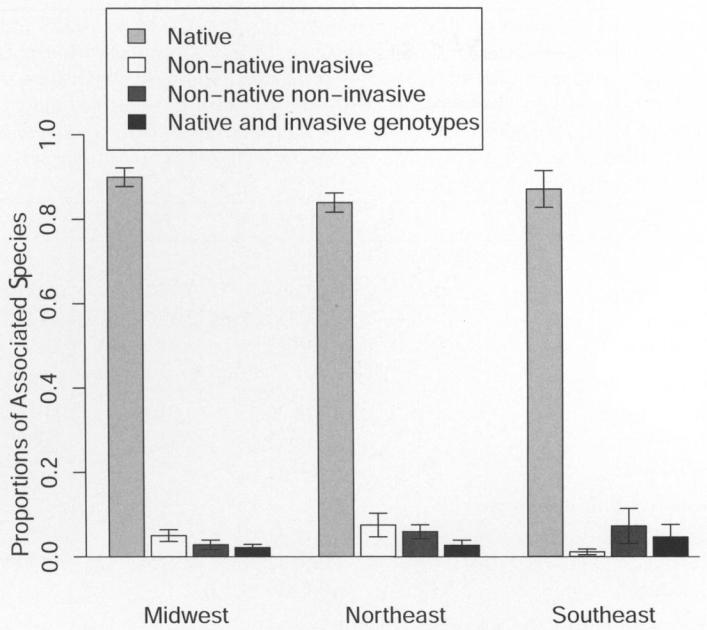
invasive species in each part of the range (core or edge) and region

(Figure 3). Sixteen non-native invasive and 23 non-native non invasive species co-occurred with Pedicularis lanceolata in the 22

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 135



* Native
* Non-native invasive
  + Non-native non-invasive
    - Native and invasive genotypes

rEi

Midwest Northeast Southeast

Figure 3. Average proportions of natives, non-native inva

non-invasives, and species with native and non-native genot

lanceolata in the Midwest, Northeast, and Southeast regions

abundances. The Midwest region is equivalent to the core, a

proportions for the Northeast and Southeast regions is the

show one standard error of the mean.

populations sampled. Two of the 16 non-native invasive species

were found in both edge and core populations (Rhamnus frangula and Lonicera morrowii). Phalaris arundinacea and R. frangula were the most predominant species, with co-occurring native and non

native genotypes and non-native invasive species, respectively,

associated with P. lanceolata in the Midwest. In the Northeast,

the most common non-native invasive species or species with

co-occurring native and non-native genotypes growing with P. lanceolata were Cynanchum louiseae, Lythrum salicaria, and P. arundinacea. In the Southeast, Lonicera japonica and Ligustrum

vulgare were the non-native invasives that occurred with P.

lanceolata at the highest frequencies. The percent covers of natives,

non-native invasives, non-native non-invasives, and species with

native and non-native genotypes did not differ between core and

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

Rhodora [Vol.

Table 1. A summary of statistical result

for effects of region (Northeast, Southeast range (core or edge) on the percent cover o

native non-invasives, and species with

associated with Pedicularis lanceolata. In was classified as a non-native invasive sp

native and non-native genotypes.

Effect df M.S. F P

Natives

Core/Edge 1 0.0400 3.3947 0.0819

Region 2 0.0251 2.1269 0.1482

Residuals 18 0.0118

Non-native invasives

Core/Edge 1 0.0020 0.0108 0.9183

Region 2 0.0508 2.8129 0.0865

Residuals 18 0.0181

Non-native non-invasives

Core/Edge 1 0.0631 3.7076 0.0701

Region 2 0.0132 0.7756 0.4752

Residuals 18 0.0170

Species with native and non-native g

Core / Edge 1 0.0010 0.7661 0.3930

Region 2 0.0212 1.6266 0.2242

Residuals 18 0.0130

edge populations or regions

ANOVA results were consiste

nacea was classified as a non-

with native and non-native gen

results of the analysis where native invasive species (Table

DISCUSSION

This study has documented associated species for a regionall

rare hemiparasite, Pedicularis lanceolata, across a broad geogra

extent, and found that there were no significant differences amon

edge and core populations in the relative abundances of nativ non-native invasives, non-native non-invasives, and species w native and non-native genotypes. For P. lanceolata, greenhous (Foster 2003; Lackney 1981) and root excavation (Piehl 1965)

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 137

studies have provided data on hosts with which haustoria were formed, but the majority of the documented species came from

a single study in Michigan (Piehl 1965). Hosts with which P.

lanceolata formed haustoria, documented from these past studies, did not occur in 9% of the plots I sampled, suggesting that there were undocumented hosts of P. lanceolata in these plots.

The ordination analysis showed that associated species in the Midwest and Northeast had more overlap with one another than

with the Southeast (Figure 2). The Northeast and Midwest regions lie on similar latitudes, so this result was likely due to latitudinal differences in species distributions. In the ordination, there were a

number of distinct species that projected far from regional centroids and did not fall within the standard deviations of species' scores for

other regions, suggesting that some species were exclusive to a

particular region. Data in the Appendix also show that there were a

number of species that were unique to each region. These results

suggest that Pedicularis lanceolata grew with some unique species in

different parts of its range.

Based on the data, Lycopus uniflorus was a candidate host plant

because it occurred most frequently and occasionally at high

abundances in all three subregions. In the Midwest, Pedicularis lanceolata was most often found growing with Cirsium discolor,

Eupatorium maculatum, and Equisetum palustre. Likely candidates for

hosts in the Northeast included Cornus amomum and Eupatorium

perfoliatum. In the Southeast, Clematis virginiana L., Impatiens capensis,

and Vernonia gigantea subsp. gigantea commonly co-occurred with P. lanceolata. Also, the families of plants most frequently associated with

P. lanceolata were the Asteraceae and Poaceae, so members of these

families were also candidates for potential hosts.

In the populations sampled, the proportions of non-native

invasives, non-native non-invasives, and species with native and

non-native genotypes were much smaller than those of native species

(Figure 3). This high ratio of native to non-native species could be due to a number of reasons. The sites sampled in this study could

have been at early stages in the invasion process. Alternatively,

Pedicularis lanceolata may not have been able to establish haustoria with many invasives and thus did not occur with them. Pedicularis

lanceolata could also have been associated with some other variable

(e.g., historical land-use practices) that resulted in sites being less invaded. The differences between non-native invasive species' cover

among all populations were all less than five percent and there were

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

138 Rhodora [Vol. 113

no significant differences between the percent covers of natives and

non-natives. These results imply that at the sites sampled, the edge populations were not more likely to be threatened by non-native

species than the core populations. This conclusion should not,

however, discount the relevance of future studies investigating the relationships between hemiparasites, native hosts, and non-native

hosts because non-native invasives may be locally dominant at

particular sites of interest. For instance, the only population of P.

lanceolata in the entire state of Massachusetts has been heavily

invaded by Phalaris arundinacea (Farnsworth et al. 2007).

There are some limitations to this study that should be addressed. First, the number of plants sampled per population was low due to the

scarcity of individuals in populations along the east coast where Pedicularis lanceolata was rare. One potential caveat to such a low

sample size is that the associated species might not have been

representative of a site. Small sample sizes are an inherent issue when working with rare species that are not locally abundant. Despite this

limitation, it is reassuring that in this study, the associated species

within different populations were not highly variable, so the sampling

scheme presented here is likely a good representation of the associated species at the sites sampled. A second limitation of this study is that haustorial connections between P. lanceolata and its associated species

were not confirmed, so the data provided suggest potential rather than

known hosts. While it was not possible to quantify haustorial

connections in the field due to the rarity of P. lanceolata in many of

the sites sampled, the documentation of associated species in this study

is relevant for comparing characteristics of populations that occurred where the species was rare versus where the species was common.

