

## Supplementary Materials

Appendix 1. Calculation of habitat indication scores and weighted mean habitat fidelity. Effects of oak-hickory woodland restoration treatments on native groundcover vegetation and an invasive grass, *Microstegium vimineum*. J. Stephen Brewer, Matthew J. Abbott, and Sean A. Moyer.

Step 1. Generating a regional species × habitat presence-absence matrix from regional flora manuals. Manuals used included:

Clewell, A.F. 1985. *Guide to the Vascular Plants of the Florida Panhandle*. Tallahassee, FL: Florida State University Press.

Godfrey RK, J. Wooten (1979a). *Aquatic and Wetland Plants of Southeastern United States: Monocotyledons*. Athens, GA: University of Georgia Press.

Godfrey RK, J. Wooten (1979b). *Aquatic and Wetland Plants of Southeastern United States: Dicotyledons*. Athens, GA: University of Georgia Press.

Jones R.L. 2005. *Plant Life of Kentucky: An Illustrated Guide to the Vascular Flora*. Lexington, KY: University Press of Kentucky.

Radford A.R., H.A. Ahles, C.R. Bell (1968). *Manual of the Vascular Flora of the Carolinas*. Chapel Hill, NC: University of North Carolina Press, (with updates by A. Weakley).

Species included were those encountered by Brewer or co-workers throughout Mississippi, a total of 404 species.

Step 2. Pooling specific habitats (as named and identified in the floral manuals cited in Step 1) into three general habitat categories of interest, Fire-Maintained Open Habitats (open habitats), Forests, and habitats characterized by Severe Anthropogenic Disturbance (disturbed habitats).

Open habitats specifically included open woods, mesic open woods, dry open woods, semi-open dry woods, low open woods, sparsely wooded areas, dry open oak woods, prairies, acid prairies, barrens, bogs (i.e., fire-maintained bogs of the southeast USA), bog margins, borders of bays/shrub bogs, depressions in bogs and pine savannas, depressions in flatwoods or pine savannas, poorly-drained pinelands and pine savannas, flatwoods, sandhills, savannas, pine savannas, pine seepage slopes, moist edges of scrub oak-pine barrens, wet pine flatwoods, wet pine savannas. Non-native species were assumed not to be indicative of any of these habitats, regardless of whether they had become naturalized within these habitats.

Forests specifically included woods, oak-hickory forests, mesic woods, rich or loamy woods, shady and mesic slopes, mesic slopes, hammocks, beech woods, calcareous hammocks, coastal hammocks, woods with basic or neutral pH soil, woods with acid soils, forested bluffs, floodplain/bottomland forests, wet woods, low woods, upland woods, alluvial woods, ravine bottoms and slopes, wet calcareous hammocks, wet limestone hammocks, ridgetop woods, dry woods, wooded river banks, pine-oak-hickory woods, pine-oak woods, wooded stream banks, banks of stream draining bays, creek swamps, cypress depressions, cypress swamps, forested wetlands, acid swamps, rocky woods, sandy woods, seepage areas in woodlands, springs, and titi swamps. As with open habitats, non-native species were assumed not to be indicative of any of these native forested habitats.

Disturbed habitats specifically included disturbed areas, waste places, areas with ruderals, fallow fields, ditches, borrow pits, lawns, paths, old home sites, gardens, ditchbanks, disturbed soils in wet areas, wet disturbed sandy soils, sandy-peaty ditches, ditchbanks, and roadsides adjacent to nutrient-poor habitats. In contrast to open and forest habitats, non-native species were not assumed non-indicative of severely disturbed habitats.

Step 3. Calculating proportional similarity in species composition between each pooled general habitat category of interest and each specific habitat type not within the pooled habitat category of interest. This was done as a separate analysis for each of the three pooled habitat categories of interest. Proportion similarity calculated as Sørensen's quotient of similarity:

$$Q = 2c/(s_s+s_g)$$

where  $Q$  is the quotient of similarity between a specific habitat and the general pooled habitat category of interest,  $c$  is the number of species common to both the specific habitat and the general pooled habitat category,  $s_s$  is the number of species in the specific habitat, and  $s_g$  is the number of species in the general pooled habitat category.

