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The Illinois Native Plant Society Journal

The Illinois Native Plant Society is dedicated to the preservation, conservation, and study of the native plants and vegetation of Illinois.

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ERIGENIA is named for *Erigenia bulbosa* (Michx.) Nutt. (harbinger of spring), one of our earliest blooming woodland plants. The first issue was published in August, 1982.

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COVER ILLUSTRATION: Drawing of Short Pioneer Cemetery Prairie by Domenico D'Alessandro

LETTER FROM THE EDITOR:

Greetings fellow plant enthusiasts.

At the annual meeting hosted by the INPS Board, there was some discussion about moving into the 21st century and providing Erigenia as an on-line only journal. Expenses continue to rise and there is a need to justify all major expenses of the society. As editor, I am happy to report that the journal will continue to be published as a print edition. For myself, I appreciate the touch of paper, the ability to flip pages from text to table and back again. We also discussed the role of the journal in Illinois ecology. The documentation of restoration efforts, threats, and inventories are critical to future restoration activities.

One of the functions of Erigenia is to post Flora Updates for the state of Illinois. The updates were proposed as a solution for several problems: 1) publication of new distribution records for either the state or specific counties; 2) rediscoveries of species thought to be extant; 3) the spread of non-native species; and 4) no centralized tracking for new species and rediscoveries. Please consider publishing your Flora Updates. Contact tracy.evans@illinois.gov to obtain the September 2003 Erigenia pdf which sets out protocols for reporting.

Tracy Evans, Editor

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About Our Authors

W. Clark Ashby taught forest ecology and other botany courses at the University of Chicago and later at Southern Illinois University at Carbondale from the 1940's to 1992 when he retired. He is a Past-President of the Southern Chapter of the Illinois Native Plant Society.

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John E. Ebinger is emeritus professor of botany at Eastern Illinois University. His research focuses on the structure and composition of forest, glade and sand prairie communities in Illinois as well as the tropical genus *Acacia*.

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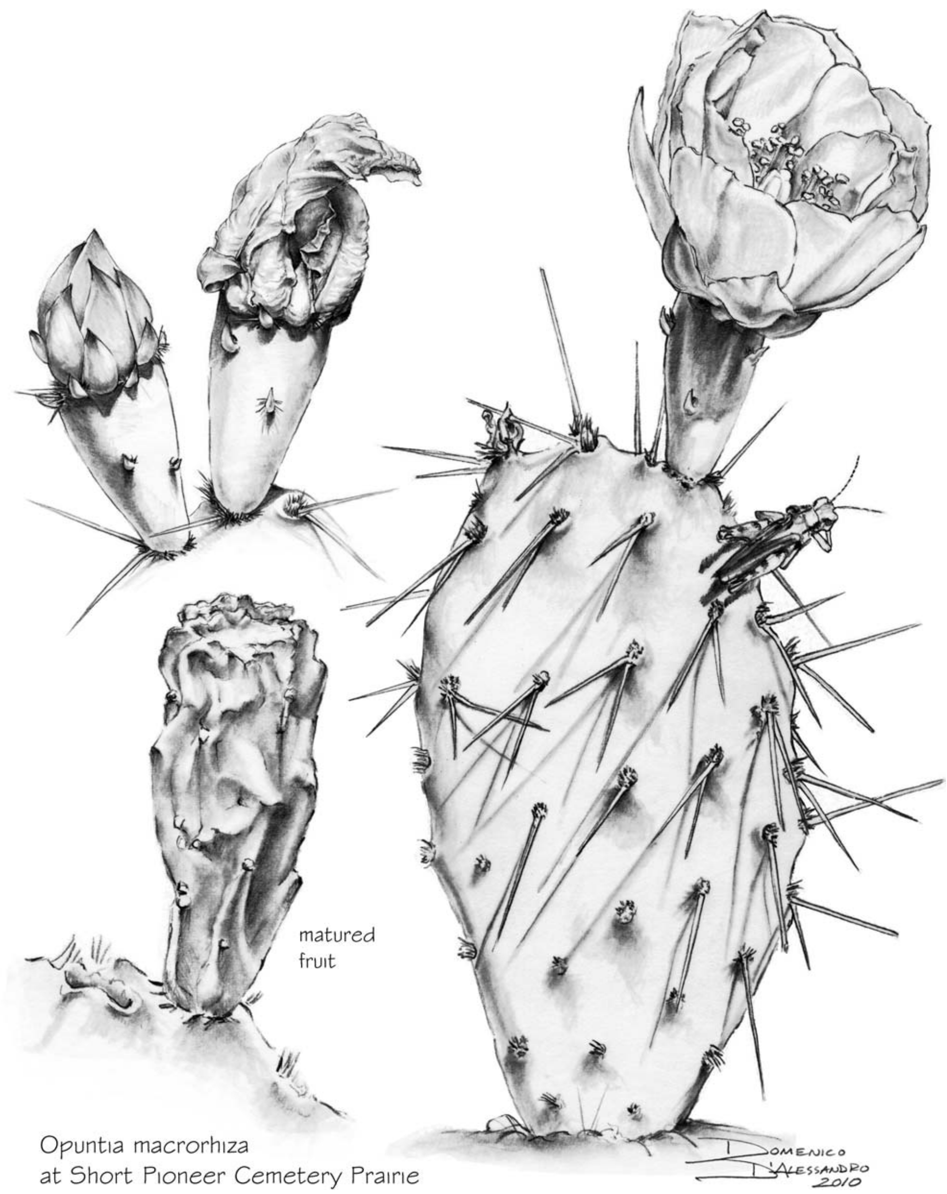
Elise M. Tulloss is a Ph.D. candidate in the Ecology Graduate Group at the University of California, Davis. Her research focuses on plant communities in heterogeneous landscapes. She is interested specifically in understanding the role of spatial heterogeneity in shaping plant species interactions.

Mickayla Van Hoveln is a recent graduate whose research focused on the direct and indirect interactions occurring between a regimen of simulated herbivory, a native hemiparasitic plant (*Pedicularis canadensis*), and their shared host plant (*Schizachyrium scoparium*). Mickayla earned a B.S. in biological sciences and an M.S. in ecology from Illinois State University.



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Sacred Space and Restoration Ecology

Domenico D'Alessandro[1]

Short Pioneer Cemetery Prairie in Grundy County was dedicated as an Illinois Nature Preserve in 1988, 131 years after Lemuel Short was deeded the land in 1857 from Martin and Ursula Luther, the original homesteaders. In 1894 Warham and Mary Short deeded 100 square rods (0.65 acres) to the Oak Ridge Cemetery Association. An additional 0.65 acres were deeded from John Fred Wilneow, the neighbor to the south, making the 1.3 acres total deeded land that persists to this day.

The nature preserve is not easy to find. The old road connections have been severed and access now is only from Carper Road through an unmarked gated trail. The cemetery is located about 96 yards in from the road, approximately one mile south of the Goose Lake Prairie Preserve. The cemetery prairie is somewhat degraded although still home to many native species. The surrounding woodland has many invasive species which have encroached into the boundaries of the cemetery. This article is not concerned with the flora composition. An extensive account on the subject is given by others including John Ebinger, (Phillippe et al. 2010). My approach is from a cultural perspective, in particular recognizing the role of the sacred places such as cemeteries in restoration ecology.

Short Pioneer Cemetery Prairie was surrounded by strip mining operations for coal that changed forever the hydrology and topography of the region. This place and its plants survived because they were on sacred ground that even the powerful mining companies would not disturb. This is not true for every designated sacred space; at times the profit driven motives supersede preservation, especially where cultural links are severed. Restoration ecologists owe much to such preserved consecrated lands; their cultural place in our psyche has assured continuity of minimally disturbed ecological communities. Ironically, though, it is the neglected sacred places, those without the constant care needed to maintain carpets of lawn, as found in typical cemeteries, which have served as refuge to the native flora.

In his landmark book, *The Sacred & The Profane* (1959) Mircea Eliade distinguishes two spaces: the sacred is the structured, significant place that anchors life's orientation, while the profane is the amorphous, inconstant, chaotic place, one in which humans feel powerless. In lieu of scientific knowledge our distant ancestors often interpreted natural occurrences in anthropomorphic ways as the realm and power of gods on whose mercy we depend. Sacred places were chosen based on the characteristics of a particular god (*genius loci*). Because most major gods were associated with the sky or heavens sacred places tended to be located on higher ground. These were the places where humans could approach and befriend the gods to appease their temperament and thus gain favorable outcomes. Burial grounds became powerful sacred spaces, as thresholds to the realm of the gods; here human souls leave this world to be in one shared with the gods themselves, away from everyday toils and finite life. If any harm was done to these places, the whole community would suffer from the ancestors' wrath and that of the gods to whom the space was consecrated. To consecrate a space a religious ritual needed to be performed and a marker such as a temple built to house a god that would oversee the territory. The records do not give a reason for selecting the location for Short Cemetery; however it is described as "an upland site" in the dedication proposal, which fits within the traditional high ground selective process.

When Europeans began to settle the New World the consecration markers were typically related to a religious identity, for example, the Christian symbol of the cross. I restrict my comments to the colonial aspirations of Western Europe in post-Columbian times due to their fundamental historical impact, recognizing that others also accessed the New World shores before Columbus. For the Europeans, the New World was unknown territory, often considered hostile or at best pagan, although some accounts record its natural beauty as a found Eden. The religious marker signified consecration, ownership in the name of a higher being and thus rid of malevolent spirits. Away from their ancestral land, Europeans' consecration of religious space would assure continuity with a home left behind. The simple act of declaration replaced the *genius loci* of the ancient civilizations; an opportunistic means, given the lack of intimate knowledge they had of the New

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World. The nostalgic desire to transpose a homeland onto the new landscape undermined the existing community. The consequences of settlement to the native peoples and their association with the land are considered reprehensible, but nonetheless in line with the traditions of creating order out of the perceived chaotic (pagan) land. It is a strange turn of events that those very places that represented *Manifest Destiny*, including the railroads and the consecrated appropriated land for cemeteries, were the very places of refuge for the native flora. In fact a reversal of roles has occurred, where the pagan entities of a landscape the Europeans perceived as wilderness and drastically curtailed, have found sanctuary in these neglected spaces and in time became the hope of ecological regeneration.

Archaeological works in the twentieth century have amply demonstrated that the pre-Columbian Americas were home to highly evolved, ancient civilizations that rivaled those of the Old World. The territory was heavily populated throughout, and the wilderness the Europeans perceived was in effect an anthropogenic landscape. By the time permanent settlement occurred, the waves of diseases brought over by the Europeans had decimated the population, thus accounting for the erroneous perception of poor and primitive inhabitants (Mann 2005).

Dr. Robert Betz recognized the importance of pioneer cemeteries, inventorying 824 of them in 64 Illinois and Indiana counties. He founded the Illinois Cemetery Association with a membership of one to advocate the protection of these sites. He also reintroduced fire ecology as a management tool in prairie restoration at a time when fire was still considered a great threat. (Bowles and DeMarco 2007) It was the aspired start of the road back to an anthropogenic landscape reminiscent of pre-Columbian America.

In 1988 when Short Pioneer Cemetery Prairie was designated as a nature preserve the sacred status did not change. It was transformed from a religious consecrated space with scientific interest to a science-based consecrated space with religious interest. Nature preserves serve other purposes, which trigger emotional connections for people, in addition to sustaining ecological communities. The anthropomorphic portrayal of natural phenomena is not limited to religious beliefs. The interpretation may also be part of local community folklore and even express a sense of community humor. In 1998 I was given the task to create an ecological restoration plan for my hometown in Italy. I decided that part of the restoration would include what I termed *mythological landscape*s. These were natural features that inspired local folkloric tales as late as the 20th century when a rock outcropping was named: 'The Pope's Eyeglasses' referring to the similarity in shape to the glasses worn by Pius XII, who had become a sacred hero to many. My task proved harder than anticipated. With the exception of a few elders, most had forgotten these tales handed down through oral recounting. Few still farmed and even fewer practiced animal husbandry. The majority worked in urban centers and visited the town only periodically. The farmers rode in air-conditioned, stereo-equipped tractors with enormous shock absorbers to provide a smooth ride. The wind, the sun, the odors of the soil, and the land formations no longer played a role in this experience, whereas the folktales were created by my ancestors walking on the ground, noticing the form of rocks, the gurgling of springs, and the sound of the wind moving through a mountain pass. Their bloodline solely connected to this place, building on generations dating back to antiquity. This I realized was a lost world, and the only remnants were the names bestowed on particular features in the landscape. However naming the landscape insured some protection. Even though the original motives had been forgotten, a respect lingered, and it was in these locations where less environmental disturbance occurred. In my restoration plan I proposed sculptural storyboards to be placed at specified locations linked by a heritage path so that the tales and associated cultural connections would be preserved with the physical formations that inspired them.