The results of this study are valuable for tailoring the

management of core and edge populations of Pedicularis lanceolata and for providing data on host plants that can be used to broaden

inferences from subsequent field or greenhouse experiments. Given

their potential management implications, future studies on the

effects of non-native invasive species on hemiparasites, such as P.

lanceolata, should include a field component and management

treatments. Using the rare hemiparasite, Castilleja levisecta

Greenm. with different native hosts, Lawrence and Kaye (2008)

showed that greenhouse experiments alone were poor predictors of how the hemiparasite and hosts interacted in the field because the

experiments lacked important indirect effects between host and

hemiparasite exerted by vole herbivory. Without a field component,

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 139

experiments on non-native invasive species and hemiparasites may

not accurately portray host-hemiparasite interactions. Further, few

experiments on hemiparasites include possible management scenar

ios (but see Petrû 2005). In combination with the extensive field

survey data illustrated here, manipulative studies of P. lanceolata

and other rare hemiparasites will provide many opportunities to

better understand the interactions between hemiparasites and their

native and non-native hosts.

acknowledgments. N. Charney, A. Ellison, E. Farnsworth, D.

Kittredge, M. Hoopes, K. Searcy, two anonymous reviewers, and

the Harvard Forest Lab Group provided essential insights for this

study and manuscript. P. Jenkins and N. Charney helped in the field. This work was supported by NSF grant DBI 04-52254, the

Massachusetts Natural Heritage and Endangered Species Program,

a Jane Hallenbeck Bemis Endowment Scholarship from the

University of Massachusetts (UMass) Natural History Collections, a UMass Plant Biology R.J. Davis Botany Fund Research Award, and a UMass Plant Biology Gilgut Fellowship.

LITERATURE CITED

Adler, L. S. 2002. Host effects on herbivory and pollination in a hemipa

plant. Ecology 83: 2700-2710.

Allard, D. J. 2001. Pedicularis lanceolata Michx. (Swamp wood-beto conservation and research plan. New England Wild Flower Soci

Framingham, MA.

Brumback, W. E. and L. J. Mehrhoff, et al. 1996. Flora Conservanda

England. The New England Plant Conservation Program (NEPCoP) li plants in need of conservation. Rhodora 98: 233-361.

Farnsworth, E. J., K. Frost, P. Somers, and S. Record. 2007. Manage plan for Pedicularis lanceolata Michx. (Scrophulariaceae) Swamp w betony. Massachusetts Natural Heritage and Endangered Species

gram, Westborough, MA.

Fellows, M. Q. N. and J. B. Zedler. 2005. Effects of the non-native Parapholis incurva (Poaceae), on the rare and endangered hemipar

Cordylanthus maritimus subsp. maritimus (Scrophulariaceae). Madrono

91-98.

Foster, R. D. 2003. Fire, soil, native species, and control of Ph

arundinacea in a wetland recovery project. M.S. thesis, East Tenne

State Univ., Johnson City, TN.

Franklin, S., K. Johnson, G. Call, M. Webber, and B. Bowen. 2004. Tennessee Exotic Pest Plant Council's invasive exotic pest plants in

Tennessee. Wildland Weeds 9: 13-16.

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

Rhodora

Gibson, C. C. and A. R. Watkinson. 1989. The host range and selectivity of a parasitic plant: Rhinanthus minor L. Oecologia 78: 401-406.

Gifford, A. L. S., J. B. Ferdy, and J. Molofsky. 2002. Genetic composition and morphological variation among populations of the invasive grass,

Phalaris arimdinacea. Canad. J. Bot. 80: 779-785.

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed. The New York Botanical Garden, New York, NY.

Grant, M. C. and J. Antonovics. 1978. Biology of ecologically marginal

populations of Anthoxanthum odoratum. I. Phenetics and dynamics.

Evolution 32: 822-838.

Haahr, M. 2006. Random.org: True random number service. School of

Computer Science and Statistics, Trinity College, Dublin, Ireland. Website (http://www.random.org). Accessed 10 Mar 2010.

Heide-J0rgensen, H. S. 2008. Parasitic Flowering Plants. Brill, Leiden, The

Netherlands.

Howe, K., M. Renz, K. Kearns, J. Hillmer, and E. Jacquart. 2008. A Field

Guide to Invasive Plants of the Midwest. Midwest Invasive Plant Network,

Chicago, IL.

Integrated Taxonomic Information System. 2010. Integrated taxonomic

information system on-line database. ITIS Partnership, T. Orrell, Acting Director, c/o Smithsonian Institution, Washington, DC. Website (http:// www.itis.gov). Accessed 2 Apr 2010.

Invasive Plant Council of New York State. 2011. Interim invasive species

plant list. New York State Department of Environmental Conservation, Albany, NY. Website (http://www.dec.ny.gov/animals/65408.html). Ac

cessed 11 Jun 2011.

Knight, M. E., A. P. Martin, S. Bishop, J. L. Osborne, R. J. Hale, R. A.

Sanderson, and D. Goulson. 2005. An interspecific comparison of foraging range and nest density of four bumblebee (Bombus) species.

Molec. Ecol. 14: 1811-1820.

Kunin, W. E. and K. J. Gaston. 1997. The Biology of Rarity: Causes and Consequences of Rare-Common Differences. Chapman and Hall, New

York, NY.

Lackney, V. K. 1981. The parasitism of Pedicularis lanceolata Michx., a root hemiparasite. Bull. Torrey Bot. Club 108: 422^129.

Lammi, A., P. Siikamäki, and K. Mustajärvi. 1999. Genetic diversity,

population size, and fitness in central and peripheral populations of a

rare plant Lychnis viscaria. Conservation Biol. 13: 1069-1078. Lawrence, B. A. and T. N. Kaye. 2008. Direct and indirect effects of host

plants: Implications for reintroduction of an endangered hemiparasitic

plant (CastiUeja levisecta). Madrono 55: 151-158.

Lesica, P. and F. W. Allendorf. 1995. When are edge populations valuable for

conservation? Conservation Biol. 9: 753-760.

Macior, L. W. 1969. Pollination adaptation in Pedicularis lanceolata. Amer. J.

Bot. 56: 853-859.

Marvier, M. A. and D. A. Smith. 1997. Conservation implications of host use for rare parasitic plants. Conservation Biol. 11: 839-848.

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata

McGarigal, K., S. Cushman, and S. Stafford. 2000. Multivariate Statistics

for Wildlife and Ecology Research. Springer-Verlag, New York, NY.

Mehrhoff, L. J., J. A. Silander, S. A. Leicht, E. S. Mosher, and N. M.

Tabak. 2003. IP ANE: Invasive plant atlas of New England. Dept. Ecology

and Evolutionary Biology, Univ. Connecticut, Storrs, CT. Website (http://

nbii-nin.ciesin.columbia.edu/ipane/). Accessed 30 Mar 2009.

Miller, J. H. 2003. Non-Native Invasive Plants of Southern Forests: A Field

Guide for Identification and Control. U.S. Dept. Agriculture Forest

Service, Southern Research Station, Auburn Univ., Auburn, AL.

NatureServe. 2009. NatureServe Explorer: An on-line encyclopedia of life.

Association for Biodiversity Information, Arlington, VA. Website (http:// www.natureserve.org/explorer). Accessed 2 Feb 2009.

O'Neill, C. 2008. New York Invasive Species Information. Cornell Univ.

Cooperative Extension, Ithaca, NY. Website (http://nyis.info). Accessed 30

Mar 2009.

Petrù, M. 2005. Year-to-year oscillations in demography of the strictly biennial

Pedicularis sylvatica and effects of experimental disturbances. PI. Ecol.

181: 289-298.

Piehl, M. A. 1965. Studies of root parasitism in Pedicularis lanceolata.

Michigan Bot. 4: 75-81.

Prider, J., J. Watling, and J. M. Facelli. 2009. Impacts of a native parasitic

plant on an introduced and a native host species: Implications for the

control of an invasive weed. Ann. Bot. 103: 107-115.