Step 4. Calculating unrefined habitat indication scores for each species for each of the three general habitat categories of interest. This was accomplished by taking the species  $\times$  habitat matrix (with some specific habitats pooled into the general habitat category of interest) and replacing the 1's (presences) with the proportional similarity between each specific habitat with the general habitat category of interest (calculated in Step 3). From the new matrix, weighted averages of the proportional similarity scores were then calculated for each species. This was done three times, a separate analysis for each of the three general habitat categories of interest, yielding an unrefined indication of each general habitat category of interest for each species.

Step 5. Refining habitat indication scores. To account for overlap among the general habitat categories of interest and therefore to quantify each species' association with each general habitat category of interest independently of the other two, indication scores for all species for a given general habitat category were regressed against scores for the remaining two categories, using multiple regression, and the residual responses scores were obtained. These residual habitat indication scores were rescaled to be centered around the original (raw) mean score to produce leverage residuals. These leverage residual scores represented the refined habitat indication scores. Those native species with high refined open-habitat indication scores were considered desirable *restoration* targets, whereas those native species with high refined forest indication scores were considered desirable *conservation* target species. Those species (native and non-native) with high refined disturbed-habitat indication scores were considered to be undesirable *ruderal* or "weedy" species. Positive responses of either open-habitat indicators or forest indicators, combined with negative responses of disturbance indicators, to the restoration treatments was considered the most desirable response.

Step 6. Calculating weighted mean fidelity of samples (sub-subplot or patch assemblages) to each general habitat category of interest. The refined habitat indication scores and the abundances of all species present within a sample (and for which a habitat indication score was calculated) were used to calculate weighted average abundances and thus weighted mean fidelities of the samples to each general habitat category of interest.

Desirable responses to treatments include:

- 1) an increase in weighted mean fidelity to open habitats combined with a decrease in weighted mean fidelity to disturbed habitats; and/or
- 2) an increase or lack of change in weighted mean fidelity to forests combined with a decrease in weighted mean fidelity to disturbed habitats.

Undesirable responses to treatments include:

- 1) an increase in weighted mean fidelity to disturbed habitats combined with a decrease or lack of increase in weighted mean fidelity to either open habitats or forests;
- 2) a decrease in weighted mean fidelity to forests combined with no increase in weighted mean fidelity to open habitats; and/or
- 3) no increase in weighted mean fidelity to open habitats.

Table S1. Habitat indication values for species encountered and identified in groundcover vegetation sub-subplots and *Microstegium* patches. Methods of calculation are described in Appendix 1 and are derived from a list of 404 plant species encountered in Mississippi (see J.S. Brewer and W.C. Bailey. 2014. Competitive effects of non-native plants are lowest in native plant communities that are most vulnerable to invasion. *Plant Ecology* 215:821–832). Values are leverage residuals obtained from multiple regressions of indicator values for each habitat regressed against the other two habitats. Open habitat indication and forest indication values for non-native species (indicated with bold type) were not used in calculations of weighted mean fidelity of samples to these two habitats. Because of difficulties in identifying *Carex* spp. to species, indication scores for *Carex* species were not used in the calculation of weighted mean fidelity to any of the habitats. Effects of oak-hickory woodland restoration treatments on native groundcover vegetation and an invasive grass, *Microstegium vimineum*. J.S. Brewer, M.J. Abbott, and S.A. Moyer.

Species	Indication of severe anthropogenic disturbance (ruderals)	Indication of fire- maintained open woodlands (open habitat species)	Indication of forests (forest species)
<i>Acalypha rhomboidea</i>	0.41	0.40	0.33
<i>Acalypha</i> spp. ( <i>virginica</i> and <i>gracilens</i> )	0.65	0.62	0.54
<i>Acer rubrum</i>	0.42	0.36	0.81
<i>Agalinis aphylla</i>	0.38	0.35	0.32
<i>Agrimonia rostellata</i>	0.45	0.44	0.85
<i>Ambrosia artemisiifolia</i>	0.62	0.40	0.44
<i>Ambrosia bidentata</i>	0.66	0.40	0.47
<i>Andropogon virginicus</i>	0.49	0.37	0.34
<i>Aralia spinosa</i>	0.20	0.98	0.27
<i>Arisaema dracontium</i>	0.31	0.30	0.34
<i>Aristida longespica</i>	0.56	0.35	0.35
<i>Aristolochia serpentaria</i>	0.39	0.36	0.56
<i>Asclepias variegata</i>	0.35	0.65	0.35
<i>Asplenium platyneuron</i>	0.31	0.41	0.29
<i>Botrychium virginianum</i>	0.37	0.36	0.53
<i>Carex</i> spp.	NA	NA	NA
<i>Carya tomentosa</i>	0.30	0.34	0.44
<i>Cercis canadensis</i>	0.47	0.43	0.86
<i>Chaerophyllum procumbens</i>	0.31	0.42	0.32
<i>Chamaecrista fasciculata</i>	0.60	0.39	0.42
<i>Chasmanthium laxum</i>	0.41	0.38	0.36
<i>Claytonia virginica</i>	0.52	0.32	0.55