In 2009 a talk given by Ed Collins at the Wild Things Stewardship Conference held at the University of Illinois at Chicago, brought me back to this work. Ed presented a series of personal encounters with the landscape as experienced by restoration volunteers and him. These were heartfelt, visceral episodes based on the personalized intimate knowledge of the landscape that comes with continuous contact over time. What I had proclaimed a lost world had reincarnated itself. The contemporary local nature preserves including places such as Short Pioneer Cemetery Prairie can be a way to reconnect to a primal relationship to the land for those who wish to do so; to recognize and perform our role as stewards, and this too is of value and somewhat transcendent.

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Vascular Flora of Short Pioneer Cemetery Prairie Nature Preserve, Grundy County, Illinois: Composition and Change Since 1977

Loy R. Phillippe[1], Paul B. Marcum[1], Daniel T. Busemeyer[2], and John E. Ebinger[3]

Abstract: The vascular flora of the dry-mesic sand prairie at Short Pioneer Cemetery Prairie Nature Preserve, Grundy County, Illinois, was studied during the 2005 and 2006 growing seasons. Located at the western edge of the Kankakee sand deposits, this 0.5 ha prairie was examined by the Illinois Natural Areas Inventory in 1976, and dedicated as an Illinois Nature Preserve in 1988. The composition and structure of the flora was determined using m^2 plots placed along line transects. The site supported 137 vascular plant species of which 55 were encountered in the plots. *Helianthus occidentalis* was the dominant species encountered (I.V. of 24.3/possible 200), followed by *Shizachyrium scoparium* (I.V. of 19.6), and *Leptoloma cognatum* (I.V. of 13.4). There has been a dramatic decrease in the number of forb species, at least 15 being lost since 1977. Exotic species were represented by 43 taxa, 31.4% of the flora. The community had a Floristic Quality Index of 25.31 when exotic species were included in the calculations and 30.38 when they were excluded.

Introduction

At the time of European settlement prairie vegetation covered about 60% of Illinois (Iverson et al. 1991). Most was "black soil" tall-grass prairie of the prairie peninsula (Transeau 1935), though sand prairies were relatively common (Schwegman 1973). Sand deposits are found in the northern half of Illinois, accounting for nearly 5% of the land surface of the state (Willman and Frye 1970). These sand deposits occur on glacial outwash plains associated with erosional events of Wisconsin glaciation (King 1981; Willman and Frye 1970). The most extensive of these deposits in Illinois is the Kankakee sand deposits in parts of Grundy, Iroquois, Kankakee, and Will counties, Illinois, and Newton County, Indiana (Schwegman 1973). This sand deposit remained after large glacial lakes were drained about 14,500 years ago as glacial moraines and ice dams were breached resulting in the Kankakee Torrent (Willman 1973).

The present study was undertaken to determine the vascular plant species composition, vegetation structure, and floristic quality of a small dry-mesic sand prairie remnant found associated with a rarely used cemetery, and to compare results with a previous study of the site in 1977 by the Illinois Natural Areas Inventory (White 1978).

Description of the Study Area

Short Pioneer Cemetery Prairie Nature Preserve, Grundy County, Illinois, about 0.5 ha in size, is located about 2 km south of Goose Lake Prairie Nature Preserve and 10 km east of Morris, Illinois (SE1/4 S15, NE1/4 S22 T33N R8E; 41.33136° N, 88.28809° W). Situated at the northwestern edge of a sand deposit in the shallow valley and adjacent uplands of the Kankakee River, the preserve is 8 km south of the confluence of the Kankakee and Des Plaines Rivers. It is located on Wisconsin glacial till in the Kankakee Sand Area Section of the Grand Prairie Natural Division (Schwegman 1973), and is about 169 m above sea level (McFall and Karnes 1995).

This small dry-mesic sand prairie is surrounded by upland, immature, disturbed forest, and immediately to the south is an extensive area strip mined for coal (McFall and Karnes 1995). At the northwest corner of the preserve is a *Schizachyrium scoparium* hay field. The cemetery was founded in 1894, almost all burials were prior to 1910, the last in 1963 (Burnett 1987).

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The soil of the preserve is Sparta loamy fine sand, an excessively drained soil that occurs on ridges and uplands of the sand deposits. It has a very dark brown surface layer about 50 cm thick that is loose and subject to blowing (Reineback 1980). The climate is continental and characterized by hot, humid summers and cold winters. Annual precipitation averaged 93.9 cm, with July having the highest rainfall (11.0 cm). Mean annual temperature is 9.7° C, the hottest month being July (average of 23.2° C), the coldest being January (average of −5.7° C). The average number of frost-free days is 177 (Midwestern Regional Climate Center 2009)

METHODS

Short Pioneer Cemetery Prairie Nature Preserve was visited every 3–4 weeks during the 2005 and 2006 growing seasons. During each trip flowering or fruiting species encountered were collected and voucher specimens deposited in the Stover-Ebinger Herbarium of Eastern Illinois University, Charleston, Illinois (EIU) and the Illinois Natural History Survey Herbarium, Champaign, Illinois (ILLS). Nomenclature follows Mohlenbrock (2002) and assignment of native vs. non-native status was determined using Taft et al. (1997) and Mohlenbrock (2002).

Ground-layer species were analyzed in September 2005 using m^2 plots located at 1 m intervals along two 25 m transects oriented at right angles to each other (n=25/transect). Even-numbered plots were placed to the right, odd-numbered to the left of the transect. Herbaceous species, shrubs, and tree seedlings to 0.4 m in height were included in the sampling. Percent cover for each species, as well as for bare ground and litter, were determined by using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968): class 1 = 0–1%, class 2 = 2–5%, class 3 = 6–25%, class 4 = 26–50%, class 5 = 51–75%, class 6 = 76–95%, class 7 = 96–100%. Mean cover, relative cover, frequency (%), relative frequency, and importance value (I.V.) were determined for each species. The I.V. is the sum of the relative frequency and relative cover.

Floristic Quality Index (FQI) of the site was determined using the coefficient of conservatism (CC) assigned to each species by Taft et al. (1997). For each species in the Illinois flora, the CC was determined by subjectively assigning an integer from 0 to 10, based on its tolerance to disturbance and its fidelity to habitat integrity. FQI is a weighted index of species richness (N = number of species present), and is the arithmetic product of average coefficient of conservatism (C-Value = the average of all species CCs) multiplied by square root of the species richness ($\sqrt{N}$): FQI = C-Value ($\sqrt{N}$).

RESULTS

A total of 137 species representing 51 families and 114 genera were documented at Short Pioneer Cemetery Prairie Nature Preserve (Appendix). Fern-allies and gymnosperms were represented by six species in five families. Of the remainder, 93 were dicots in 40 families and 81 genera, while 38 were monocots in 6 families and 27 genera. Of these totals, 22 were woody species while 43 were exotic which represented 31.4% of the flora. Predominant plant families were Poaceae with 24 species and Asteraceae with 16 species. FQI for this site, when non-native species were included, was 25.49 with a mean C-value of 2.19; with non-native species excluded from the calculations FQI was 30.38 with a mean C-value of 3.15. No state endangered or threatened species were found (Herkert and Ebinger 2002).

Of 137 species encountered, 55 were recorded in the plots (Table 1). Of these, *Helianthus occidentalis* had the highest mean cover (15.11), the highest importance value (I.V. of 24.3), but was only found in 58% of the plots. *Schizachyrium scoparium*, in contrast, was second in importance (I.V. of 19.6), had a mean cover of 9.66 but was found in 98% of the plots (Table 1). Other important grasses included *Leptoloma cognatum* (third in I.V.) and *Dichanthelium oligosanthes* (seventh in I.V.). Two frequently encountered exotic grasses were *Poa pratensis* and *Bromus inermis* with frequencies of 68% and 16% respectively. A few woody species were common prairie components with *Rosa carolina* and *Amorpha canescens* fifth and sixth in I.V. Of the forbs tallied *Ambrosia artemisiifolia* ranked fourth in I.V., with other important taxa including *Phlox bifida*, *Ruellia humilis*, *Opuntia macrorhiza*, and *Senecio plattensis* (Table 1). Bare ground and litter accounted for a mean cover of 23.76.

Of the 43 exotic species encountered nine were found in the plots (Table 1). The remaining exotic species were restricted to disturbed habitats mostly at the forest edge or small disturbances along the north edge where some dirt had been removed. No exotic shrubs or trees were encountered in the plots, but *Elaeagnus umbellata*, *Rhamnus cathartica*, and *Lonicera maackii* were encountered at the edges of the prairie and adjacent woods. Other woody plants observed included planted ornamentals and seedlings of native trees and shrubs, some being found in the plots (Table 1).

DISCUSSION

Short Pioneer Cemetery Prairie Nature Preserve is similar in native species composition to that described by White and Madany (1978) for dry-mesic sand prairie. Unlike dry sand prairies the soils of dry-mesic

Table 1: Frequency (%), mean cover (% of total area), relative frequency, relative cover, and importance value (I.V.) of the ground layer species encountered in the Fall of 2005 in a dry-mesic sand prairie at Short Pioneer Cemetery Prairie Nature Preserve, Grundy County, Illinois. Species with an I.V. below 0.5 are listed as others. (* non-native species).

Species	Frequency %	Mean Cover	Relative Frequency	Relative Cover	Importance Value
Helianthus occidentalis	58	15.11	3.8	20.5	24.3
Schizachyrium scoparium	98	9.66	6.4	13.2	19.6
Leptoloma cognatum	72	6.27	4.8	8.6	13.4
Ambrosia artemisiifolia	86	5.39	5.7	7.4	13.1
Rosa carolina	94	3.71	6.2	5.1	11.3
Amorpha canescens	44	4.69	2.9	6.4	9.3
Dichanthelium oligosanthes	76	2.88	5.0	3.9	8.9
Phlox bifida	74	2.74	4.9	3.7	8.6
Ruellia humilis	72	2.82	4.8	3.8	8.6
Opuntia macrorhiza	66	2.92	4.4	4.0	8.4
Senecio plattensis	56	2.96	3.7	4.0	7.7
**Poa pratensis*	68	1.44	4.5	2.0	6.5
Callirhoe triangulata	38	1.76	2.5	2.4	4.9
Heterostipa spartea	58	0.84	3.8	1.1	4.9
Tephrosia virginiana	28	2.18	1.9	3.0	4.9
Poinsettia dentata	54	0.32	3.6	0.4	4.0
Carex spp.	50	0.50	3.3	0.7	4.0
**Rumex acetosella*	40	0.65	2.7	0.9	3.6
Solanum carolinense	36	0.83	2.4	1.1	3.5
Cyperus lupulinus	42	0.21	2.9	0.3	3.2
Croton glandulosus	34	0.17	2.3	0.2	2.5
Lespedeza capitata	22	0.41	1.5	0.6	2.1
**Euphorbia cyparissias*	10	0.78	0.7	1.1	1.8
**Bromus inermis*	16	0.47	1.1	0.6	1.7
Lithospermum croceum	10	0.73	0.7	1.0	1.7
Physalis virginiana	22	0.16	1.5	0.2	1.7
Tridens flavus	20	0.20	1.3	0.3	1.6
Equisetum laevigatum	20	0.10	1.3	0.1	1.4
Oenothera biennis	16	0.18	1.1	0.2	1.3
Dichanthelium villosissimum	12	0.26	0.8	0.4	1.2
Ageratina altissima	10	0.20	0.7	0.3	1.0
Physalis heterophylla	10	0.25	0.7	0.3	1.0
**Chenopodium album*	10	0.05	0.7	0.1	0.8
Dichanthelium depauperatum	8	0.24	0.5	0.3	0.8
Euphorbia corollata	10	0.05	0.7	0.1	0.8
Prunus serotina	6	0.13	0.4	0.2	0.6
**Silene pratensis*	8	0.09	0.5	0.1	0.6
Sporobolus cryptandrus	8	0.04	0.5	0.1	0.6
Andropogon gerardii	4	0.12	0.3	0.2	0.5
Eragrostis spectabilis	4	0.12	0.3	0.2	0.5
Panicum virgatum	6	0.08	0.4	0.1	0.5
Quercus velutina	4	0.12	0.3	0.2	0.5
Others (13 species)		0.44	1.5	0.6	2.1
Totals		73.27	100.0	100.0	200.0
Bare ground and litter		23.76			

sand prairies have a dark A horizon, the grasses are commonly more than 1 m tall, and more mesic species of forbs are present. Though the dominant grass of this community is *Schizachyrium scoparium*, White and Madany (1978) listed *Sorghastrum nutans* and *Heterostipa spartea* as co-dominants with *S. scoparium*. *Heterostipa spartea* ranked fourteenth on this dry-mesic sand prairie with an I.V of 4.9, while *S. nutans* was rare, not being recorded for the plots. *Andropogon gerardii* was present but rare, being found in two plots and having an I.V. of 0.5.