R Development Core Team. 2005. R: A language and environment for

statistical computing, reference index version 2.2.1. R Foundation for

Statistical Computing, Vienna, Austria.

Rabinowitz, D. 1981. Seven forms of rarity, pp. 205-217. In: H. Synge, ed., The

Biological Aspects of Rare Plant Conservation. Wiley, New York, NY. Reinartz, J. A., E. Parker, and H. Patti. 2003. Invasive Plants Association of

Wisconsin's list of invasive plants of Wisconsin. Plants Out of Place

Newsletter 4: 1-19.

Smith, C. 2008. Invasive Plants of North Carolina. North Carolina Dept.

Transportation, Raleigh, NC.

USDA, NRCS. 2009. The Plants Database. National Plant Data Center, Baton Rouge, LA. Website (http://usda.plants.gov). Accessed 30 Mar 2009.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. Bioscience

48: 607-615.

APPENDIX

SPECIES FOUND GROWING WITH PEDICULARIS LANCEOLATA

This appendix contains a list of all species that were found growing with Pedicularis lanceolata in this study and in previous studies. Cit. = Citatio reference the following studies by the first author's initials shown here i

parentheses: Farnsworth et al. 2007 (EF), Foster 2003 (RF), Lackney 198

(VL), Macior 1969 (LM), and Piehl 1965 (MP). An asterisk (\*) indicates specie for which direct haustorial attachments between P. lanceolata and the speci

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

142 Rhodora [Vol. 113

have been documented in the indicated studies. The numbers listed for each

species by region (Midwest, Northeast, or Southeast) are the occurrence

(proportion of sites where the species occurred within the region) and the % cover (mean and variance of the percent cover of that species in the region).

'N/A' for 'not applicable' = species not found in a particular region in this

study, but previously documented as an associated species in other studies.

Voucher specimens are housed in the herbaria of the University of

Massachusetts Amherst (mass), the University of Tennessee Knoxville (tenn),

and the University of Wisconsin Madison (wis). The herbarium acronym where the specimen is stored and the accession number, where available, appear below

the taxon's name.

Occurrence and % Cover ± Variance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Taxon (Voucher) | Cit. | Midwest | Northeast | Southeast |
| ACERACEAE |  |  |  |  |
| Acer rubrum L. | EF | 0.09 | 0.71 | 0.25 |
|  |  | 0.02±0.02 | 2±46 | 6+193 |
| ALISMATACEAE |  |  |  |  |
| Sagittaria latifolia Willd. | | 0.18 | 0.14 | 0 |
|  |  | 0.3±4 | 1 ±41 |  |
| AMARANTHACEAE |  |  |  |  |
| Gomphrena globosa L. | | 0 | 0.14 | 0 |
|  |  |  | 2±47 |  |
| ANACARDIACEAE |  |  |  |  |
| Toxicodendron radicans |  | 0.09 | 0.29 | 0.25 |
| (L.) Kuntze |  | 0.8+12 | 2±47 | 4+137 |
| APIACEAE |  |  |  |  |
| Angelica atropurpurea L. | | 0.18 | 0 | 0 |
|  |  | 2+55 |  |  |
| Cicuta bulb if era L. |  | 0.27 | 0.14 | 0 |
|  |  | 0.1+0.09 | 0.03±0.03 |  |
| Cicuta maculata L. | EF | 0.09 | 0.29 | 0 |
|  |  | 0.7+26 | 2±80 |  |
| \*Daucus carota L. | EF; MP | 0.18 | 0.57 | 0.25 |
|  |  | 0.06+0.06 | 1+ OO 4^ | 0.05±0.05 |
| Hydrocotyle americana L. | | 0 | 0.14 | 0 |
|  |  |  | 0.03±0.03 |  |
| Oxypolis rigidior (L.) Raf. | | 0.27 | 0 | 0.25 |
|  |  | 3± 121 |  | 0.8+11 |
| Sanicula odorata (Raf.) | | 0.09 | 0 | 0 |
| K.M. Pryer & L.R. |  | 1 ±30 |  |  |

Phillippe

(wis: #0260350)

(tenn: #not available)

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicular is lanceolata 143

Appendix. Continued.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± | | Variance |
| Taxon (Voucher) | Cit. | Midwest | Northeast | Southeast |
| APOCYNACEAE |  |  |  |  |
|  | MP | N/A | N/A | N/A |
| \*Apocynum carmabinum L. | |  |  |  |
| ARACEAE |  |  |  |  |
| \*Peltandra virginica | MP | N/A | N/A | N/A |
| (L.) Schott |  |  |  |  |
| Symplocarpus foetidus (L.) |  | 0 | 0.14 | 0 |
| Salisb. ex Nutt. |  |  | 0.03±0.03 |  |
| ASCLEPIADACEAE |  |  |  |  |
| Asclepias incarnata L. EF | | 0.27 | 0.29 | 0 |
|  |  | 0.8+26 | 1+41 |  |
| Asclepias syriaca L. | EF | N/A | N/A | N/A |
| Cynanchum louiseae | EF | 0 | 0.29 | 0 |
| Kartesz & Gandhi |  |  | 4+123 |  |
| ASTERACEAE |  |  |  |  |
| Achillea millefolium L. | | 0.18 | 0.14 | 0.25 |
|  |  | 0.05±0.05 | 1+41 | 6±194 |
|  | EF | 0.09 | 0.14 | 0.25 |
| Ambrosia artemisiifolia L. | |  |  |  |
|  |  | 0.7±26 | 0.03+0.03 | 0.05±0.05 |
| Ambrosia trifida L. |  | 0.09 | 0 | 0 |
|  |  | 0.7+26 |  |  |
| Antennaria neglecta |  | 0.09 | 0 | 0 |
| Greene |  | 0.3+4 |  |  |
| Arnoglossum |  | 0.09 | 0 | 0 |
| plantagineum Raf. |  | 0.02±0.02 |  |  |
| Bidens cernua L. |  | 0 | 0 | 0.25 |
|  |  |  |  | 0.8±11 |
| Bidens cormata Muhl. |  | 0.09 | 0 | 0 |
| ex Willd. |  | 0.02±0.02 |  |  |
| Bidens frondosa L. | EF | 0 | 0.14 | 0 |
| (wis: #0260354) |  |  | 0.03+0.03 |  |
| Carduus arvensis (L.) |  | 0.09 | 0 | 0 |
| Robson |  | 0.3±4 |  |  |
| Cirsium altissimum | LM | N/A | N/A | N/A |
| (L.) Hill |  |  |  |  |
| Cirsium discolor (Muhl. |  | 0.55 | 0.14 | 0 |
| ex Willd.) Spreng. |  | 4+121 | 1 ±41 |  |
| Doellingeria (Mill.) Nees |  | 0 | 0.29 | 0 |
| umbellata var. |  |  | 2+47 |  |
| umbellata |  |  |  |  |
| Eupatorium flstulosum |  | 0 | 0 | 0.50 |
| Barratt |  |  |  | 2+12 |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