<i>Clematis virginiana</i>	0.31	0.31	0.30
<i>Clitoria mariana</i>	0.27	0.50	0.23
<i>Commelina erecta</i>	0.28	0.29	0.24
<i>Conyza canadensis</i>	0.62	0.40	0.44
<i>Coreopsis tripteris</i>	0.30	0.38	0.32
<i>Cornus florida</i>	0.46	0.45	0.87
<i>Corylus americana</i>	0.45	0.46	0.86
<i>Crotalaria sagittata</i>	0.53	0.36	0.35
<i>Croton capitatus</i>	0.54	0.53	0.42
<i>Cyperus echinatus</i>	0.20	0.23	0.04
<i>Desmodium laevigatum</i>	0.32	0.45	0.33
<i>Desmodium paniculatum</i>	0.46	0.66	0.62
<i>Dichanthelium acuminatum</i> var. <i>lindheimeri</i>	0.32	0.47	0.26
<i>Dichanthelium boscii</i>	0.33	0.62	0.53
<i>Dichanthelium commutatum</i>	0.47	0.53	0.57
<i>Dichanthelium depauperatum</i>	0.27	0.45	0.32
<i>Dichanthelium dichotomum</i>	0.61	0.37	0.43
<i>Dichanthelium laxiflorum</i>	0.37	0.50	0.47
<i>Digitaria filiformis</i>	0.34	0.45	0.36
<b><i>Digitaria sanguinalis</i></b>	<b>0.57</b>	<b>NA</b>	<b>NA</b>
<i>Diodea teres</i>	0.49	0.49	0.47
<i>Diospyros virginiana</i>	0.43	0.51	0.57
<i>Elephantopus carolinianus</i>	0.32	0.30	0.27
<i>Elephantopus tomentosus</i>	0.55	0.47	0.71
<i>Eragrostis spectabilis</i>	0.43	0.40	0.30
<i>Erechtites hieracifolia</i>	0.63	0.41	0.57
<i>Eupatorium capillifolium</i>	0.52	0.35	0.34
<i>Eupatorium compositifolium</i>	0.51	0.49	0.39
<i>Eupatorium rotundifolium</i>	0.33	0.35	0.28
<i>Eupatorium serotinum</i>	0.37	0.35	0.26
<i>Fagus grandifolia</i>	0.43	0.41	0.84
<i>Fraxinus americana</i>	0.45	0.43	0.85
<i>Galactia volubilis</i>	0.31	0.46	0.36
<i>Galium circaezans</i>	0.39	0.40	0.56
<i>Gamachaeta purpurea</i>	0.57	0.52	0.45
<i>Gelsemium sempervirens</i>	0.33	0.38	0.33
<i>Gentiana villosa</i>	0.28	0.39	0.27
<i>Helenium autumnale</i>	0.48	0.43	0.44
<i>Helianthus hirsutus</i>	0.41	0.49	0.45
<i>Helianthus microcephalus</i>	0.37	0.48	0.37
<i>Helianthus silphoides</i>	0.36	1.00	0.47
<i>Hieracium gronovii</i>	0.47	0.54	0.50
<i>Hypericum hypericoides</i>	0.45	0.46	0.86
<i>Hypoxis hirta</i>	0.41	0.59	0.45
<i>Juncus tenuis</i>	0.55	0.36	0.32