During the Illinois Natural Areas Inventory on August 7 and 8 of 1976 the vegetation at the Short Pioneer Cemetery was examined by Harty and Strange (1976). The report lists many species that we were unable to find during our study in 2005 and 2006. Among these species where *Coreopsis tripteris*, *Dalea purpurea*, *Desmodium cuspidatum*, *D. illinoensis*, *Eryngium yuccifolium*, *Helianthus divaricatus*, *H. grosseserratus*, *Monarda fistulosa*, *Parthenium integrifolium*, *Polygonatum commutatum*, *Potentilla arguta*, *Ratibida pinnata*, *Rudbeckia hirta*, *Salix humilis*, *Silphium integrifolium*, and *S. terebinthinaceum*. The reason for this loss in not known. It is possible that these species were lost due to the small size of the prairie remnant and shading by surrounding vegetation. It is also possible that sometime in the past someone used herbicide on this small prairie with the corresponding loss of many larger forbs. For whatever reason, species diversity in this small prairie remnant has been substantially decreased since 1976. Management alone may not restore these species to this natural area as no seed source is present in the immediate area.

Removing woody and exotic forbs will be necessary to maintain this dry-mesic sand prairie which is slowly disappearing due to woody encroachment. Without management this small dry-mesic sand prairie will become smaller, decreasing species diversity by shading and competition from exotic species. Very little management has occurred on this site, it was burned in 1984 and occasionally mowed around that time, and only rarely have exotic shrubs and other woody undergrowth been removed (Burnett 1987). Maintenance will be necessary to prevent the loss of this dry-mesic sand prairie. To restore and maintain this prairie will require prescribed burns, in high frequencies during restoration, and then every 3 to 5 years depending upon thatch accumulation. Also, removal of exotic species will occasionally be required, and the removal of trees and shrubs at the prairie/forest interface will be necessary to prevent excessive shading.

Acknowledgments

We thank the Illinois Department of Natural Resources for a grant and for permission to study the Short Pioneer Cemetery Prairie Nature Preserve, and Dr. Gordon Tucker for his help in species identification, particularly members of the genus *Carex*.

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Appendix

Vascular plant species encountered at Short Pioneer Cemetery Prairie Nature Preserve, Grundy County, Illinois are listed alphabetically by family under the major plant groups. An asterisk indicates non-native species. Collecting numbers are preceded by the initial of the collector (B = Daniel T. Busemeyer; P = Loy R. Phillippe ; E = John E. Ebinger). Specimens are deposited in the Illinois Natural History Survey Herbarium (ILLS), Champaign, Illinois, with a few at the Ebinger/Stover Herbarium, Eastern Illinois University, Charleston, Illinois (EIU).

FERNS AND FERN-ALLIES

ASPLENIACEAE
Asplenium platyneuron (L.) Oakes; B2494

EQUISETACEAE
Equisetum laevigatum A. Br.; B2475

OPHIOGLOSSACEAE
Botrychium dissectum Spreng. var. *obliquum* (Muhl.) Clute; B2505

GYMNOSPERMS

CUPRESSACEAE
Juniperus virginiana L.; B2306
**Thuja occidentalis* L.; B2313 (planted)

PINACEAE
**Picea abies* (L.) H.Karst.; B2333 (planted)

MONOCOTS

COMMELINACEAE
Tradescantia ohiensis Raf.; E32157

CYPERACEAE
Carex blanda Dewey; B2320
Carex foenea Willd. var. *foenea*; B2310
Carex muhlenbergii Schk.; B2286
Carex pensylvanica Lam.; B2297
Carex swanii (Fern.) Mack.; E32014
Cyperus lupulinus (Spreng.) Marcks; B2499

IRIDACEAE
**Iris flavescens* DC.; B2307

LILIACEAE
Allium canadense L.; E32178
**Asparagus officinalis* L.; B2334
**Convallaria majalis* L.; B2319
Smilacina racemosa (L.) Desf.; B2324
Smilacina stellata (L.) Desf.; B2322

POACEAE
Andropogon gerardii Vitman; E32016
**Bromus inermis* Leyss.; E32670
**Bromus tectorum* L.; B2302, E32017
**Dactylis glomerata* L.; B2329
Dichanthelium depauperatum (Muhl.) Gould; observed
Dichanthelium oligosanthes (Schult.) Gould; B2488
Dichanthelium villosissimum (Nash) Freckm.; E32018
**Digitaria sanguinalis* (L.) Scop.; E32019
**Eragrostis cilianensis* (All.) Vign.; B2519
**Eragrostis neomexicana* Vasey; E32020
Eragrostis spectabilis (Pursh) Steud.; B2493
Heterostipa spartea (Trin.) Barkworth; E32021
Leptoloma cognatum (Schult.) Chase; E32022
Muhlenbergia schreberi J.F. Gmel.; B2495
Panicum capillare L.; B2502
Panicum virgatum L.; B2504
Paspalum setaceum Michx.; E32023
**Poa pratensis* L.; B2288
Schizachyrium scoparium (Michx.) Nash; B2480
**Setaria faberi* R.A.W. Herm.; E32024
Sorghastrum nutans (L.) Nash; B2507
Sporobolus cryptandrus (Torr.) A. Gray; B2514
Tridens flavus (L.) Hitchc.; B2479
Vulpia octoflora (Walt.) Rydb.; B2298

SMILACACEAE
Smilax tamnoides L.; B2318

DICOTS

ACANTHACEAE
Ruellia humilis Nutt.; B2510

ACERACEAE
Acer negundo L.; B2331

APIACEAE
**Daucus carota* L.; E32027
Osmorhiza longistylis (Torr.) DC.; B2311
Sanicula canadensis L.; E32028

ASCLEPIADACEAE
Asclepias amplexicaulis Small; E32171
Asclepias verticillata L.; E32158

ASTERACEAE
**Achillea millefolium* L.; E32159
Ageratina altissima (L.) R.M. King & H. Robins.; B2485
Ambrosia artemisiifolia L.; B2486
Antennaria plantaginifolia (L.) Hook.; B2327
Artemisia campestris L. spp. *caudata* (Michx.) Hall & Clem.; E32029
Aster pilosus Willd.; B2487
Conyza canadensis (L.) Cronq.; B2509
Erigeron strigosus Muhl.; E32160
Eupatorium altissimum L.; B2489
Euthamia gymnospermoides Greene; B2498
Helianthus occidentalis Riddell; B2492
Lactuca canadensis L.; B2501
Senecio plattensis Nutt.; B2304
Solidago canadensis L.; B2481
**Taraxacum officinale* Weber; B2332
**Tragopogon dubius* Scop.; E32161

BERBERIDACEAE
**Berberis thunbergii* DC.; B2312

BORAGINACEAE
Hackelia virginiana (L.) I.M. Johnston; E32031
Lithospermum croceum Fern.; B2305

BRASSICACEAE
**Alliaria petiolata* (Bieb.) Cavara & Grande; B2292

CACTACEAE
Opuntia macrorhiza Engelm.; B2517

CAMPANULACEAE
Campanulastrum americanum (L.) Small; E32032

CANNABINACEAE
**Cannabis sativa* L.; E32033

CAPRIFOLIACEAE
**Lonicera maackii* (Rupr.) Maxim.; B2300
**Lonicera morrowii* Gray; B2301
Triosteum perfoliatum L.; E32034
**Viburnum opulus* L.; B2314

CARYOPHYLLACEAE
**Arenaria serpyllifolia* L.; B2316
**Cerastium fontanum* Baum; B2326
**Holosteum umbellatum* L.; P37377
**Saponaria officinalis* L.; E32035
**Silene pratensis* (Spreng.) Godron & Gren.; B2511
**Stellaria media* (L.) Cyrillo; B2325

CELASTRACEAE
Celastrus scandens L.; B2317

CHENOPODIACEAE
**Chenopodium album* L.; E32037
Chenopodium desiccatum A. Nels.; B2478

ELAEAGNACEAE
**Elaeagnus umbellata* Thunb.; B2315

EUPHORBIACEAE
Chamaesyce nutans (Lag.) Small; E32038
Croton glandulosus L.; B2490, E32039
Euphorbia corollata L.; B2516
**Euphorbia cyparissias* L.; B 2309
Poinsettia dentata (Michx.) Kl. & Garcke; E32040

FABACEAE
Amorpha canescens Pursh; E32041
Lespedeza capitata Michx.; B2483
Tephrosia virginiana (L.) Pers.; B2497
**Vicia villosa* Roth; E32043

FAGACEAE
Quercus velutina Lam.; B2512

GROSSULARIACEAE
Ribes missouriense Nutt.; P37376

LAMIACEAE
**Nepeta cataria* L.; E32044

MALVACEAE
Callirhoe triangulata (Leavenw.) Gray; E32045

MOLLUGINACEAE
**Mollugo verticillata* L.; E32026

MORACEAE
**Morus tatarica* L.; B2303

ONAGRACEAE
Oenothera biennis L.; B2513

OXALIDACEAE
Oxalis stricta L.; B2290

PHRYMMACEAE
Phryma leptostachya L.; E32046

PLANTAGINACEAE
Plantago patagonica Jacq.; E32047
Plantago rugelii Decne.; E32048
Plantago virginica L.; B2330

POLEMONIACEAE
Phlox bifida Beck; B2283

POLYGONACEAE
**Fallopia convolvulus* (L.) A. Love; B2503
**Rumex acetosella* L.; B2291

PORTULACACEAE
**Portulaca oleracea* L.; E32050

RANUNCULACEAE
Anemone cylindrica Gray; E32051
Ranunculus abortivus L.; B2328

RHAMNACEAE
**Rhamnus cathartica* L.; B2299

ROSACEAE
Agrimonia pubescens Wallr.; E32052
Fragaria virginiana Duchesne; B2308
Geum canadense Jacq.; E32176
Prunus serotina Ehrh.; B2296
**Prunus triloba* Lindl.; B2284 (planted)
Rosa carolina L.; B2508
Rubus occidentalis L.; B2295
Rubus pensilvanicus Poir.; B2294

RUBIACEAE
Galium aparine L.; B2293

SCROPHULARIACEAE
Nuttallanthus canadensis (L.) D. Sutton; B2285
Scrophularia lanceolata Pursh; B2289
**Verbascum thapsus* L.; E32053
**Veronica arvensis* L.; B2287

SOLANACEAE
Physalis heterophylla Nees var. *heterophylla*; B2476
Physalis virginiana Mill.; E32165
Solanum carolinense L.; B2477, E32055
Solanum ptychanthum Dunal; B2520

ULMACEAE
Celtis occidentalis L.; B2321

URTICACEAE
Parietaria pensylvanica Muhl.; E32177

VERBENACEAE
Verbena stricta Vent.; B2484
Verbena urticifolia L.; E32057

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Edge Influence on the Reproductive Success of *Symphoricarpos orbiculatus* Moench

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Abstract: With continued forest fragmentation, edge effects play an important role in shaping the structure and composition of plant communities. Despite well-documented edge effects, there are few studies that document underlying effects on population dynamics of individual edges. *Symphoricarpos orbiculatus* Moench (Coralberry) is a fleshy-fruited native shrub present at both forest edge and interior open woodlands. In order to assess spatial demographic responses of *S. orbiculatus*, reproductive success was determined for individuals occurring along transects perpendicular to the forest edge. Correlated with light gradients, population density of *S. orbiculatus* declined with distance, with few individuals occurring 8 m into the forest. Similarly, total fruit production by each individual was positively correlated with light intensity and negatively correlated with distance from the edge. The quality of offspring produced was unaffected by the edge as the weight of individual seeds and fruits did not change significantly with distance from the edge. For this species, increased growth and reproductive performance at forest edges appears sufficient to generate the observed spatial pattern of the species. With increasing forest fragmentation, these data suggest that populations of this understory shrub could undergo rapid growth at edges and that high seed production by edge plants may increase seed availability even beyond edges.