144 Rhodora [Vol. 113

Appendix. Continued.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | Occurrence and % Cover ± | | Variance |
| Taxon (Voucher) |  | Cit. | Midwest | Northeast | Southeast |
| \*Eupatorium | EF; MP | | 0.63 | 1 | 0 |
| maculatum L. |  |  | 10±228 | 8± 185 |  |
| Eupatorium perfoliatum L. EF | | | 0.36 | 0.71 | 0.50 |
|  |  |  | 4+108 | 4±95 | 3±87 |
| Euthamia graminifolia | | EF | 0.36 | 0.43 | 0 |
| (L.) Nutt. |  |  | 6 ±208 | 9±261 |  |
| Euthamia tenuifolia |  |  | 0.09 | 0 | 0 |
| (Pursh) Nutt. var. |  |  | 0.9± 12 |  |  |
| tenuifolia |  |  |  |  |  |
| Helenium autumnale L. |  |  | 0.18 | 0 | 0.25 |
|  |  |  | 1 ±30 |  | 0.8+11 |
| Helianthus decapetalus L. |  | LM | N/A | N/A | N/A |
| Helianthus giganteus L. |  |  | 0.36 | 0 | 0 |
|  |  |  | 5± 171 |  |  |
| Helianthus grosseserratus |  |  | 0.09 | 0 | 0 |
| M. Martens |  |  | 2±58 |  |  |
| (wis: #0260360) |  |  |  |  |  |
| Hieracium caespitosum | |  | 0.09 | 0.43 | 0 |
| Dumort. |  |  | 1 ±30 | 3±84 |  |
| Lactuca sp. |  | EF | N/A | N/A | N/A |
| Leucanthemum vulgare |  |  | 0.09 | 0.43 | 0.25 |
| Lam. |  |  | 0.02±0.02 | 1 ±41 | 0.05+0.05 |
| Liatris scariosa (L.) Willd. | | | 0 | 0.14 | 0 |
| var. novae-angliae |  |  |  | 0.4±6 |  |
| Lunell |  |  |  |  |  |
| Machaeran thera |  |  | 0 | 0 | 0.25 |
| parviflora A. Gray |  |  |  |  | 2+12 |
| Oligoneuron ohioensis | |  | 0.27 | 0 | 0 |
| (Frank ex Riddell) |  |  | 5 ±146 |  |  |
| G.N. Jones |  |  |  |  |  |
| Oligoneuron riddellii |  |  | 0.09 | 0 | 0 |
| (Frank ex Riddell) |  |  | 0.7±26 |  |  |
| Rydb. |  |  |  |  |  |
| (wis: #0260364) |  |  |  |  |  |
| Packera schweinitziana |  |  | 0.09 | 0 | 0 |
| (Nutt.) W.A. Weber & |  |  | 0.04±0.04 |  |  |
| A. Löve |  |  |  |  |  |
| Rudbeckia fulgida Aiton | | | 0 | 0 | 0.25 |
| var. speciosa (Wender.) |  |  |  |  | 0.8±11 |
| Perdue |  |  |  |  |  |
| Rudbeckia laciniata L. |  |  | 0 | 0 | 0.25 |
|  |  |  |  |  | 0.8 ± 11 |
| Solidago canadensis L. |  |  | 0.36 | 0.14 | 0 |
|  |  |  | 7 ±202 | 0.4±6 |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC

All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 145

Appendix. Continued.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± | | | Variance |  |
| Taxon (Voucher) | Cit. | Midwest | | Northeast | Southeast |  |
| Solidago canadensis var. LM | | 0 |  | 0.14 | 0 |  |
| scabra Torr. & A. Gray |  |  |  | 2±80 |  |  |
|  | EF | 0.55 |  | 0.43 | 0.50 |  |
| Solidago gigantea Aiton | |  |  |  |  |  |
|  |  | 10±213 | | 2±80 | 3±80 |  |
| Solidago nemoralis Aiton | | 0.09 | | 0 | 0 |  |
|  |  | 0.04±0.04 | |  |  |  |
| \* Solidago patula Muhl. | MP; EF | 0 |  | 0.43 | 0.5 |  |
| ex Willd. |  |  |  | 1+ OO | 2±30 |  |
| Solidago rugosa Mill. | EF | 0 |  | 0.57 | 0 |  |
|  |  |  |  | 7+185 |  |  |
| Solidago uliginosa Nutt. |  | 0.18 |  | 0.43 | 0.25 |  |
|  |  | 4±106 | | 6±195 | 0.8±11 |  |
| Solidago sp. | EF | N/A | | N/A | N/A |  |
| Sonchus arvensis L. |  | 0.27 |  | 0 | 0 |  |
|  |  | 1±33 | |  |  |  |
| Symphyotrichum boreale |  | 0.09 |  | 0 | ' 0 |  |
| (Torr. & A. Gray) Â & |  | 0.04±0.04 | |  |  |  |
| D. Löve |  |  |  |  |  |  |
| Symphyotrichum laeve | | 0.09 | | 6 | 0 |  |
| (L.) Â & D. Löve |  | 1±30 | |  |  |  |
| var. laeve |  |  |  |  |  |  |
| \* Symphyotrichum | MP | 0 |  | 0.14 | 0.25 |  |
| lateriflorum (L.) A & |  |  |  | 2±80 | 2±72 |  |
| D. Löve var. |  |  |  |  |  |  |
| lateriflorum |  |  |  |  |  |  |
| \* Symphyotrichum novae | LM; MP | 0.45 |  | 0.57 | 0 |  |
| angliae (L.) G.L. |  | + 1 | OO IT) | 7± 184 |  |  |
|  |  |  |  |  |  |
| Nesom |  |  |  |  |  |  |
| Symphyotrichum pilosum LM | | N/A | | N/A | N/A |  |
| (Wiild.) G.L. Nesom | |  |  |  |  |  |
| var. pilosum |  |  |  |  |  |  |
| Symphyotrichum |  | 0.09 |  | 0 | 0 |  |
| praealtum (Poir.) G.L. |  | 0.3±4 |  |  |  |  |
| Nesom var. praealtum | |  |  |  |  |  |
| Symphyotrichum |  | 0.09 | | 0 | 0 |  |
| prenanthoides (Muhl. |  | 1 ±34 |  |  |  |  |
| ex Willd.) G.L. Nesom |  |  |  |  |  |  |
| Symphyotrichum | EF | 0.36 |  | 0.29 | 0.50 |  |
| puniceum (L.) A & D. | | 4± 127 | | 3±84 | 5± 145 |  |

Löve var. puniceum

(wis: #0260352)

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

146 Rhodora [Vol. 113

Appendix. Continued.

