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Alien and Native Woody Species Invasion of Abandoned Crop Land and Reestablished Tallgrass Prairie in East-Central Illinois

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ABSTRACT

A study of composition and density of woody species within a successional old field and a seeded tallgrass prairie community at the Eastern Illinois University Environmental Biology Area was conducted in the spring of 1988. Woody plant invasion exceeded 16,500 stems/ha in the seeded tallgrass prairie and over 6,500 stems/ha in the old field. A number of alien species, including autumn olive (*Elaeagnus umbellata* Thunb.), multiflora rose (*Rosa multiflora* Thunb.) and Siberian elm (*Ulmus pumila* L.) were present in relatively high numbers, while the most common native species encountered were poison ivy (*Toxicondendron radicans* [L.] Kuntze), black berry (*Rubus allegheniensis* Porter), and dewberry (*Rubus flagellaris* L.).

INTRODUCTION

Since the beginning of the latter half of the nineteenth century the number of alien vascular plant species in the United States has increased dramatically. Henry and Scott (1980, 1981) reported that all alien species now constitute approximately 29% of the Illinois flora, while woody alien species are 13% of the flora. Several alien species, including Amur maple (*Acer ginnala* Maxim.), Norway maple (*Acer platanoides* L.), red-osier dogwood (*Cornus stolonifera* Michx.), autumn olive (*Elaeagnus umbellata* Thunb.), Japanese honeysuckle (*Lonicera japonica* Thunb.), multiflora rose (*Rosa multiflora* Thunb.), and Siberian elm (*Ulmus pumila* L.) were observed in the seeded tallgrass prairie and old field at the Environmental Area on the east edge of the Eastern Illinois University campus. Red-osier dogwood is a native Illinois species, but probably not to the prairie peninsula region of east-central Illinois, while the others are all introduced Eurasian species.

The 16 ha EIU Environmental Biology Area was established in 1974, having been in continuous row crop agriculture for the preceding 40 years (Figure 1). Prairie soils cover approximately half of the site (seeded with tallgrasses) while the remainder is covered with forest soils and was allowed to reestablish naturally (old field). Autumn olive, red-osier dogwood, and Tatarian honeysuckle (*Lonicera tatarica* L.) were planted in border rows and between the seeded tallgrass prairie and old field in late winter 1974 using Illinois Department of Conservation seedling stocks. The prairie community was planted in the spring of 1974 from Nebraska seed that included: big bluestem (*Andropogon gerardii*

Vitman), indian grass (*Sorghastrum nutans* [L.] Nash), switch grass (*Panicum virgatum* L.), little bluestem (*Schizachyrium scoparium* [Michx.] Nash), and side-oats grama (*Bouteloua curtipendula* [Michx.] Torr.). The seeded tallgrass community was burned in the spring in 1984 and 1986, while the adjacent successional old field has had no maintenance. The present study was undertaken to document the density and distribution of native and alien woody species in the EIU Environmental Area.

METHODS AND MATERIALS

The composition, density and distribution of the woody species were determined in the spring of 1988 using 25m x 400m (1 ha) east-west transects. One transect was established in the seeded tallgrass prairie and the successional old field. These transects were divided into 50m plots with the 50m end plots of each transect further stratified into smaller subplots (2.5m x 50m). The subplots were created and sampled separately from the remainder of the transect's plots due to the high density of woody species encountered there. Half of these smaller subplots within each end plot were randomly selected and sampled. These end plot data were later multiplied by the appropriate factor to fully account for all woody individuals of the entire area of the end plots. The east end of each transect bordered a mown meadow fescue (*Festuca pratensis* Huds.) community along Illinois Route 130 while the entire west border was an over-grown fence row. Samplers included ten faculty and graduate students who walked each transect as an organized line and recorded all woody individuals encountered within each persons subtransect. The individuals of each species were divided into two height categories: less than 4dm and more than 4dm. Each sampler had a 4dm lath stick for these sampling determinations. All individuals of the genera *Lonicera*, *Rubus*, *Toxicodendron* and *Vitis* were placed in the less than 4dm category. Data from each sampler were later combined to form the whole data set. Nomenclature follows Molenbrock (1986).

RESULTS AND DISCUSSION

The woody species encountered, along with their general distribution and density (#/ha), are listed in Tables 1 and 2. The highest concentrations of woody individuals were near east and west borders of each transect. Most species showed heavy concentrations at one border with fewer individuals in the interior of the transects. The location of a seed source has been shown to be correlated with successional rate and distribution of successional species (Coile 1940, McQuilken 1940, Potzger and Potzger 1950, and Bazzaz 1963, 1968).

Of the alien species present on the site, multiflora rose and Japanese honeysuckle have likely invaded from an over-grown fence row on the west border of the site. Autumn olive, red-osier dogwood, multiflora rose, and Japanese honeysuckle are most likely spread by animals, particularly birds, because of their edible fruit. Amur maple, Norway maple and Siberian elm are wind disseminated species that probably arrived at the site from the EIU campus and surrounding residential areas. The major concern with all alien species has been that they replace native species that might otherwise occupy a site (Bratton 1982).