Introduction

An edge is a landscape element often described as a boundary or transition zone between different habitat types (Wales 1972, Chen et al. 1992). The increased diversity often associated with these transition zones has been called the edge effect (Harris 1988). Changes in vegetation at edges are a well-documented phenomenon in which many plant species exhibit either positive or negative spatial associations with the edge (Matlack 1994, Jules 1998, Jules and Rathcke 1999, Meiners and Pickett 1999). This spatial heterogeneity in plant abundance can be attributed to two general mechanisms functioning at the population scale: differential dispersal and differential plant performance.

Edges generate abiotic heterogeneity in forests that may create subsequent heterogeneity within the vegetation. Forest edges have been shown to affect a plant community by altering availability of resources, changing microclimate, and shifting competitive outcomes between plant species (Matlack 1993, Jules 1998, Jules and Rathcke 1999, Bach et al. 2004). Edges also generate complex gradients of changing abiotic conditions, such as light intensity, air temperature, wind speed, humidity, and soil moisture (Wales 1972, Williams-Linera 1990, Brothers and Spingarn 1992, Matlack 1994, Cadenasso and Pickett 2001). Greater tree density at edges further alters the environment by affecting shrub cover, sapling growth, and increasing variability in canopy cover. These characteristics lead to variability in light and rainfall penetration that can influence community composition (Chen et al. 1992, Matlack 1993, Matlack 1994, Goldblum and Beatty 1999, Meiners and Pickett 1999).

Edges also affect climatic factors. Forest interiors have a more homogeneous light environment than edges (Chen et al. 1992). The consistently low light levels of forest interiors prevents many species from regenerating except in forest gaps, a natural source of environmental heterogeneity within a forest (Ricklefs 1977, Anderson and Leopold 2002). Gap regenerating species are opportunistic by nature, and would be expected to rapidly colonize and spread within locations with increased light availability including edge systems.

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Alteration of plant performance is one mechanism that can lead to large changes in vegetation associated with edges. Selective assortment of individuals can be due, in part, to climate conditions in each microhabitat. Variation in climatic conditions across the edge gradient can lead to variation in resource allocation patterns within populations including effects on seed set, leaf area, and survivorship of seeds, which can produce spatial variation in population density (Jules 1998). Some species reach peak densities at the edge, while others peak in the interior, indicating that climatic conditions may differentially influence distribution of individual species along the gradient (Wales 1972, Harris 1988, Williams-Linera 1990, Chen et al.. 1992, Matlack 1994, Goldblum and Beatty 1999). Dense vegetation common at forest edges can be an effective barrier to abiotic seed dispersal affecting spatial distribution of plant communities (Cadenasso and Pickett 2001). Edge vegetation may likewise function as a refuge for many seed dispersers as well as a collector of seeds, leading to high species densities and heterogeneity in the spatial distribution of species (Thompson and Willson 1978, Cadenasso and Pickett 2001), though seed predation may also be greatest at the edge (Chen et al. 1992, Meiners and LoGiudice 2003).

Most forest edge studies focus on changes across the entire plant community to document edge responses, often resulting in a structural edge response (Brothers and Spingarn 1999, Chen et al. 1992, Goldblum and Beatty 1999). However, plant species may exhibit individualistic edge patterns that can be explained by population-level responses (Jules 1998, Jules and Rathke 1999, Cadenasso and Pickett 2001, Bach et al. 2004). By examining static community patterns across an edge, population-level mechanisms are often missed. The purpose of this research was to assess the population-level characteristics of *Symphoricarpos orbiculatus* Moench to assess the response of plant size and population density along the forest edge gradient, and to evaluate reproductive variation as a potential mechanism generating observed spatial patterns.

MATERIALS AND METHODS

Study Site and Species

This study was conducted at Warbler Woods Nature Preserve in Coles County, Illinois. The site is a highly dissected upland that contains 18.6 ha of former pasture (last harvested in 1996) on the level ridge tops surrounded by 62 ha of mature oak-hickory forests on the steeper slopes. Due to the irregular nature of the forest-field border, this site contained over 4500 m of forest edge. At the time of this study, the pasture land was still dominated by remaining forage grasses.

S. orbiculatus is a native, understory shrub that spreads clonally through a series of rhizomes. This small shrub (typically less than 1 m in height) is slender with arching branches containing clusters of purple drupes along the stem. Seeds of *S. orbiculatus* have underdeveloped embryos that require stratification in order to germinate (Hidayati et al.).

Sampling Design

Twelve 10×2 m transects were spaced at least 60 m apart throughout the site. For each transect, the position of the forest edge was defined as the base of the first tree with $\geq$10 cm dbh to account for the non-linear nature of the forest-field edge. Ten transects were oriented east-west with five transects having a forest edge to the east and five transects with a forest edge to the west. Two transects were oriented north-south with a forest edge facing south. Light measurements (PAR, photosynthetically active radiation)) were conducted at *S. orbiculatus* canopy height with a 1 m long light sensor (LI-191, LI-COR Biosciences, Lincoln, NE). These data were collected every 2 m from the edge into the forest interior and in the open pasture between 1200 and 1400 hours on a cloudless day. Light data were collected to a maximum of 10 m into the forest to follow the distribution of *S. orbiculatus*. Percent transmittance was calculated as the amount of light that reached the forest floor relative to the open pasture. This accounted for variation in light availability within the sampling period.

Individual stems were censused and mapped within each transect to document growth and reproduction, but because *S. orbiculatus* plants are strongly clonal, it was not possible to identify separate genetic individuals. For this reason, data analyses were conducted on a per stem basis. For each individual stem, the number of branches and fruit were recorded. After the fruit had ripened (November 2005), a subsample of each stem's fruit was collected and average wet fruit mass was determined for each stem. This sample represented the majority of fruit remaining on the plants following losses due to dispersal and 60% of total fruit production. From these fruit, seed mass was determined for 145 stems based on samples of 25–40 seeds, when available. A subset of seeds across all transects and edge distances was tested for viability using a 1% tetrazolium solution.

Statistical Analyses

Transect data were divided into 1 m increments to calculate the density of stems, branches and fruit across the edge gradient. These data were analyzed with ANOVA followed by Tukey's post-hoc tests. Density data were analyzed using distance from edge as a categorical variable to allow detection of non-linear edge responses. Light data were treated similarly to examine the response of individual plants to the edge gradient. Pearson correlations were calculated between distance from the edge and number of branches, total number of fruit produced, fruit produced per branch, and seed mass. To control for multiple comparisons, significance criteria were Bonferonni-adjusted. To improve normality of the response variables, seed mass was analyzed as ln (seed mass); total number of fruit and fruit produced per branch were analyzed as ln (count + 1). Stem density and fruit mass data did not require transformation. All analyses were conducted using SPSS 13.0 (SPSS Inc, Chicago, Illinois).

RESULTS

A total of 154 *S. orbiculatus* stems were monitored for reproduction across the 10 transects. *S. orbiculatus* stem density was greater near the forest edge and declined dramatically with distance into the forest interior (Fig. 1). Stem density ($F_{9,110} = 9.32$; $P < 0.001$; $R^2 = 0.43$) and branch density ($F_{9,110} = 3.44$; $P < 0.01$; $R^2 = 0.22$) were both negatively associated with distance from the edge, with very few stems located >8 m into the forest. Similarly, fruit production was greatest 1–2 m into the forest, then dramatically decreased ($F_{9,110} = 3.27$; $P = 0.001$; $R^2 = 0.211$).

Performance of individual plants also varied across the edge gradient. Larger stems with more branches produced more fruit ($R=0.640$; $P<0.001$). However, plant size did not change across the edge as the number of branches produced by each stem was not correlated with distance ($R=0.069$, $P=0.394$). Reproductive output changed dramatically with both the total number of fruit produced by a plant ($R=-0.290$; $p<0.001$) and the number produced per branch ($R=-0.465$; $P<0.001$) negatively correlated with distance (Fig. 2). Despite changes in number of fruit produced, average fruit and seed mass did not change with edge position. Viability testing revealed that 99% (131/132) of seeds were viable. Given the uniformly high viability of seeds across the site, additional samples were not tested. Light also significantly differed in relation to the edge with light highest immediately inside the edge, and uniformly low at greater distances into the forest interior (Fig. 3).

DISCUSSION

Populations of *S. orbiculatus* responded positively to habitat fragmentation with greater stem and fruit density at the forest edge. This positive association appears linked with both increased reproductive success and increased vegetative spread in association with edges.

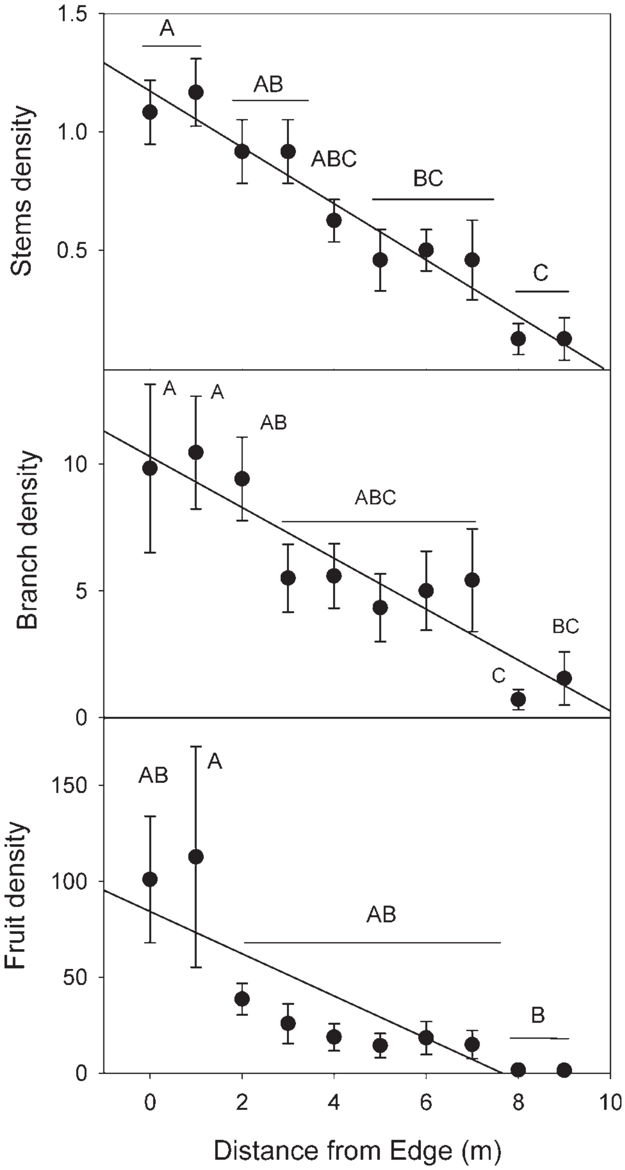

Figure 1. Population density and fruit production of *Symphoricarpos orbicularis* across a forest edge gradient. Data plotted are means ± 1 SE. Line is a best-fit line through the means at each distance class. Means sharing the same letter are not statistically different at P<0.05.

Fleshy-fruited species are often more abundant along edges because of increased seed dispersal (Williams-Linera 1990). The increased seed production as well as disperser activity at the edge would have helped to generate greater densities of *S. orbiculatus* seeds in edge habitats and potentially greater plant density. However, seed predation rates may also be higher at edges and may offset dispersal patterns (Meiners and LoGiudice 2003, Tallmon et al. 2003).