Occurrence and % Cover ± Variance

Taxon (Voucher) Cit. Midwest Northeast Southeast

Symphyotrichum sp. EF N/A N/A N/A

Taraxacum officinale 0.45 0.57 0.50 F.H.Wigg. 0.1±0.1 2±46 2±72

Vernonia gigantea 0.09 0 0.75 (Walter) Trel. subsp. 1 ±30 6± 196

gigantea

Vernonia noveboracensis 0 0.14 0.25

(L.) Michx. 2±47 4±93

BALSAMINACEAE

\*Impatiens capensis EF; MP 0.55 0.43 0.75

Meerb. 3±78 3±84 10±235

BERBERIDACEAE

Berberis thunbergii DC. 0 0.14 0 var. atropurpurea 1±41

Chenault

BETULACEAE

Alnus incana (L.) Moench EF 0 0.29 0.25 subsp. rugosa (Du Roi) 8 ±338 3 ±80

R.T. Clausen

BICNONIACEAE

Campsis radicans (L.) 0 0 0.25

Seem, ex Bureau 0.8±11

BORAGINACEAE

Myosotis scorpioides L. EF 0.09 0 0

0.7±26

BRASSICACEAE

Alliaria petiolata (Bieb.) 0 0.14 0

Ca vara & Grande 1 ±41

CAMPANULACEAE

Campanula aparinoides 0.55 0 0.25

Pursh 2±75 0.1 ±0.1

Lobelia kalmia L. 0.18 0.14 0 0.7±26 0.03±0.03

Lobelia siphilitica L. 0 0.14 0

0.03±0.03

CAPRIFOLIACEAE

Lonicera japonica Thunb. 0 0 0.25

2±30

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 147

Appendix. Continued.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± Variance | | |
| Taxon (Voucher) | Cit. | Midwest | Northeast |  |
| Lonicera morrowii A. | EF | 0.09 | 0.43 |  |
| Gray |  | 1±30 | 2+80 |  |
| Lonicera tatarica L. |  | 0.09 | 0 |  |
|  |  | 0.5±8 |  |  |
| Viburnum acerifolium L. | | 0 | 0.14 |  |
|  |  |  | 0.03±0.03 |  |
| Viburnum dentatum L. |  | 0.09 | 0.14 |  |
|  |  | 3±124 | 0.06±0.06 |  |
| Viburnum dentatum L. |  | 0 | 0.43 |  |
| var. lucidum Aiton |  |  | 3+116 |  |
| Viburnum lentago L. |  | 0.09 | 0.29 |  |
|  |  | 0.7±26 | 1 ±41 |  |
| Viburnum nudum L. |  | 0 | 0 |  |
| Viburnum opulus L. var. |  | 0 | 0.14 |  |
| americanum Aiton |  |  | 0.03±0.03 |  |
| CARYOPHYLLACEAE |  |  |  |  |
| Cerastium fontanum |  | 0.09 | 0.14 |  |
| Baumg. subsp. vulgare | | 0.02±0.02 | 0.03±0.03 |  |
| (Hartm.) Greuter & | |  |  |  |
| Bürdet |  |  |  |  |
| CELASTRACEAE |  |  |  |  |
| Celastrus orbiculata EF | |  | 0.14 |  |
| Thunb. |  |  | 2± 113 |  |
| Celastrus scandens L. |  |  | 0 | 0.25 |
|  |  |  |  | 12+494 |
| CLUSIACEAE |  |  |  |  |
| Hypericum mutilum L. | |  |  | 0.25 |
|  |  |  |  | 0.8 ± 11 |
| Hypericum perforatum L. | | 0.09 | 0.29 | 0.25 |
|  |  | 0.04±0.04 | 1 ±41 | 0.05+0.05 |
| CONVOLVULACEAE |  |  |  |  |
| Calystegia sepium (L.) R. | | 0.09 0 | |  |
| Br. subsp. sepium |  | 2±58 |  |  |
| CORNACEAE |  |  |  |  |
| Cornus amomum Mill. EF | | 0.55 | 0.86 |  |
| (wis: #0260351) |  | 5±129 | 5+153 |  |
| \* Cornus foemina Mill. MP | | 0 | 0.29 |  |
|  |  |  | 3± 116 |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 148 | Rhodora | |  | [Vol. 113 |  |
| Appendix. Continued. | | |  |  |  |
|  |  | Occurrence and % Cover + Variance | | |  |
| Taxon (Voucher) | Cit. | Midwest | Northeast Southeast | |  |
| Cornus rugosa Lam. |  | 0 | 0.14 | 0 |  |
|  |  |  | 0.4±6 |  |  |
| \* Cornus sericea L. | MP | 0 | 0.14 | 0 |  |
|  |  |  | 1 ±41 |  |  |
| CUSCUTACEAE |  |  |  |  |  |
| Cuscuta gronovii Willd. | | 0.09 | 0 | 0 |  |
| ex Schult. |  | 0.02±0.02 |  |  |  |
| CYPERACEAE |  |  |  |  |  |
| Carex aquatilis Wahlenb. | | 0.09 | 0.29 | 0 |  |
| (wis: #0260347) |  | 4± 165 | 2±47 |  |  |
| Carex buxbaumii |  | 0.09 | 0 | 0 |  |
| Wahlenb. |  | 3+167 |  |  |  |
| (wis: #0260356) |  |  |  |  |  |
| Carex communis Bailey |  | 0.09 | 0 | 0 |  |
|  |  | 1 ±72 |  |  |  |
| Carex crinita Lam. | EF | 0 | 0 | 0.75 |  |
|  |  |  |  | 5±98 |  |
| Carex hystericina Muhl. | | 0.09 | 0.14 | 0 |  |
| ex Willd. |  | 1+72 | 3± 151 |  |  |
| (wis: #0260363) |  |  |  |  |  |
| (mass: #313340) |  |  |  |  |  |
| Carex lacustris Willd. |  | 0 | 0.14 | 0 |  |
|  |  |  | 0.9± 12 |  |  |
| Carex lasiocarpa Mack. |  | 0 | 0.14 | 0 |  |
| ex Bright |  |  | 3± 116 |  |  |
| Carex lurida Wahlenb. | EF | 0 | 0.29 | 0.25 |  |
| (mass: #313333) |  |  | 2±80 | 5±28f |  |
| (tenn: # not available) | |  |  |  |  |
| Carex sartwellii Dewey |  | 0.09 | 0 | 0 |  |
|  |  | 0.7±26 |  |  |  |
|  | EF | 0 | 0.29 | 0 |  |
| Carex vulpinoidea Michx. | |  | 4+120 |  |  |
|  |  |  |  |  |
| Carex sp. | EF | N/A | N/A | N/A |  |
| Cyperus sp. | EF | N/A | N/A | N/A |  |
| Dulichium arundinaceum |  | 0 | 0.29 | 0 |  |
| (L.) Britton |  |  | 2±80 |  |  |
| Eleocharis acicularis (L.) | | 0.09 | 0 | 0 |  |
| Roem. & Schult. |  | 0.02+0.02 |  |  |  |
| Eleocharis rostellata |  | 0.09 | 0.14 | 0 |  |
| (Torr.) Torr. |  | 0.7+26 | 1 ±41 |  |  |
| Rhynchospora capitellata | EF | N/A | N/A | N/A |  |
| (Michx.) Vahl |  |  |  |  |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 149

Appendix. Continued.

Occurrence and % Cover ± Variance

Taxon (Voucher) Cit. Midwest Northeast Southeast

Scirpus atrovirens Willd. 0 0.43 0 (wis: #0260355) 4± 150

\*Scirpus cyperinus EF; RF N/A N/A N/A (L.) Kunth

Scirpus hattorianus 0.27 0 0

Makino 3±101

(mass: #313338)

Scirpus tabernaemontani 0 0.14 0 (C.C. Gmel.) Palla 1±41

DROSERACEAE

Drosera rotundifolia L. 0.09 0 0

0.05+0.05

DRY OPTERID ACEAE

Onoclea sensibilis L. EF 0.09 0.57 0

1 ±30 6± 157

EQUISETACEAE

\*Equisetum arvense L. MP 0 0.43 0

5± 152

Equisetum hyemale L. 0.09 0.14 0

0.7+26 0.03±0.03

Equisetum laevigatum A. 0.27 0 0

Braun 3±101

Equisetum palustre L. 0.72 0.29 0

12±352 6 ±294

Equisetum variegatum 0 0.29 0

Schleich, ex F. Weber 0.4+6

& D.M.H. Möhr

ERICACEAE

Andromeda polifolia L. 0 0 0.25 var. glaucophylla 4+136 (Link) DC.

FABACEAE

Amphicarpaea bracteata EF 0.09 0.71 0.50 (L.) Fernald 0.02±0.02 0.5±6 9±241 Apios americarta Medik. EF 0 0.14 0.75