Of the native species encountered, most were common at the west end of the transects near the over-grown fence row. In the seeded tallgrass prairie community, poison ivy (*Toxicodendron radicans* [L.] Kuntze) was very common at both edges of the transect while honey locust (*Gleditsia triacanthos* L.), red mulberry (*Morus rubra* L.), black cherry (*Prunus serotina* Ehrh..), black berry (*Rubus allegheniensis* Porter), and raspberry (*Rubus occidentalis* L.) were common in and near the fence row at the western edge of the transect (Table 1). Similar results were obtained for the successional old field, with most woody species being found near the over-grown fence row (Table 2). Most of these species were likely spread by birds or mammals, though some have wind disseminated seeds.

If the presence of dense populations of blackberry, raspberry, dewberry (*Rubus flagellaris* L.) and poison ivy are minimized; the data indicate that the prairie grasses and the two burns have rendered the seeded tallgrass prairie community relatively more resistant to both native and alien woody species invasion than the successional old field.

The size class (<4dm and >4dm tall) proportions contributed to community composition for all species in the two communities were compared using total density figures (Tables 1 and 2). The percentage contribution to total density (PCTD) by size class (<4dm or >4dm) for alien or native species = size class density for community type (prairie or old field) divided by total community type (prairie or old field) density (<4dm + >4dm) x 100. PCTD for the <4dm size class in the prairie area was 95.3% native and 0.4% alien species. While the <4dm size class PCTD for the old field was 63.6% native and 1.6% alien species. The prairie >4dm size class PCTD was 3.4% native and 0.9% alien species. While the old field PCTD for >4dm size class was 25.0% native and 9.8% alien species. Native species in each community type and size class were predominantly the highest contributors to community composition. Alien species contributions to community composition indicated successful establishment and future survival potential especially in the old field.

The 18 year secondary successional history of this site would place it in a mid-successional seral stage where there is less emphasis on reproduction and greater emphasis on survival of the more mature woody vegetation. The ratio of native woody species reproduction (<4dm excluding *Lonicera*, *Rubus*, *Toxicodendron*, and *Vitis*) to more mature woody vegetation (>4dm all species) in all plots of each transect indicated that the >4dm native species contributed 1.7 (prairie) to 2.2 (old field) times more to composition than reproduction; while the >4dm alien species contribution to composition was 2.5 (prairie) to 6.0 (old field) times greater than reproduction. Reproduction data seemed to indicate that competition within the mid-successional seral stage was keeping the alien woody species increase somewhat in check. Contribution to composition by native species <4dm (excluding *Lonicera*, *Rubus*, *Toxicodendron*, and *Vitis*) for all transect plots was 1.3 to 5.8 (prairie) and 1.6 to 21.2 (old field) times greater than alien species reproduction. This trend was also found in the >4dm vegetation; where native species were 1.2 and 7.6 (prairie) and 0.1 to 3.0 (old field) times greater contributors to composition than alien species. An exception to the >4dm trend was found in the old field's east end plot. Conditions a number of years ago (within the 18 year successional period) must have been very favorable for reproduction of certain species (ie. red-osier dogwood and autumn olive). The contribution to composition by alien >4dm in this end plot was 8.6 times greater than native >4dm vegetation. The intense interspecific

competition that occurs during early seral stages was transcending into the more balanced competition found in later successional stages (Parrish and Bazzaz 1982); and it would be expected that the trend of less emphasis on reproduction and greater emphasis on survival of more mature vegetation will continue into the future.

These data also seemed to indicate that the burning treatments and the structure and density of the seeded tallgrass prairie community were having a differential effect on the resultant composition. When the data for alien species were combined, the PCTD was 1.3% (prairie) and 11.4% (old field). Therefore the PCTD by alien species in the prairie area was 8.8 times less than the old field. A very different result was obtained if the number of alien species, rather than density, was used to compute composition in the two communities. The percentage of alien species in the prairie was 33.3% and old field was 20.7%. These are considerably higher than the 13% alien species for the whole Illinois flora reported by Henry and Scott (1980, 1981). This indicates that there were 1.6 times more alien species actually present in the prairie. While there were slightly greater numbers of alien species in the prairie's composition, the density-composition data indicated that the old field, because of the relatively high numbers of individuals of each alien species, will likely have its successional pattern much more influenced by these species. However, the greater proportion of the alien species in the prairie (count-composition data) indicated that this community will continue to be impacted by their presence. These data indicated that native and alien woody species invasion and establishment were following the relatively well documented trends of succession and diversity relationships in Illinois (Bazzaz 1968, Parrish and Bazzaz 1979, 1982). These data also indicated that the alien woody species had been invading this site in relatively high numbers. Their presence (density-composition data) indicated that they will likely have a considerable impact on future successional events in the two communities at this site. As Bratton (1982) pointed out, these alien species have occupied habitats of, and in effect have replaced, the native species that would otherwise have occupied the site. Alien species influences on future successional events will likely be considerable because they will establish competitive relationships with current native species and future invaders that will be different from their native niche counterparts.