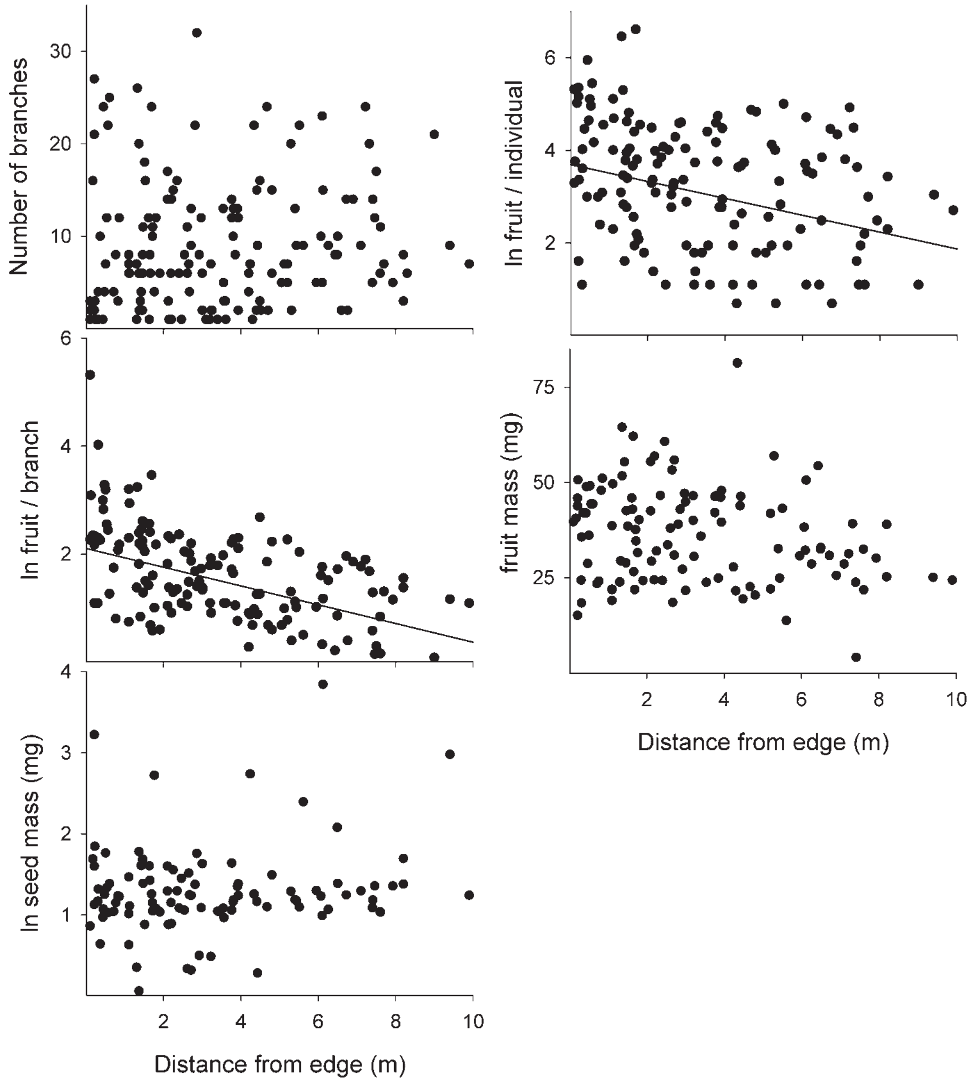

Figure 2. Response of individual plant performance to the edge gradient. Best-fit lines are plotted on those graphs with significant correlations.

Although differences in pollination can lead to higher rates of seed viability and may influence plant densities along edges, this seems unlikely in this study given the uniformly high viability of seeds. However, low pollination rates could contribute to the low number of mature fruit produced in the forest interior (Jules and Rathcke 1999). The clonal spread of *S. orbiculatus* would reduce the importance of seed-based regeneration in determining the local stem density along the edge gradient. However, seed deposition and seedling establishment would be necessary for initial colonization of edge or interior habitats. We also observed terminal fruit clusters that were removed by deer, suggesting a potential long-distance dispersal vector (Myers et al. 2004).

Variation in plant performance across the edge appears to be the primary determinant of the spatial pattern seen in *S. orbiculatus*. The pattern likely relates to the ability of an individual to compete for and capture essential resources. Light is especially important in forested systems with a closed canopy that reduces light in the forest interior (Williams-Linera 1990, Matlack 1993, 1994). *S. orbiculatus* responded strongly to the light gradient, particularly in fruit density, indicating that light availability may be the primary determinant of edge effects in this species. Branch density would also function to maximize light gain with highly branched individuals better able to capture sunlight and may have increased survival relative to less branched individuals. *S. orbiculatus*

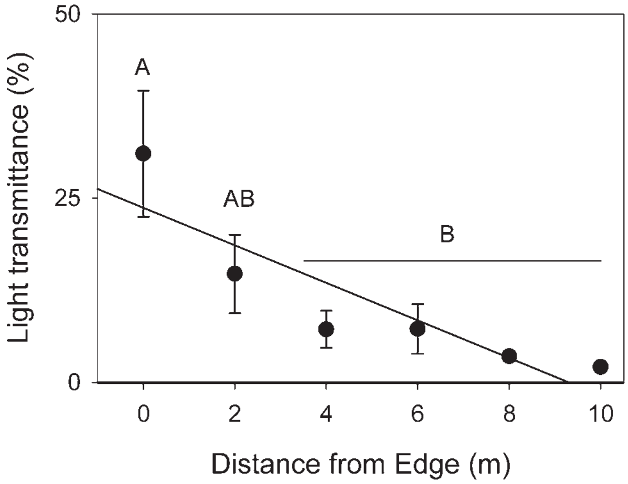

Figure 3. Influence of the forest edge on percent light transmittance. Means sharing the same letter are not statistically different at P<0.05.

stems exhibited more branching at the edge; therefore light may drive spatial patterns of plant size and ultimately the production of more seed at forest edges.

Demographic effects of the increased branch and stem density at the edge involve the production of more fruits and seeds. With greater availability of resources, individuals of *S. orbiculatus* were able to allocate more resources towards fruit production at the edge. In our study, *S. orbiculatus* produced more fruits per square meter and fruits per branch at the forest edge. However, fruit size and seed size did not vary across the edge. Thus, it appears that plants in low light of the forest interior reduced the quantity but not the quality of offspring. Therefore, *S. orbiculatus* should not show differences in the establishment of seedlings based on where the seeds were produced.

With increases in habitat fragmentation and the concomitant increase in forest edges many natural forest species are undergoing dramatic population shifts (Matlack 1994, Talmon et al. 2004). Detailed knowledge of the population mechanisms responsible for edge responses will allow us to better understand impacts of habitat fragmentation and develop better methods for conservation of impacted species. Although edge habitats are often a concern because of the establishment of non-native species (Matlack 1994, Goldblum and Beatty 1999, Cadenasso and Pickett 2001, Harper and Macdonald 2002, Flory and Clay 2006) native gap-regenerating species like *S. orbiculatus* may also increase in association with edges. It is expected that these effects will become more pronounced with continued forest fragmentation.

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Variation in Plant Performance among Seed Sources: Implications for Prairie Restoration

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Abstract: As a result of reduction in habitat size, plant species within remnants may be exposed to inbreeding depression and loss in genetic diversity, which can cause an overall loss of fitness in the population. Prairie restorations often rely on seed collections from small, isolated populations, which may lead to many of the same problems in restored areas. Seeds of five common prairie species (*Dalea purpurea*, *Eryngium yuccifolium*, *Parthenium integrifolium*, *Amorpha canescens*, and *Pycnanthemum virginianum*) were collected from 4 remnant prairies (1 large, HWY 45 and 3 small, Loda Cemetery Prairie, Prospect Cemetery Prairie and Capel Hill Prairie) and were planted into a restoration site in spring of 2005 to determine the influence of seed source on restoration success. Total above ground biomass varied inconsistently across source remnants in three of the five species, and plants from the large remnant did not consistently outperform those from the smaller remnants. These results suggest that plant performance is unpredictable based on remnant size or identity and that the use of seed collections from several sites, even if a large contiguous site is available, is the best choice for restoration practice. This practice may assist restoration efforts in avoiding the loss of genetic fitness and help to produce healthy, viable restored plant populations.

Introduction

The majority of the tallgrass prairie that existed prior to European settlement has been converted to agriculture throughout the Midwestern U.S. (Brothers 1990) with as little as 0.1% of the original prairie remaining in some areas of the Midwest, including east-central Illinois (Menges 1995). The goal of prairie restoration is to achieve a functional, self-sustaining community resembling one which occurred historically (Palmer et al. 1997). In these efforts, it has become increasingly important to use not just native species, but local populations of those species (Lesica and Allendorf 1999). In some instances, adaptations to local conditions or rare alleles may be lost when individuals from more distant populations are used as seed sources (McKay et al. 2005). To avoid these problems, seed used in restoration is often collected from local remnant populations. However, in extremely fragmented habitats, local populations that can serve as seed sources may be difficult to find (Belnap 1995).

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Because tallgrass prairie remnants are isolated and harbor small populations which are greatly reduced from pre-disturbance conditions, there may be problems when prairie restorations depend on remnant seed collections for locally adapted plant materials. Studies have shown loss of fitness in small populations of both rare and common species resulting from inbreeding depression (Karron 1989, Menges 1991, Heschel and Paige 1995), genetic drift (Heschel and Paige 1995), and reduced gene flow (Jennersten 1988) though not all populations are affected (Van Treuren et al. 1993, Ouborg and Van Treuren 1995). These processes may eventually decrease the genetic variation and increase the occurrence of deleterious alleles within a population (Menges 1995). Individuals in small populations may show reduced seed size, seed viability, plant size, and increased susceptibility to environmental stress as a result of these impacts (Menges 1991, Oostermeijer et al. 1994). Decreases in mutualistic interactions such as pollination (Fischer and Matthies 1998) or environmental stochasticity (Heschel and Paige 1995, Young et al. 1996, Gordon and Rice 1998) may exacerbate these problems.

The use of seed from populations that have already been subjected to some degree of loss in fitness may directly lead to many of the same problems in restored populations, inhibiting the formation of self-sustaining populations (Gordon and Rice 1998). The end result of a prairie restoration should include more than just the species that originally existed, but also a restoration of the processes that helped to establish and maintain these systems (Packard and Ross 1997), which is linked to the overall viability of the component populations. In a successful prairie restoration, populations should maintain diversity and out-crossing without supplemental planting, mowing, or other continued management (Higgs 1997). For this reason, the selection of area(s) from which seed sources are drawn is crucial to insure the performance and adaptive ability of the restored population (Knapp and Rice 1996, Gordon and Rice 1998).

To determine whether plant performance in a prairie restoration is affected by the seed source, a common garden experiment was utilized to compare growth and survivorship of individuals collected from several prairie remnants within a restoration setting. As population viability is often linked with population size, we also compared performance of individuals collected from small (1–2 ha) remnants with the performance of collections from a narrow, but contiguous railroad prairie (260 ha). This experiment was conducted using five common prairie plant species of varying breeding systems. While most studies of fragmentation focus solely on the performance of rare species, we specifically focused on common prairie species to generate information practical to seed source selection for restoration.

METHODS

The five plant species used in the experiment are commonly found in prairie habitats and are often included in prairie restoration plantings: leadplant (*Amorpha canescens*, Pursh.); purple prairie clover (*Dalea purpurea*, Vent.); rattlesnake master (*Eryngium yuccifolium*, Michx.); wild quinine (*Parthenium integrifolium*, L.); and Virginia mountain mint (*Pycnanthemum virginianum*, (L.) Durand and B. D. Jackson) (nomenclature follows Gleason and Cronquist 1991). These species have a variety of reproductive strategies including self-compatibility (*A. canescens*, *D. purpurea*, and *E. yuccifolium*), self-incompatibility (*P. integrifolium*), and a species which to some degree produces seeds asexually (*P. virginianum*; Molano-Flores 2004).

Seed collection was conducted at four prairie remnants (one large, >100 ha and three small, 1–2 ha) spanning four Illinois counties (Ford, Iroquois, Shelby and Champaign). The three small remnant prairie populations consisted of Loda Cemetery prairie (40 31′38.26″N; 88 06′20.78″W), Prospect Cemetery prairie (40 26′43.20″N; 88 05′50.28″W), and Capel Hill prairie (39 30′02.27″N; 88 41′11.48″W), all within 63–74 km of the study site (Table 1). Remnant prairies were selected because of their proximity both to one another and to the study site; however, under these conditions, few suitable prairie sites were available, two of which were <2 ha in area. All sites were managed through periodic burns and were separated from one another by agricultural land and forests. The large remnant (Highway 45 near Paxton, IL) (40 26′15.28″N; 88 06′20.78″W) exists as a right of way along a railroad track, is approximately 25 m in width and is essentially continuous along a 10.8 km section of highway. Because this site covered more area than the others, seed collection was restricted to an area approximately equal in size (1–2 ha.) to minimize sampling bias. The location of the sampled area was chosen as the area closest to HW45 prairie and started at a road crossing. Historic land purchase data showed that the cemetery prairies and HW45 remnant first became fragmented 140 to 170 years ago, while the hill prairie would have been historically isolated from other grasslands by forest cover. Population estimates from the collection sites suggested there was no direct relationship between remnant size and the number of individuals for the species examined (Table 1). However, contemporary population size may reflect recent management efforts or absence there of and not fragmentation history. While the portion of the HW45 remnant sampled contained fewer individuals of most species suggesting an artifact of sampling area, the continuous nature of the site would make the effective population size much larger as the study species were patchily distributed along this right of way.