0.9± 12 9±241

Baptisia tinctoria (L.) R. 0 0.14 0

Br. ex Aiton f. 0.4 ±6

Desmodium cuspidatum 0.09 0.14 0

(Muhl, ex Willd.) DC. 1±34 1±41

ex Loudon

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 150 |  | Rhodora |  | [Vol. 113 |  |
| Appendix. Continued. | | |  |  |  |
|  |  | Occurrence and % Cover ± | | Variance |  |
| Taxon (Voucher) | Cit. | Midwest | Northeast | Southeast |  |
| Lathyrus palustris L. |  | 0.27 | 0 | 0 |  |
|  |  | 1 ±51 |  |  |  |
| Lespedeza procumbens |  | 0 | 0 | 0.25 |  |
| Michx. |  |  |  | 0.05±0.05 |  |
| Lotus corniculatus L. |  | 0 | 0.14 | 0 |  |
|  |  |  | 0.4+6 |  |  |
| Medicago lupulina L. |  | 0 | 0.14 | 0 |  |
|  |  |  | 0.03±0.03 |  |  |
| Melilotus alba Medik. |  | 0.09 | 0 | 0 |  |
|  |  | 0.02±0.02 |  |  |  |
| Melilotus officinalis (L.) | | 0 | 0.14 | 0 |  |
| Lam. |  |  | 0.06±0.06 |  |  |
| Trifolium campestre |  | 0.09 | 0 | 0 |  |
| Schreb. |  | 0.02+0.02 |  |  |  |
| Trifolium dubium Sibth. |  | 0 | 0 | 0.25 |  |
|  |  |  |  | 0.05±0.05 |  |
| \* Trifolium incarnatum VL. | | N/A | N/A | N/A |  |
| Trifolium pratense L. |  | 0.09 | 0 | 0.25 |  |
|  |  | 0.7±26 |  | 3+80 |  |
| Trifolium repens L. |  | 0.09 | 0.14 | 0 |  |
|  |  | 0.02±0.02 | 0.03±0.03 |  |  |
| FAGACEAE |  |  |  |  |  |
| Quercus macrocarpa |  | 0.09 | 0.14 | 0 |  |
| Michx. |  | 0.02±0.02 | 0.03±0.03 |  |  |
| Quercus rubra L. |  | 0.09 | 0 | 0 |  |
|  |  | 0.3+4 |  |  |  |
| GENTIANACEAE |  |  |  |  |  |
| Gentiana andrewsii | LM | N/A | N/A | N/A |  |
| Griseb. |  |  |  |  |  |
| Gentiana clausa Raf. |  | 0.09 | 0.14 | 0 |  |
|  |  | 0.7±26 | 2+46 |  |  |
| Gentiana puberulenta J.S. | | 0.09 | 0 | 0 |  |
| Pringle |  | 0.02+0.02 |  |  |  |
| Gentianopsis crinita |  | 0 | 0.14 | 0 |  |
| (Froel.) Ma |  |  | 1+41 | 0 |  |
| Gentianopsis virgata |  | 0.09 | 0 |  |
| (Raf.) Holub |  | 0.02±0.02 |  |  |  |
| GROSSULARIACEAE |  |  |  |  |  |
| Ribes hirtellum Michx. |  | 0.18 | 0.14 | 0 |  |
| (wis: #0260346) |  | 0.3±4 | 1 ±41 |  |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 151

Appendix. Continued.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± | | Variance |
| Taxon (Voucher) | Cit. | Midwest | Northeast | Southeast |
| HAMAMELIDACEAE |  |  |  |  |
| Liquidambar styraciflua L. | | 0 | 0 | 0.25 |
|  |  |  |  | 0.05+0.05 |
| HYDROPHYLLACEAE |  |  |  |  |
| Hydrophyllum |  | 0 | 0.14 | 0 |
| appendiculatum Michx. |  |  | 1+41 |  |
| IRIDACEAE |  |  |  |  |
| Iris pseudacorus L. | EF | N/A | N/A | N/A |
| Iris versicolor L. |  | 0.18 | 0 | 0 |
|  |  | 3±101 |  |  |
| \*Iris virginica L. | MP | N/A | N/A | N/A |
| JUNCACEAE |  |  |  |  |
| Juncus brevicaudatus |  | 0 | 0.14 | 0 |
| (Engelm.) Fernald |  |  | 0.4+6 |  |
| Juncus canadensis |  | 0.09 | 0 | 0 |
| J. Gay ex Laharpe |  | 0.7±26 |  |  |
| \* Juncus effusus L. | EF; RF | 0.09 | 0.14 | 0.75 |
|  |  | 0.7±26 | 1 ±41 | 6+196 |
| Juncus nodosus L. |  | 0.36 | 0.71 | 0 |
|  |  | 2±55 | 12±297 |  |
| Juncus tenuis Willd. | EF | 0.09 | 0.14 | 0 |
|  |  | 0.3±4 | 3± 116 |  |
| JUNCAGINACEAE |  |  |  |  |
| Triglochin maritima L. | | 0.09 | 0 | 0 |
|  |  | 0.02±0.02 |  |  |
| LAMIACEAE |  |  |  |  |
| Clinopodium vulgare L. | | 0 | 0.14 | 0.25 |
|  |  |  | 0.03+0.03 | 2±72 |
| Glechoma hederacea L. |  | 0 | 0.14 | 0 |
|  |  |  | 0.03±0.03 |  |
| Lycopus americanus |  | 0.64 | 0.29 |  |
| Muhl, ex W.P.C. |  | 3±99 | 0.06±0.06 |  |
| Barton |  |  |  |  |
| Lycopus uniflorus Michx. EF | | 0.91 | 0.86 | 0.75 |
| (wis: #0260358) |  | 10+258 | 11 ±271 | 6±196 |
| Mentha aquatica L. |  | 0.09 | 0 | 0 |
|  |  | 0.02±0.02 |  |  |
| Mentha arvensis L. | EF | 0.09 | 0 | 0 |
|  |  | 0.04±0.04 |  |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 152 | Rhodora | |  | [Vol. 113 |
|  | Appendix. Continued. | |  |  |
|  |  | Occurrence and % Cover ± Variance | | |
| Taxon (Voucher) | Cit. | Midwest | Northeast Southeast | |
| Monarda media Willd. |  | 0.09 | 0 | 0 |
|  |  | 0.5±8 |  |  |
| Prunella vulgaris L. | LM | 0.45 | 0.86 | 0.50 |
|  |  | 4+127 | 12±244 | 0.2±0.2 |
| Pycnanthemum |  | 0.18 | 0 | 0 |
| tenuifolium Schrad. |  | 0.7+26 |  |  |
| \*Pycnanthemum | MP | 0.27 | 0.29 | 0.25 |
| virginianum (L.) T. |  | 3+103 | 3±85 | 0.1 ±0.1 |
| Durand & B.D. Jacks. |  |  |  |  |
| ex B.L. Rob. & Fernald |  |  |  |  |
| Scutellaria galericulata L. | | 0.09 |  |  |
|  |  | 1+52 |  |  |
| Scutellaria lateriflora L. EF | | 0.18 | 0.14 |  |
|  |  | 0.07+0.07 | 0.03 ±0.03 |  |
| LILIACEAE |  |  |  |  |
| Maianthemum canadense |  | 0.09 |  |  |
| Desf. |  | 0.7±26 |  |  |
| Maianthemum racemosum |  | 0.09 |  |  |
| (L.) Link subsp. |  | 1+52 |  |  |
| racemosum |  |  |  |  |
| LYTHRACEAE |  |  |  |  |
| Decodon verticillatus (L.) | | 0 | 0.14 |  |
| Elliott |  |  | 1+41 |  |
| Lythrum alatum Pursh | | 0.18 | 0 |  |
|  |  | 0.7+26 |  |  |
| Lythrum salicaria L. | | 0 | 0.28 |  |
|  |  |  | 4 ±260 |  |
| MALVACEAE |  |  |  |  |
| Hibiscus moscheutos L. |  |  |  | 0.25 |
| subsp. moscheutos |  |  |  | 2±72 |
| MYRICACEAE |  |  |  |  |
| Myrica gale L. |  |  | 0.14 |  |
|  |  |  | 0.4 ±6 |  |
| OLEACEAE |  |  |  |  |
| Fraxinus pennsylvanica | |  | 0.43 | 0.25 |
| Marshall |  |  | 3± 116 | 3±80 |
| Ligustrum vulgare L. |  |  | 0 | 0.25 |
|  |  |  |  | 0.8±11 |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 153

Appendix. Continued.