<i>Juniperus virginiana</i>	0.40	0.44	0.47
<i>Krigia dandelion</i>	0.41	0.31	0.29
<i>Lactuca canadensis</i>	0.63	0.41	0.57
<i>Leersia virginica</i>	0.65	0.41	0.62
<b><i>Lespedeza cuneata</i></b>	<b>0.41</b>	<b>NA</b>	<b>NA</b>
<i>Lespedeza hirta</i>	0.35	0.50	0.30
<i>Lespedeza repens</i>	0.42	0.45	0.42
<i>Lespedeza virginica</i>	0.47	0.60	0.55
<i>Linum medium</i>	0.39	0.33	0.30
<i>Liquidambar styraciflua</i>	0.41	0.37	0.59
<i>Lobelia puberula</i>	0.36	0.39	0.33
<b><i>Lonicera japonica</i></b>	<b>0.51</b>	<b>NA</b>	<b>NA</b>
<i>Mikania scandens</i>	0.41	0.45	0.47
<i>Morus rubra</i>	0.43	0.32	0.41
<i>Nyssa sylvatica</i>	0.34	0.35	0.48
<i>Ophioglossum vulgatum</i>	0.39	0.34	0.53
<i>Orbexilum pedunculatum</i>	0.34	0.45	0.36
<i>Oxalis stricta</i>	0.51	0.32	0.41
<i>Oxalis violacea</i>	0.46	0.40	0.85
<i>Parthenocissus quinquefolia</i>	0.28	0.34	0.22
<b><i>Paspalum notatum</i></b>	<b>0.74</b>	<b>NA</b>	<b>NA</b>
<i>Passiflora incarnata</i>	0.53	0.37	0.38
<i>Phytolacca americana</i>	0.59	0.55	0.47
<i>Pinus taeda</i>	0.37	0.32	0.37
<b><i>Poa pratensis</i></b>	<b>0.74</b>	<b>0.00</b>	<b>0.00</b>
<i>Polygonum virginianum</i>	0.31	0.30	0.32
<b><i>Poncirus trifoliata</i></b>	<b>0.65</b>	<b>NA</b>	<b>NA</b>
<i>Potentilla simplex</i>	0.47	0.37	0.41
<i>Prunus serotina</i>	0.49	0.43	0.44
<i>Pseudognaphalium obtusifolium</i>	0.59	0.55	0.47
<i>Pteridium aquilinum</i>	0.49	0.47	0.67
<i>Ptilimnium capillaceum</i>	0.44	0.31	0.25
<i>Quercus alba</i>	0.39	0.41	0.81
<i>Quercus coccinea</i>	0.39	0.33	0.79
<i>Quercus falcata</i>	0.31	0.32	0.45
<i>Quercus marilandica</i>	0.30	0.42	0.33
<i>Quercus nigra</i>	0.35	0.33	0.36
<i>Quercus stellata</i>	0.27	0.37	0.28
<i>Quercus velutina</i>	0.31	0.34	0.44
<i>Rhus copallina</i>	0.41	0.49	0.34
<i>Rosa carolina</i>	0.35	0.48	0.28
<i>Rubus argutus</i>	0.39	0.34	0.34
<i>Rubus trivialis</i>	0.37	0.34	0.25
<i>Saccharum alopecuroides</i>	0.57	0.38	0.40
<i>Sanicula canadensis</i>	0.46	0.37	0.42
<i>Sassafras albidum</i>	0.34	0.40	0.25

<i>Schizachyrium scoparium</i>	0.46	0.37	0.36
<i>Scleria pauciflora</i>	0.37	0.37	0.35
<i>Scutellaria elliotii</i>	0.37	0.47	0.44
<i>Smilax bona-nox</i>	0.32	0.34	0.31
<i>Smilax glauca</i>	0.35	0.36	0.33
<i>Smilax rotundifolia</i>	0.31	0.36	0.27
<i>Solanum carolinense</i>	0.59	0.45	0.47
<i>Solidago canadensis</i>	0.39	0.43	0.36
<i>Solidago nemoralis</i>	0.50	0.47	0.45
<i>Solidago ulmifolia</i>	0.38	0.39	0.57
<i>Strophostyles umbellata</i>	0.39	0.56	0.47
<i>Stylosanthes biflora</i>	0.39	0.38	0.34
<i>Symphyotrichum dumosum</i>	0.33	0.33	0.22
<i>Symphyotrichum patens</i>	0.39	0.49	0.42
<i>Symphyotrichum pilosum</i>	0.54	0.52	0.43
<i>Toxicodendron radicans</i>	0.52	0.37	0.46
<i>Tridens flava</i>	0.48	0.63	0.45
<b><i>Trifolium dubium</i></b>	<b>0.68</b>	<b>NA</b>	<b>NA</b>
<i>Triodanis perfoliata</i>	0.60	0.50	0.44
<i>Ulmus alata</i>	0.38	0.38	0.56
<i>Vaccinium arborea</i>	0.23	0.33	0.18
<i>Verbena urticifolia</i>	0.51	0.30	0.42
<i>Vitis rotundifolia</i>	0.31	0.40	0.33

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