To compare nutrient levels, soil cores were taken randomly along a transect line using a hand held soil corer in the summer and fall of 2005. Soil samples were collected from all four of the seed collection sites as well as the prairie restoration site. Tests to determine the levels of nitrogen, phosphorus, potassium, calcium, cation exchange capacity, soil pH and percent organic matter were analyzed at KSI Laboratories in Shelbyville, IL. Values from each site were averaged and soil analysis showed few differences between the prairie remnants and the prairie restoration site (Table 2). Phosphorus was noticeably higher in the prairie restoration site than in any of the collection sites possibly due to residual fertilizer. The prairie restoration site was also slightly more acidic. Sites were comparable in all other aspects of soil analysis with the exception of Capel which showed decreased nutrient levels in comparison with the remaining sites.

Seeds were collected from 16 to 20 individuals of each species in each site during the late summer and fall of 2004. Excepting *A. canescens*, which was sampled only from Highway 45 and Prospect, seeds were collected from three of the four sites (one large and two small). Plants used in the seed collection were selected at random and individuals used did not visually appear to be a clone. Seeds from each plant

Table 1: Remnant area and population size for the seed collections used in this experiment. Data from the HW45 collection are for the 2 ha area sampled and are direct counts of flowering individuals. Population sizes from other sites are estimates. *Pycnanthemum virginianum* is a spreading clonal species, so population estimates were based on the number of distinct clumps.

	HW45	Prospect	Loda	Capel
Area (ha)	>100 total; 2 ha sampled	2.02	1.37	1.41
Amorpha canescens	170	—	500	—
Dalea purpurea	125	1700	—	1300
Eryngium yuccifolium	86	6500	900	—
Parthenium integrifolium	191	1200	1900	—
Pycnanthemum virginianum	64	1000	1100	—

were kept separate during storage and stratification. Seeds were stratified in moist perlite for a three month period at 5° C. Two species, *Amorpha canescens* and *Dalea purpurea*, require scarification before stratification (Baskin and Baskin 1998), which was done by scraping the seed with a fine grit sand paper to remove a portion of the seed coat (Sorensen and Holden, 1974). Seeds from each unique individual were germinated in Petri dishes lined with moist filter paper and placed in a growth chamber 12:12 hr. diurnal cycle at 25/20° C respectively. Seedlings were then transplanted into 164 ml (1.5 × 8.25 cm) individual Conetainers (Stuewe & Sons, Inc., Corvallis, OR) in a sterile potting mix (Pro-Mix, Premier Horticulture Inc., Quakertown, PA) and grown in a greenhouse at ambient temperature, on the Eastern Illinois University campus. All seedlings were moved outside of the greenhouse to harden off for a period of 3 to 4 weeks prior to transplantation. The sample size used in the experimental planting varied between 16 and 20 seedlings, each from a separate maternal plant, for each species collected in each site due to the failure of seeds from several individuals to germinate.

Plants were transplanted into a prairie restoration site adjacent to a cemetery (39 51′ 10.8″N; 88 09′ 31.62″W) in Douglas Co., IL in the spring of 2005. The site was previously a crop field (the final planting in corn), and had been abandoned for 1 year prior to the experimental planting. Due to the short time span since abandonment, this site consisted largely of annual species and remaining corn stubble thus, the removal of existing plants prior to the experimental planting was not necessary. The prairie remnants used represent the closest accessible prairie remnants that would serve as seed sources for prairie restoration.

All individuals were of similar size and were planted randomly along four, 220 m transects, with all 5 species represented in each transect. Plants were spaced 2 m apart to allow for growth and eventual clonal expansion. Supplemental watering was used on 2 occasions as needed during drought conditions early in the summer of 2005, water was supplied from an on site water source. Plants were monitored throughout the growing season for growth and survival. Height measurements were taken from 23 June–9 Sept. 2005 (data not shown). Following this period, only mortality was monitored as the plants had begun to senesce. Following the senescence of each plant, all aboveground biomass was harvested and dried to determine total growth as a measure of plant performance and vigor.

Table 2: Soil analysis results from four seed sample sites and restoration site. Soil analysis conducted by KSI laboratories, Shelbyville, IL.

	HW 45 (large)	Prospect (small)	Loda (small)	Capel (small)	Villa Grove (planting site)
Nitrate PPM	1	1	1	1.5	1.5
Soil pH	7.2	6.9	6.8	7.4	5.8
P kg/ha	11.7	15.15	17.9	9.7	70.6
K kg/ha	453	405.5	535.5	261.6	343.6
Ca kg/ha	5550	5660	5715	4880	2923.3
Mg kg/ha	1340	1310	1210	768.6	477.3
% Org. mat.	3.5	3.6	3.5	2.6	3
Cation exchange capacity	17.8	18.3	18.6	−2.9	11.4

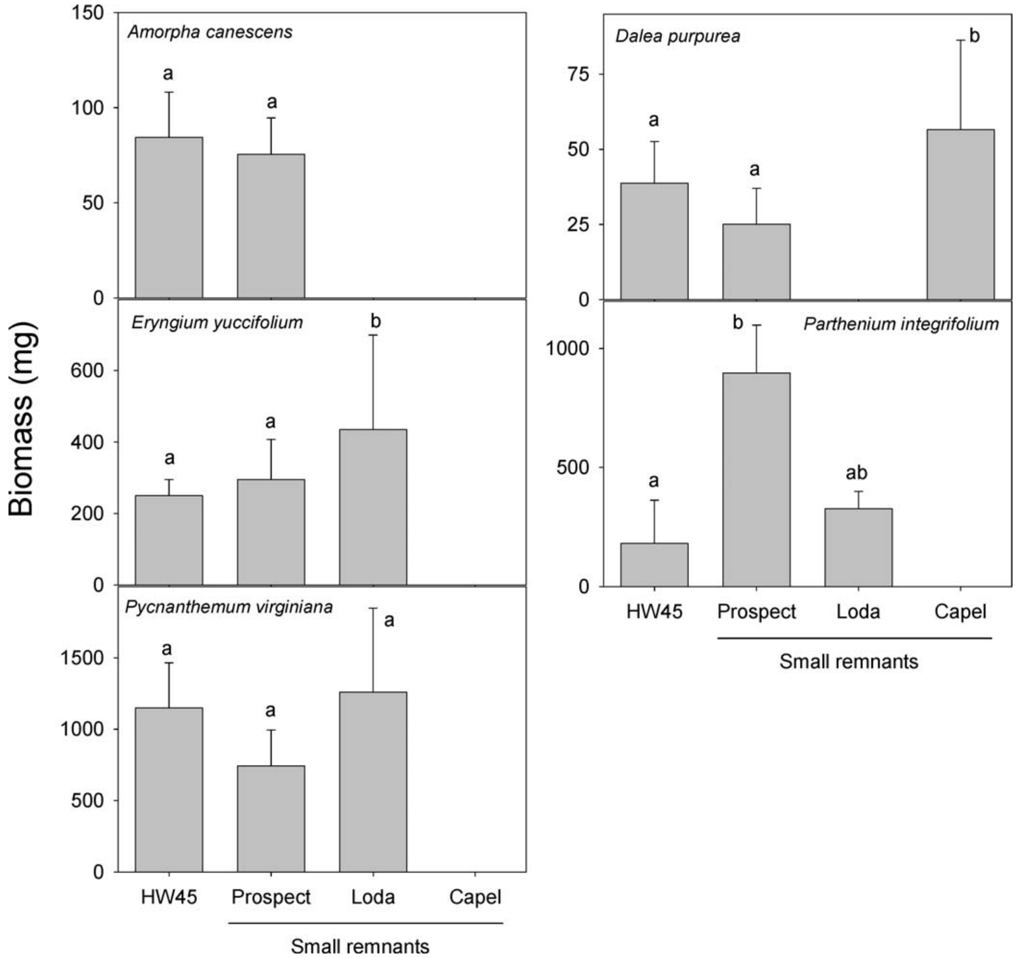

Figure 1. Variation in growth within a common garden among remnants for five common prairie species. Data plotted are means ± SE. Means sharing the same letter in panel are not statistically different based on Duncan *post-hoc* test.

One-way ANOVA were used to assess the effect of source population identity on total above ground biomass for each species. Biomass data were log-transformed to comply with ANOVA assumptions. A Chi-square analysis was used to test for variation in survivorship across collection sites for each species and among species as a whole. The relationship between percent mortality and species' growth was assessed with a non-parametric Spearman correlation. Data analyses were conducted using SPSS version 13.0 (SPSS Inc. Chicago, IL).

RESULTS

Plant performance among species, measured as above ground biomass, varied dramatically within the prairie restoration site (Fig. 1). *Pycnanthemum virginianum* grew significantly faster than all other species, while *Dalea purpurea* and *Amorpha canescens* had overall poor performance in growth (ANOVA $F_{4,183}$=28.86; P<0.001; R^2=0.39). Survivorship was relatively high in most species, though there was significant variation, with a high of 91.7% survival for *P. virginiana* and low of 52.7% for *D. purpurea* (Chi-square: P<0.001). The other species, *E. yuccifolium* (67.6%), *A. canescens* (82.3%) and *P. integrifolium* (88.3%), had intermediate levels of survival. Some of the observed mortality was apparently due to herbivore damage. *Amorpha canescens* and *Dalea purpurea* received the majority of the damage, possibly from deer browsing. *Eryngium yuccifolium* also received some damage from small mammals burrowing at the base of the plants. Overall, growth rate was linked with the risk of mortality in this experiment with the lowest mortality occurring in species with the greatest growth (Spearman correlation: $R_s=-0.90$; P=0.037).

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The common garden experiment showed significant variation among remnants in overall plant performance for three of the five species tested (Fig. 1); however, variation among collection sites did not follow the prediction of greatest performance in the large contiguous remnant. Total biomass varied significantly for *D. purpurea* ($F_{2,21}$=3.485, P=0.049, r^2=0.249), *E. yuccifolium* ($F_{2,37}$=3.263, P=0.049, r^2=0.150), and *P. integrifolium* ($F_{2,43}$=4.266, P=0.020, r^2=0.166). For *Dalea purpurea*, significant differences were found between the Capel site and both the Prospect and Highway 45 sites, with HW45 showing an intermediate level of biomass. *Eryngium yuccifolium* biomass was significantly greater in the Loda site (small) than in both the Highway 45 (large) and Prospect (small) sites. Finally, *Parthenium integrifolium* biomass was significantly smaller in the Highway 45 site than in Prospect prairie. The remaining species, *Amorpha canescens* and *Pycnanthemum virginianum*, had relatively consistent biomass across collection sites. Despite significant among-site variation in growth within some species, there were no significant effects of collection site on survivorship for any of the 5 species tested (Chi-square, all P>0.05).

DISCUSSION

Seed source location influenced plant performance in 3 of the 5 species tested, but this performance did not consistently vary among sites. It is often expected that fragmented populations will suffer decreases in heterozygosity (Kolb 2005) that may lead to a loss in fitness from inbreeding depression and genetic drift (Heschel and Paige 1995), ultimately lowering the population's ability to persist under adverse environmental conditions (Kolb and Lindhorst 2006). However, we found no evidence for a difference in plant performance in relation to remnant size, despite the large contiguous nature of the HW45 remnant. This lack of effect could be attributable in part to the size of the area sampled which was similar to that of the small remnants and therefore may only display a portion of the overall genetic diversity. The poor performance of some species from the large remnant suggests that even these populations may have been effectively fragmented by the narrow nature of the site and are now exhibiting a loss of vigor relative to other sites. This result is alarming as railroad prairie remnants often serve as local seed sources in prairie restorations.

The lack of relationship between remnant size and population performance may be caused by several pre- and post-fragmentation mechanisms. Over sufficient time spans, deleterious alleles may be purged from small populations (Barrett and Charlesworth, 1991). The time since fragmentation may have been a sufficiently long period to lose these deleterious alleles. However, the level of variation among remnants suggests that if this has occurred, it has not occurred within all remnants and all species. Alternatively, the fragmentation process may have generated some remnant populations which retained sufficient genetic diversity or were large enough to maintain vigor (Van Treuren et al. 1993, Ouborg and Van Treuren 1995). For example, even small remnant populations of *D. purpurea* were shown to retain a large amount of genetic diversity when seed samples were used in a restoration (Gustafson et al. 2002, Gustafson et al. 2005, Moncada et al. 2007). Other populations may have been fragmented from less diverse sub-populations that relied on gene flow to maintain vigor. As these are all perennial species, the fragmentation may have been too recent to show a reduction in performance. The way in which the prairie became fragmented may also be a factor in the vigor of a population. In this respect, the Capel Hill prairie site differed from the other remnants in that the fragmentation experienced occurred naturally, becoming isolated by an oak hickory forest. The remaining sites were isolated as the land was divided up and converted for agricultural uses.