Occurrence and % Cover ± Variance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Taxon (Voucher) | Cit. | Midwest | Northeast Southeast | |
| ONAGRACEAE |  |  |  |  |
| Circaea lutetiana L. |  | 0.09 |  |  |
| subsp. canadensis (L.) |  | 0.04±0.04 |  |  |
| Asch. & Magnus |  |  |  |  |
| Epilobium coloratum | EF | 0 | 0 | 0.25 |
| Biehler |  |  |  | 0.8±11 |
| Epilobium leptophyllum |  | 0.09 | 0 | 0 |
| Raf. |  | 0.02+0.02 |  |  |
| Epilobium strictum Muhl. |  | 0 | 0.29 | 0 |
| ex Spreng. |  |  | 0.1+0.1 |  |
| (mass: #313334) |  |  |  |  |
| Ludwigia alternifolia L. |  |  |  | 0.25 |
|  |  |  |  | 2±21 |
| OXALIDACEAE |  |  |  |  |
| Oxalis corniculata L. |  |  | 0.14 |  |
|  |  |  | 1 ±41 |  |
| Oxalis stricta L. |  | 0.09 | 0.14 | 0.50 |
|  |  | 0.02±0.02 | 3±89 | 4±136 |
| PINACEAE |  |  |  |  |
| Larix laricina |  |  | 0.14 |  |
| (Du Roi) K. Koch |  |  | 1 ±41 |  |
| Pinus strobus L. EF | | 0.09 | 0 | 0 |
|  |  | 0.3+4 |  |  |
| PLANTAGINACEAE |  |  |  |  |
| Plantago lanceolata L. | | 0 | 0.43 | 0 |
|  |  |  | 2±52 |  |
| Plantago major L. |  | 0 | 0.43 | 0 |
|  |  |  | 2±80 |  |
| Plantago rugelii Dene. |  | 0.27 | 0.14 | 0 |
|  |  | 1+30 | 1+41 |  |
| POACEAE |  |  |  |  |
| Agrostis capillaris L. |  | 0 | 0.29 | 0.25 |
|  |  |  | 5+181 | 2±72 |
| Agrostis gigantea Roth |  | 0.55 | 0.29 | 0.25 |
|  |  | 5+129 | 2±80 | 4± 137 |
| Agrostis stolonifera L. |  | 0 | 0.14 | 0.25 |
| (mass: #313339) |  |  | 2±52 | 4± 137 |
| (tenn: # not available) |  |  |  |  |
| Alopecurus carolinianus |  | 0 | 0 | 0.25 |
| Walter |  |  |  | 2±21 |
| Bromus inermis Leyss. EF | | N/A | N/A | N/A |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

154 Rhodora [Vol. 113

Appendix. Continued.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± Variance | | |
| Taxon (Voucher) | Cit. | Midwest | Northeast | Southeast |
| Cinna arundinacea L. | EF | N/A | N/A | N/A |
| Danthonia spicata (L.) P. |  | 0.09 | 0 | 0 |
| Beauv. ex Roem. & |  | 0.7±26 |  |  |
| Schult. |  |  |  |  |
| Deschampsia cespitosa |  | 0.09 | 0.14 | 0 |
| (L.) P. Beauv. |  | 2±58 | 1 ±41 |  |
| Dichanthelium |  | 0.09 | 0.43 | 0 |
| acuminatum (Sw.) |  | 0.3±4 | 4± 122 |  |
| Gould & C.A. Clark |  |  |  |  |
| (wis: #0260353) |  |  |  |  |
| (mass: #313337) |  |  |  |  |
| Dichanthelium |  | 0 | 0.29 | 0.50 |
| clandestinum (L.) |  |  | 2±80 | 4±94 |
| Gould |  |  |  |  |
| Dichanthelium leucothrix |  | 0 | 0 | 0.25 |
| (Nash) Freckmann |  |  |  | 6± 194 |
| Echinochloa muricata | EF | N/A | N/A | N/A |
| (P. Beauv.) Fernald |  |  |  |  |
| Elymus riparius Wiegand |  | 0.09 | 0.14 | 0 |
| (wis: #0260357) |  | 0.7+26 | 3±85 |  |
| Elymus trachycaulus |  | 0.09 | 0 | 0 |
| (Link) Gould ex |  | 0.02±0.02 |  |  |
| Shinners |  |  |  |  |
| Glyceria canadensis |  | 0.09 | 0 | 0 |
| (Michx.) Trin. |  | 0.7±26 |  |  |
| Glyceria grandis S. | EF | N/A | N/A | N/A |
| Watson |  |  |  |  |
| Glyceria septentrionalis |  | 0 | 0 | 0.25 |
| A.S. Hitchc. |  |  |  | 2±21 |
| (tenn: # not available) | |  |  |  |
| Glyceria striata (Lam.) |  | 0 | 0.14 | 0 |
| A.S. Hitchc. |  |  | 1 ±41 |  |
| Leersia oryzoides (L.) Sw. | EF | 0 | 0 | 0.25 |
|  |  |  |  | 3±80 |
| Microstegium vimineum |  | 0 | 0.14 | 0 |
| (Trin.) A. Camus |  |  | 7±461 |  |
| Muhlenbergia asperifolia |  | 0.09 | 0.14 | 0 |
| (Nees & Meyen |  | 1 ±52 | 0.03±0.03 |  |
| ex Trin.) Parodi |  |  |  |  |
| Panicum flexile (Gatt.) |  | 0 | 0 | 0.75 |
| Scribn. |  |  |  | 9±241 |
| Paspalum dilatatum Poir. | | 0 | 0 | 0.50 |

(tenn: # not available) 8±243

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 155

Appendix. Continued.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Occurrence and % Cover ± Variance | | | |  |
| Tax on (Voucher) Cit. | |  | Midwest Northeast Southeast | | |  |
| \*Phalaris arundinacea L. EF; RF | |  | Ö45 Ö29 Ö | | |  |
| (wis: #0260359) |  |  | 7 ±272 3±92 | |  |  |
| (tenn: # not available) |  |  |  |  |  |  |
| Phleum pratense L. |  |  | 0 0.57 0 | | |  |
|  |  |  |  | 5± 153 |  |  |
| Poa palustris L. |  |  | 010 | | |  |
| (mass: #313336) |  |  |  | 0.03±0.03 |  |  |
| Poa pratensis L. |  |  | 0.55 0.29 0.25 | | |  |
|  |  |  | 5+165 2±52 3±80 | | |  |
| Schizachyrium scoparium |  |  | 0.09 0 0 | | |  |
| (Michx.) Nash |  |  | 0.7±26 |  |  |  |
| Spartina pectinata |  |  | 0.09 0 0 | | |  |
| Bosc ex Link |  |  | 1+52 |  |  |  |
| \*Triticum aestivum L. VL | |  | N/A N/A N/A | | |  |
| POLYGONACEAE |  |  |  |  |  |  |
|  |  |  | 0.27 0 0 | | |  |
| \* Polygonum amphibium L. MP | | | |  |  |  |
| (wis: #0260348) |  |  | 3± 121 | | |  |
| Polygonum cespitosum | |  | 0 0 0.25 | | |  |
| Blume |  |  |  |  | 6±261 |  |
| Polygonum sagittatum L. EF | |  | 0.09 0.29 0.25 | | |  |
|  |  |  | 2+76 4+150 3±80 | | |  |
| Polygonum virginianum L. |  |  | 0 0 0.25 | | |  |
|  |  |  |  |  | 0.05+0.05 |  |
| Rumex crispus L. |  |  | 0.09 0 0 | | |  |
|  |  |  | 0.5±8 |  |  |  |
| PRIMULACEAE |  |  |  |  |  |  |
|  | EF |  | 0.09 | 0.14 | 0 |  |
| Lysimachia ciliata L. | |  |  |  |  |  |
|  |  |  | 0.7±26 | 3±92 |  |  |
|  | EF |  | N/A | N/A | N/A |  |
| Lysimachia terrestris (L.) | | |  |  |  |  |
| Britton, Sterns & |  |  |  |  |  |  |
| Poggenb. |  |  |  |  | N/A |  |
| \* Lysimachia | MP |  | N/A | N/A |  |
| quadrifolia L. |  |  |  |  |  |  |
| RANUNCULACEAE |  |  |  |  |  |  |
| Caltha palustris L. |  |  | 0.18 | 0.43 | 0.25 |  |
|  |  |  | 1+33 | 9 ±297 | 2±30 |  |
| \* Clematis virginianaEF;L.RF | |  | 0 | 0.14 | 0.75 |  |
|  |  |  |  | 1 ±41 | 9±241 |  |
| Ranunculus acris L. |  |  | 0 | 0.71 | 0 |  |
|  |  |  |  | 6+181 |  |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

156 Rhodora [Vol. 113

Appendix. Continued.