Our results suggest that seed acquired from large and small populations alike can be useful for prairie restoration efforts. In general, no consistent effect of seed source location or size was seen, suggesting that seed collections could be taken from small remnant habitats without necessarily generating weak restored populations. However, plant performance across remnants was quite variable. Since plant performance varied unpredictably across source remnants and species, it may be likely that inferior unique individuals could be introduced into a prairie restoration even if collected from large remnants. To ensure that plant performance is maintained within a prairie restoration, it may be advantageous to use collections from multiple seed sources (Gustafson et al. 2002). Though individuals within restored populations established from multiple source remnants may initially retain their poor fitness, offspring resulting from these initial plantings will be of mixed parentage and should result in vigorous subsequent generations. However, to determine the success rate offspring from mixed parentage more research will be required.

Although multiple seed sources may alleviate the effects of habitat fragmentation on population vigor, it may also introduce problems from outbreeding depression or a reduction in population fitness as a result of disrupting local adaptations (Fenster and Galloway 2000). However, outbreeding depression may not be a significant problem in a restoration effort as long as source populations are not in excess of 100 km apart (Fenster and Galloway 2000). These collection areas would also need to be within this 100 km proximity to the restoration site to preserve localized adaptations (Fenster and Galloway 2000, McKay et al. 2005). However, this effect for Partridge Pea (*Chamaecrista fasciculata*, Michx.) may not generalize to all prairie species. The lack of documented outbreeding depression supports the utility of mixing several source populations within a restoration (Fenster and Galloway 2000, Gustafson et al. 2002, McKay et al. 2005) and provides a clear benefit in increasing the diversity, and potentially the long-term viability of the reintroduced population.

While most studies of fragmentation on plant performance focus on rare or endangered species, we specifically focused on species common to prairie habitats and likely to be included in prairie restoration efforts. These results suggest that even common species may exhibit reduced performance within isolated prairie remnants. Therefore, the viability of all populations may be threatened in fragmented habitats and should be a conservation concern. Our results also suggest that seed collections from multiple local source populations will be a necessary and viable method of ensuring population viability within prairie restorations (Gustafson et al. 2002). Clearly, there is large variation among species' performance in fragmented populations. Ultimately, to assess this conservation concern, studies are needed to assess the extent of the between population variation in vigor and to determine its impact on the long-term viability of populations within prairie restorations.

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Changes in Illinois' List of Endangered and Threatened Plant Species

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Abstract: During 2008 and 2009 the Illinois Endangered Species Protection Board reviewed and updated the Illinois list of endangered and threatened plant species. This review resulted in a number of status changes for plants, the results of which are summarized in this report. Four species were added to the list, eleven species were removed from the list, and three species had their status changed from endangered to threatened. The net decrease of 7 species brings the total number of endangered and threatened plant species in Illinois to 332 (251 endangered and 81 threatened). Persons wishing to obtain a complete listing of Illinois endangered and threatened species can find a *Checklist of Endangered and Threatened Animals and Plants in Illinois* posted at the Board's webpage at http://www.dnr.state.il.us/espb/index.htm, under the "List of Endangered & Threatened Species in Illinois" link.

Species Added to the List

There were three primary reasons for adding species to the list during the recent revision. One species was previously thought to be extirpated and has been recently rediscovered in Illinois. One species was newly described and separated from a complex in 2007. Two species were added based on the availability of new information on their status. Newly available species information that was considered included new information on species occurrence, declines, or rarity within Illinois. A listing of the four species added to the list follows. The status of each species is given as SE = state endangered or ST = state threatened. Primary reasons for addition are also given (NI = new information regarding species status within Illinois, ND = newly described species, RD = recently rediscovered in Illinois).

Species	Status	Reason
Buchnera americana L. (blue hearts)	ST	NI
Carex plantaginea Lam. (plantain-leaved sedge)	SE	RD
Delphinium carolinianum Walt. (wild blue larkspur)	ST	NI
Gratiola quartermaniae D. Estes (hedge hyssop)	SE	ND, NI

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Species Removed From the List

There were four main reasons for removing plants from the state list. Two species were removed because they were now considered to be peripheral species that presently occur only in disturbed/non-native habitats in Illinois. Two species were removed because Illinois records for these species are now believed to be based on misidentified specimens. One species was removed because it is now known to be more common in Illinois than previously thought. Five species were removed because they are now considered extirpated in Illinois. One species was removed both because it was deemed to be a peripheral species that only occurred in Illinois in non-native habitats and is also now considered extirpated. RE indicates removed from endangered and RT indicates removed from threatened. Primary reasons for addition are also given (EX = extirpated within Illinois, AD = adventives, MI = misidentification, TC = considered too common to remain listed).

Species with a Change in Status

The status of three species was changed from endangered to threatened because their statewide populations are increasing in numbers and/or distribution.

Species Changed from Endangered to Threatened

Berchemia scandens (Hill) K. Koch (supple-jack)
Cyperus lancastriensis Porter (galingale)
Juncus alpinus (*Juncus alpinoarticulatus*) Vill. (Richardson's rush)

Species	Status	Reason
Hydrocotyle ranunculoides L. f. (water-pennywort)	RE	TC
Ranunculus cymbalaria Pursh (seaside crowfoot)	RE	AD
Scirpus paludosus (*Bolboschoenus maritimus*) A. Nels (alkali bulrush)	RE	AD
Carex lucorum Willd.(sedge)	RE	MI
Carex striatula Michx. (lined sedge)	RE	MI
**Isotria medeoloides* (Pursh) Raf. (small whorled pogonia)	RE	EX
Lathyrus maritimus (L.) Bigel.(beach pea)	RE	EX
Milium effusum L. (millet grass)	RE	EX
Potentilla millegrana Engelm.(cinquefoil)	RE	EX/AD
Pycnanthemum albescens Torr. & Gray (white mountain mint)	RE	EX
Triadenum virginicum (L.) Raf. (marsh St. John's wort)	RE	EX

* = According to the Illinois Endangered Species Protection Act, federally listed species are automatically added to the Illinois list and the Illinois Endangered Species Protection Board does not have the authority to remove federally listed species from the Illinois list; the U.S. Fish and Wildlife Service would need to remove the species from the federal list for Illinois, so that it would no longer be automatically included in the Illinois list. For this reason, this species remains on the Illinois list and the Board will submit a correction to the Illinois Administrative Rule sometime in 2010.

TYPOGRAPHIC CORRECTION

Incorrect Common Name Spelling	**Corrected Common Name Spelling**
Polygonum arifolium (Halbred-leaved Tearthumb)	Halberd-leaved Tearthumb

ACKNOWLEDGMENTS

The Illinois Endangered Species Protection Board is indebted to many people who helped in various ways during the most recent list revision. In particular, the field work of the Illinois Department of Conservation's Natural Heritage Biologists and Illinois Nature Preserves Commission's Preservation Specialists, and the data management work of the Illinois Department of Natural Resources Natural Heritage Database staff, provided very helpful status and distribution informing and the Board's Plant Endangered Species Technical Advisory Committee members John Ebinger, Susanne Masi, Bill McClain, Randy Nyboer, Loy R. Phillippe, Kenneth Robertson, John Schwegman, Beth Shimp, and John Taft, also provided important field work as well as assessment of species information to make list revision recommendations to the Board.

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Perspective

Rocks, Water, Plants, and People in Southern Illinois: Beall Woods, Lusk Creek, and Pine Hills

W. Clark Ashby[1]

The canopy of plant cover in Illinois and its variations cannot be separated from the underlying geology which has been greatly shaped by water (Wiggers 1997). This essay examines three areas in southern Illinois and the people who contributed to their preservation. Taxonomy is based on Mohlenbrock (2002).

Beall Woods State Park in Wabash County

Wiggers' (1997) Chapter 30 "The Lower Wabash Considered" describes events in the late glacial Pleistocene about 14,000 years ago and the catastrophic meltwater Maumee Flood that carved the landscape of the Park. An upper section, about half in public ownership, is a relatively level, well-forested, ancient lake bed. A lower forested section is the Coffee Creek/Wabash River floodplain with about a 6–18 m bluff between them. There are five well-marked trails.

The Beall Woods Nature Preserve has 329 acres within the 635-acre Park. This outstanding botanical area is listed in the U.S. Register of Natural Landmarks as the "Forest of the Wabash". It was purchased by the State of Illinois under eminent domain in 1965, "to preserve the virgin woodland for posterity". Dan Malkovich, editor of Outdoor Illinois and Acting Director of the then Illinois Department of Conservation (DOC), was a key player. Robert Ridgway from Mt. Carmel, a leading American ornithologist, had studied and taken pictures of its massive trees back in the 1880s. State champions for ten tree species were reported. After WWII a harvest selection of more than fifty trees included some over 1 m diameter at breast height (dbh). An upland bur oak (*Quercus macrocarpa*), and a bottomland shumard oak (*Q. shumardii*) (that probably died from trampling around its base) were reportedly both 1.5 m DBH. A huge sycamore (*Platanus occidentalis*) near the park was cut down by a landowner angered by people trespassing to see it. Archie Esarey, whose family farmed the section from 1912 to 1941, said "the big trees are gone". Forest vegetation is described by Lindsey (1962) and Ashby and Ozment (1967). A list of "Trees of Beall Woods" by Cem Basman (1980) is available at the Red Barn Interpretive Center.

Beall Woods demonstrates site selection by tree species related to substrate and topography. Above the 400-foot contour were relatively open localized stands of white oak-tulip tree (*Q. alba* - *Liriodendron tulipifera*), white oak-sugar maple (*Acer saccharum*), and oak-hickory (*Carya spp.*) with 7 hickory species. These tree groupings had characteristic herbaceous flora, not unusually rich, perhaps related to previous use of the woods by hogs and hunters. Red oak-basswood (*Q. rubra* - *Tilia americana*) with a dense understory dominated the higher bluffs. Back from a smaller area of steep rock outcrop were the only occurrences of beech (*Fagus grandifolia*), hornbeam (*Carpinus caroliniana*), and *Lespedeza spp.* On the undulating floodplain with scattered understory were lowland oak, sweetgum - hackberry (*Liquidambar styraciflua* - *Celtis occidentalis*), hackberry - elm (*Ulmus spp.*), and silver maple - pecan (*Acer saccharinum* - *Carya illinoensis*). Beall Woods had 13 oak species including southern bottomland species.

Unfortunately Beall Woods has been a classic example of how values of natural land ownership may be compromised if the surrounding environment is allowed to deteriorate. A few oil spills from local pipelines have continued from earlier times. Flooding has increased from levee construction along the Wabash. A huge new coal electrical generating plant across the Wabash in Indiana brought air pollution. A new underground coal mine threatened subsidence and contributed dust from its loading area. The surrounding forest, reportedly of even higher quality, had

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successively been cleared, exposing the Woods to windthrow. How much did any of these factors contribute to the gradual dying and/or falling of magnificent huge trees and opening the canopy? Surrounding DOC land has been planted to trees that will take years to provide protection. Jeffrey R. Short, an influential Beall Woods conservation stalwart from Chicago, commented, "It looks as though after you save something, you have to keep on saving and saving it." And the push for "development" in various guises seems never to stop.

LUSK CREEK WILDERNESS IN POPE COUNTY

Although Lusk Creek is not mentioned, Wiggers' Chapter 33 "Sandstone Gorges, Rock Shelters…Bell Smith Springs" describes a similar unglaciated landscape to the north. Garden of the Gods and Giant City State Park have remarkable sandstone cliffs and bluffs. Access to the most scenic and botanically interesting area of the Lusk Creek Wilderness Area is from a side road east of Eddyville, or from the bridge across the creek 5 km south of the canyon on Pope County Road 5. Trails are reasonably level through partly forested upland. Our study area was from the bridge roughly 8 km north and half that wide.

Ashby (1968) and Hopkins (1969) have written on botanical features of the area with much fuller taxonomic listings. The major feature of Lusk Creek is a narrow gorge or canyon entrenched 30 m or deeper. Up top were thick cushions of lichens, now bare sandstone if walkable. Some south-facing sites had prickly pear cactus (*Opuntia humifusa*). Successively deeper in the canyon and soonest on north-facing slopes were sphagnum moss (*Sphagnum spp.*), clubmosses (*Lycopodium flabelliforme*, *L. porophilum*), and cinnamon (*Osmunda cinnamomea*) and royal ferns (*O. regalis*). Soil temperature and minimum air temperature were two of the ten climatic variables most closely related to these plant distributions (Ashby 1976).

Below a pool in the canyon are gravel bars that flood and drain rapidly in storms with thickets of river birch (*Betula nigra*) or occasional deciduous holly (*Ilex decidua*). Lower down is an increasingly well-developed terrace built from silt-laden glacial meltwater of the Kankakee Torrent that filled stream courses and changed rivers about 15,500 years ago. The Ohio River captured the lower reaches of the Tennessee River and its abandoned drainage is today's Bay Creek and Cache River system. Botanical evidence of the geological findings is the absence of typical flood plain species, silver maple or pin oak (*Q. palustris*). Important species on the creek-side terraces were beech with sugar maple and tulip tree fingering up the slopes and merging with red oak in occasional ravines of the rugged terrain. White oak was more dominant and common on upper slopes. An understory of dogwood (*Cornus florida*), hop hornbeam (*Ostrya virginiana*), and winged elm (*U. alata*) and associated herbaceous species were typical for the Shawnee Hills sandstone country of southern Illinois.

A political/educational struggle to save Lusk Creek after Bill Hopkins reported a proposed USDA Forest Service dam that would flood Lusk Creek Canyon was more turbulent than the fight for Beall Woods. Delyte Morris, President of Southern Illinois University (SIU) responded to those concerns and established a research project with a field-center house. The Lusk Creek Project supported research by professors and students in Botany, Zoology, Geology, and other departments to document the unique importance of the area. Dan Malkovich again worked actively for conservation and the DOC bought a key area within the canyon that put the dam project on hold. To gain public support for saving Lusk Creek, Roger Anderson (later at Illinois State) and I gave talks and published several popular articles. Lusk Creek was saved by President Morris and Dan Malkovich supported by Governor Richard Ogilvie and by decisive support from U.S. Senator Everett McKinley Dirksen who had initially introduced the dam project in Congress. The Forest Service now administers the area and unfortunately has human problems from an invasion of equestrians, off-road vehicles, and campers that have degraded the area.

Another outcome of the Lusk Creek project was the formation of the Southern Illinois Audubon Society (SIAS). Ma Hale's restaurant in Grand Tower hosted a large dinner meeting and several conservation organizations made presentations about their purposes. The group decided to become a chapter of the Illinois Audubon Society and today is the SIAS.

LARUE-PINE HILLS ECOLOGICAL AREA IN UNION COUNTY

The truly large trees of alluvial deposits at Beall Woods and the unique flora of Lusk Creek's rugged sandstone formations are matched by the species richness and grandeur of the Pine Hills. From below on the levee road of the Big Muddy River we wonder at the 30-m high limestone cliff of Lower Devonian Bailey Limestone with a top of resistant Grassy Knob chert, part of the Missouri Ozarks. Atop the escarpment along a gravel road on the ridge are natural shortleaf pine (*Pinus echinata*), found elsewhere in Illinois only at Piney Creek Ravine Nature Preserve 40 km north-west. Our study area was the bottomland and line of hills from near the Big Muddy River levee at Winters Pond south to Union County Highway 13 that goes through the Trail of Tears State Forest near Jonesboro. From the pines on McGee Hill there is an overlook, which spans 16 km across deep sediments with swampland, cropland, and forest vegetation of the floodplain valley to cliffs in Missouri bathed by today's Mississippi River. A description of an ice dam diversion of torrential glacial meltwater to the east and creation of the Pine Hills Escarpment is discussed in Wiggers' (1997). Like Lusk Creek, the Pine Hills were unglaciated although notably affected by the near-glacial conditions including deep un-eroded loess deposits. Ashby and Kelting (1963) and Mohlenbrock and Voigt (1965) describe botanical features.

The only relatively level upland areas were an abandoned field with invading sassafras (*Sassafras albidum*) and small parking areas. The typical upland plant communities related chiefly to south or north exposure. Relatively open areas contained black oak (*Q. velutina*) with some post oak (*Q. stellata*) on upper south-facing slopes, sassafras on ridges, white oak-hickory on north slopes with thin to increasingly deep loess down-slope gave way to red oak-black gum (*Nyssa sylvatica*)-beech in ravines. We took extensive climatic measurements and discovered an orographic effect of the relatively low Pine Hills on precipitation. This research on mountain effect on precipitation was later developed more fully for the Shawnee Hills by the Illinois State Water Survey. The north-facing slopes had more precipitation and fewer high temperatures. The south-facing slopes had triple limitations for plant productivity - high insolation, less precipitation, and thinner canopy cover than north-facing slopes. I observed, but do not have data on erosion or fires, both likely greater on the south-facing than on the north-facing slopes. Local residents talked of earlier fires commonly in the hills.

McCann Springs picnic area is in a cove at the north end of the study area that had the richest diversity of tree species I have seen anywhere. More than 30 tree species can be found at the junction of bottomland and upland. Uncommon species include Kentucky coffee tree (*Gymnoclodus dioica*), cucumber magnolia (*Magnolia acuminata*), black gum, red buckeye (*Aesculus pavia*), basswood, and a fine stand of sassafras with trunks larger than the red oak above them on the hillside. There was a moderate understory and a rich ground cover in the spring where not trampled. The Pine Hills had only ten oak species, two-thirds as many as Beall Woods and one less than Lusk Creek.

Within about 100 m from the talus below the cliffs, bottomland vegetation types based on indicator species were pondweed-hornwort (*Potamogeton spp.- Ceratophyllum demersum*), dense fringing buttonbush (*Cephalanthus occidentalis*), swamp red maple - swamp cottonwood (*A. rubrum var. drummondii* - *Populus heterophylla*) with little undergrowth, and extending up the drainages sweetgum that was a rich, multilayered community. Again based on observation with no data, the water level seemed a major controlling factor.

Our studies were carried out in the 1960s when the Pine Hills Field Station under President Delyte Morris of Southern Illinois University was an active research and educational facility with much promise. Scientists from the University of Chicago and Field Museum came down for field studies of the unique simultaneous emergence of the 13-year and 17-year periodic cicadas. Soil and plant scientists and ecology classes from northern Illinois as well as from other states visited the station. Unfortunately the facility was aborted despite denials to the faculty by a later administration that the land would be taken over the USDA Forest Service. I understand it is now the Pine Hills Research Natural Area. Environmental concerns include invasive species, fire use and fire suppression.

Plans for the Future

Beall Woods, Lusk Creek, and Pine Hills are each instructive. A common feature has been change, long- and short-term, and the need for continued monitoring effects of changes, natural and man-made. All areas have had damage from invasive species, deer, windstorm, ice, flooding, and humans in recent years. We need to consider what does "natural" mean?

Ecological restoration, especially prairie restoration, has become an important segment of the conservation movement. An early example is found at the Morton Arboretum and later work by Bob Betz at the Fermi Lab. Numerous conservation-type organizations have become active locally in southern Illinois since the dynamic 1960s. A new generation of enthusiastic naturalists is needed to carry the torch. Hopefully they will have the vision to include the creation of reserved areas planted to native plants.

A large area of quality land, not easy to get, is needed to support a sustainable prairie restoration project. An unrecognized source is land after stripmining that for native plants could be reclaimed without present-day reclamation restrictions (Ashby 2009). With a pre-settlement type rooting medium, less soil handling, and lower reclamation costs, a public-spirited coal company today would likely donate substantial acreage for native plant research and demonstration natural areas. Both the original Pyramid State Park in Perry County and Sahara Woods in Saline County were given to the state by coal companies for use by the public. Our elected officials and the Illinois Department of Natural Resources which regulates stripmining would also need to be persuaded, a worthy goal for the Illinois Native Plant Society.

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Abstracts

Hemiparasite-Host Plant Interactions and the Role of Herbivory: a Field Experiment

Mickayla D. Van Hoveln[1]

Abstract: Hemiparasitic plants fix carbon via photosynthesis, but also take water and mineral nutrients from host plants via haustorial connections. Hemiparasitism can directly reduce host growth, reproduction, and survival. While providing resources to hemiparasites, host plants may simultaneously support herbivores that also reduce host performance. Resource availability for each exploiting species will be altered by changes in the host's growth as it responds to these challenges. Consequently, a host plant can mediate indirect interactions between hemiparasites and herbivores simultaneously exploiting it. I conducted a field experiment with the following objectives: (1) to investigate the direct effects of the hemiparasitic plant, *Pedicularis canadensis*, and artificial herbivory on root and shoot growth of the host, little bluestem (*Schizachyrium scoparium*), (2) to investigate how the impact on the host varies across a range of hemiparasite loads, and (3) to determine the indirect effects of artificial herbivory of the host on *P. canadensis*.

Hemiparasite load was negatively associated with host biomass. Principal Components Analysis showed that the number of leaves and inflorescences of the hemiparasite nearest to the host plant was the factor that most significantly affected host biomass. Cutting hosts early but not late significantly reduced host biomass at the end of the season but the impact was independent of parasite load. Hemiparasite mass was negatively associated with host plant size; hemiparasites growing next to large host plants fared poorly. Although artificial herbivory of the host was not a significant main effect, cutting treatment reduced the impact of host plant size on hemiparasite performance. Thus cutting treatment indirectly affected hemiparasites in this experiment. This experiment demonstrated that artificial herbivory and hemiparasitic plants have direct but independent negative effects on host plants, an increase in hemiparasite load causes a decrease in host plant performance, and artificial herbivory indirectly affects hemiparasite performance.

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Factors Influencing the Distribution of Cytotypes of *Solidago altissima*

Matthew Richardson[1]

Abstract: Conspecific plants with different numbers of chromosomes (i.e., cytotypes) may differ in geographical distribution. Cytotypes of the perennial herb *Solidago altissima* L. (tall goldenrod) are sympatric in eastern and northeastern Illinois, but differ in their small-scale distribution within sites. The hypothesis is that cytotypes compete when confined to a small space and these competitive interactions among plants can strongly influence community structure. I collected rhizomes representing all cytotypes from oldfields in eastern and northeastern Illinois and planted rhizomes of two different cytotypes in each of 30 small pots (10 pots of each pairwise interaction) in spring 2009. In October 2009, the dead ramets were clipped and the rhizomes stored (in the pots) in large plastic containers in an unheated garage. Plants will be grown in pots for one more year until April 2011, at which time the rhizomes will be removed from the pots, ramets counted that each cytotype produced, and the mass of the rhizomes weighed. This experiment will determine if one cytotype out-competes the other in pairwise interactions.

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Reproductive Ecology and Population Genetics of *Besseya bullii:* a Rare Species

Katherine Chi[1]

Abstract: *Besseya bullii* (Eaton) Rydb. (Plantaginaceae), commonly called kittentails or bull's coraldrops, is a plant species endemic to the Midwestern United States, found in savannahs, open woods, and gravel/sand prairies. Urbanization and agriculture has restricted populations of *B. bullii* to small, highly isolated remnant habitats where landscape factors could restrict pollinator movement and gene flow, potentially affecting the reproductive output of this species. In Summer 2008, over 20 populations were visited according to state records of occurrence. At each site, data was collected on population size, habitat charac-

teristics, and the presence of pollinators. From these populations, 8 were selected for a study on the reproductive ecology and population genetics of the species. At each population, 20 infructescences were collected to determine fruit/seed set and seed germination. In addition to these measures of reproductive success and fitness, a hand-pollination study was conducted at one site, the Lost Mound Field Station, to determine potential fitness differences between selfed and outcrossed seeds. Results indicate that there is a significant relationship between fruit set and population size, and a weak relationship between seed set and population size. There were also significant differences in seed germination among sites. The hand-pollination study yielded poor results, but provided insight into improving protocols for future studies. This study demonstrates that there are potentially consequences of small population size on the ability of *B. bullii* to successfully reproduce.

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BOTANISTS, SCIENTISTS, EXPLORERS, and BOTANICAL ARTISTS who have played a major role in our understanding of our state and its natural resources

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ABSTRACTS

Research and technical papers should include a one-paragraph abstract of not more than 250 words. The abstract should state concisely the goals, principal results, and major conclusions of the paper.

TAXONOMIC NAMES

Either a standard taxonomic manual should be cited whose names are followed consistently, or the scientific names should be followed by their authority. Common names, if used, should be referenced to a scientific name. Thereafter, scientific names are recommended, but either may be used if done so consistently.

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