Occurrence and % Cover ± Variance

Taxon (Voucher) Cit. Midwest Northeast Southeast

\* Ranunculus hispidus MP N/A N/A N/A

Michx.

Ranunculus sp. EF N/A N/A N/A

\*Thalictrum dasycarpum MP N/A N/A N/A

Fisch. & Avé-Lall.

Thalictrum dioicum L. 0.18 0.14 0 0.7±26 1+41

Thalictrum pubescens EF 0.27 0.57 0

Pursh 4+151 3+88

RHAMNACEAE

\*Rhamnus frangula L. EF; MP 0.45 0.29 0

7 ±209 0.06±0.06

ROSACEAE

Agrimonia parviflora 0 0.14 0.50

Aiton 1 ±41 2±21

Argentina anserine 0.09 0 0 (L.)Rydb. 3± 120

Dasiphora floribunda 0.27 0.14 0 (Pursh) Raf. comb. 5+129 4±120

nov. ined.

|  |  |  |  |
| --- | --- | --- | --- |
| Filipendula rubra (Hill) 0.09 | | 0 | 0 |
| B.L. Robins. | 0.02+0.02 |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fragaria vesca L. |  | 0.09 | 0.14 | 0 |
|  |  | 0.7±26 | 1 ±41 |  |
| Fragaria virginiana |  | 0.18 | 0 | 0 |
| Duchesne |  | 1 ±33 |  |  |
| Geum canadense Jacq. |  | 0.09 | 0.14 | 0.25 |
| (wis: #0260345) |  | 0.02±0.02 | 0.03±0.03 | 0.05±0.05 |
| Geum rivale L. |  | 0.18 | 0.14 | 0 |
|  |  | 1±51 | 0.03±0.03 |  |
| Geum sp. | EF | N/A | N/A | N/A |
| Potentilla recta L. |  | 0 | 0.29 | 0 |
| (mass: #313335) |  |  | 1+41 |  |
| Potentilla simplex Michx. | EF | 0.09 | 0.29 | 0.50 |
| (wis: #0260349) |  | 1 ±30 | 4±120 | 3±80 |
| Prunus serotina Ehrh. |  | 0.09 | 0 | 0 |
|  |  | 0.3±4 |  |  |
| Rosa Carolina L. |  | 0.09 | 0 | 0 |
|  |  | 1 ±30 |  |  |
| Rosa multiflora | EF | 0 | 0.29 | 0 |
| Thunb. ex Murray |  |  | 1 ±41 |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 157

Appendix. Continued.

Taxon (Voucher)

Rosa virginiana Mill.

Rubus allegheniensis

Porter

Rubus idaeus L.

Rubus hispidus L.

Rubus pubescens Raf.

Rubus sp.

Spiraea alba Du Roi

Spiraea tomentosa L.

RUBIACEAE

Diodia teres Walter

Galium aparine L.

Galium palustre L.

Galium tinctorium L.

Galium trifidum L.

Galium sp.

SALICACEAE

|  |  |  |  |
| --- | --- | --- | --- |
|  | Occurrence and I % Cover ± | | Variance |
| Cit. | Midwest | Northeast | Southeast |
|  | 0.09 | 0 | 0.50 |
|  | 0.7±26 |  | 6± 149 |
|  | 0.09 | 0 | 0.50 |
|  | 1 ±52 |  | 9±241 |
|  | 0.09 | 0.14 | 0 |
|  | 0.7±26 | 1 ±41 |  |
|  | 0 | 0.14 | 0 |
|  |  | 2±80 |  |
|  | 0 | 0.14 | 0 |
|  |  | 0.4±6 |  |
| EF | N/A | N/A | N/A |
|  | 0 | 0.14 | 0 |
|  |  | 1 ±41 |  |
| EF | 0 | 0.14 | 0 |
|  |  | 0.4±6 |  |
|  | 0 | 0 | 0.25 |
|  |  |  | 2±72 |
|  | 0 | 0.57 | 0.25 |
|  |  | 2±79 | 0.1 ±0.1 |
|  | 0.09 | 0.14 | 0 |
|  | 0.04±0.04 | 1 ±41 |  |
|  | 0 | 0 | 0.25 |
|  |  |  | 0.05±0.05 |
|  | 0.09 | 0 | 0 |
|  | 0.02±0.02 |  |  |
| EF | N/A | N/A | N/A |

|  |  |  |  |
| --- | --- | --- | --- |
| Populus deltoides Bartram | 0 | 0.14 | 0 |
| ex Marshall |  | 1 ±41 |  |
| Populus grandidentata | 0.09 | 0 | 0 |
| Michx. | 0.02±0.02 |  |  |
| Populus tremuloides | 0.09 | 0.14 | 0 |
| Michx. | 0.7±26 | 0.03±0.03 |  |
| Salix bebbiana Sarg. | 0.18 | 0.57 | 0 |
| (wis: #0260362) | 0.8±12 | 6± 157 |  |
| Salix bicolor Fries | 0.09 | 0 | 0 |
|  | 0.3±4 |  |  |
| Salix sericea Marshall | 0.09 | 0 | 0 |
|  | 0.7+26 |  |  |

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

158 Rhodora [Vol. 113

Appendix. Continued.

Occurrence and % Cover ± Variance

Taxon (Voucher) Cit. Midwest Northeast Southeast

SAXIFRAGACEAE

Parnassia glauca Raf. 0.27 0.29 0

3±81 4±123

Saxifraga pensylvanica L. 0.09 0 0

0.04±0.04

SCROPHULARIACEAE

Agalinis paupercula 0.09 0 0

(A. Gray) Britton 0.02±0.02

var. paupercula

\*Chelone glabra L. EF; RF; 0 0 0.25

MP 2±72

Chelone lyonii Pursh 0 0.14 0

0.03±0.03

Gratiola aurea Pursh 0.09 0 0

2±55

Mimulus ringens L. EF N/A N/A N/A

SMILACACEAE

Smilax herbacea L. 0 0.14 0

2±80

SOLANACEAE

Solanum Carolinense L. 0 0 0.75

3±80

Solanum dulcamara L. EF 0 0.14 0

0.03±0.03

SPARGANIACEAE

Sparganium androcladum 0 0 0.25

(Engelm.) Morong 2±21

THELYPTERIDACEAE

\*Thelypteris palustris MP 0 0.71 0

Schott 8± 185

TYPHACEAE

Typha angustifolia h. 0 0.14 0

1±18

\* Typha latifolia L. MP 0.09 0.14 0

0.7+26 0.03±0.03

ULMACEAE

Ulmus rubra Muhl. 0.09 0 0

0.7±26

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms

2011] Record—Species Associated with Pedicularis lanceolata 159

Appendix. Continued.

Occurrence and % Cover ± Variance

Taxon (Voucher) Cit. Midwest Northeast Southeast

URTICACEAE

Boehmeria cylindrica EF 0.09 0 0.50 (L.) Sw. 0.7±26 8±242

Pilea pumila (L.) A. Gray 0.09 0.14 0

0.6±8 0.03+0.03

VERBENACEAE

* Verbena hastata L. EF; MP N/A N/A N/A Verbena urticifolia L. 0 0.14 0

0.5±6

VIT ACE AE

Parthenocissus 0 0.29 0

quinquefolia (L.) 0.5±6

Planch.

Vitis labrusca L. 0 0.14 0.25 2±47 5± 142

Vitis riparia Michx. 0.18 0.29 0

0.7±26 0.06±0.06

This content downloaded from 129.94.142.234 on Thu, 27 Aug 2020 01:42:05 UTC All use subject to https://about.jstor.org/terms