LITERATURE CITED

Bazzaz, F.A. 1963. Secondary succession on abandoned fields in southern Illinois. Ph.D. Thesis. Univ. Ill., Urbana, IL. 190p.

Bazzaz, F.A. 1968. Succession on abandoned fields in the Shawnee Hills, southern Illinois. Ecol. 49: 924-936.

Bratton, S.P. 1982. The effects of exotic plant and animal species on the nature preserves. Nat. Areas Jour. 2: 3-12.

Coile, T.S. 1940. Soil changes associated with loblolly pine succession on abandoned agricultural land on the Piedmont Plateau. Duke Univ. School Forestry, Bull. 5. 85p.

Henry, R.D. and A.R. Scott. 1980. Some aspects of the alien component of the spontaneous Illinois vascular flora. Trans. Ill. St. Acad. Sci. 73: 35-40.

Henry, R.D. and A.R. Scott. 1981. Time of introduction of the alien component of the spontaneous Illinois vascular flora. Am. Mid. Nat. 106: 318-324.

McQuilken, W.E. 1940. The natural establishment of pine in abandoned fields in the Piedmont Plateau region. Ecol. 21: 135-147.

Mohlenbrock, R.H. 1986. Guide to the vascular flora of Illinois. Southern Illinois Univ. Press, Carbondale, 508p.

Parrish, J.A.D. and F.A. Bazzaz. 1979. Differences in pollination niche relationships in early and late successional communities. Ecol. 60: 597-610.

Parrish, J.A.D. and F.A. Bazzaz. 1982. Competitive interactions in plant communities of different successional ages. Ecol. 63: 314-320.

Potzger, J.E. and E. Potzger. 1950. Secondary succession in an Illinois tillplain habitat. Indiana Acad. Sci. Proc. 59: 95-101.

Figure 1. Environmental Area at Eastern Illinois University: Autumn Olive, Bush Honeysuckle, and Red-osier Dogwood rows were planted in the spring of 1974 as was the Seeded Tallgrass Prairie community. Prairie and Old Field transects are 25m x 400 m.

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Table 1. Density (#/ha) of all woody species encountered in the seeded tallgrass prairie community of the EIU Environmental Area. All individuals of the genera *Lonicera*, *Rubus*, *Toxicodendron*, and *Vitis* are included in the less than 4 dm tall category

Transect Zone	0-50m		50-350m		350-450m		Totals/ha	
	<4dm	>4dm	<4dm	>4dm	<4dm	>4dm	<4dm	>4dm
Native Species								
Acer negundo	1	5	-	-	2	-	3	5
Acer saccharinum	4	3	2	11	6	2	12	16
Diospyros virginiana	-	1	-	16	-	-	-	17
Gleditsia triacanthos	-	3	1	1	289	296	290	300
Malus ioensis	-	-	1	-	5	-	6	-
Morus rubra	-	-	-	5	-	62	-	67
Populus deltoides	-	-	-	4	-	-	-	4
Prunus serotina	-	11	4	1	13	125	17	137
Rubus allegheniensis	7	-	65	-	3471	-	3543	-
Rubus flagellaris	7	-	4200	-	280	-	4487	-
Rubus occidentalis	-	-	-	-	511	-	511	-
Toxicodendron radicans	4050	-	1	-	3073	-	7124	-
Ulmus americana	-	-	-	-	5	27	5	27
Vitus spp.	-	-	13	-	-	-	13	-
Totals	4069	23	4287	38	7655	512	16011	573
Alien Species								
Acer ginnala	-	-	-	1	-	2	-	3
Acer platanoides	1	2	-	-	-	1	1	3
Cornus stolonifera	1	-	3	-	1	38	5	38
Elaeagnus umbellata	1	17	-	1	12	12	13	30
Lonicera japonica	-	-	-	-	11	-	11	-
Rosa multiflora	-	-	-	2	-	75	-	77
Ulmas pumila	-	-	-	1	31	-	31	1
Totals	3	19	3	5	55	128	61	152

Table 2. Density (#/ha) of all woody species encountered in the successional old field of the EIU Environmental Area. All individuals of the genera *Lonicera*, *Rubus*, *Toxicodendron*, and *Vitis* are included in the less than 4 dm tall category.

Transect Zone	0-50m		50-350m		350-450m		Totals/ha	
	<4dm	>4dm	<4dm	>4dm	<4dm	>4dm	<4dm	>4dm
Native Species								
Acer negundo	-	1	-	7	-	-	-	8
Acer saccharinum	-	3	5	10	-	4	5	17
Crataegus mollis	-	-	-	32	64	118	64	150
Diospyros virginiana	-	-	-	4	-	2	-	6
Fraxinus pensylvanica	-	-	-	-	-	3	-	3
Gleditsia triacanthos	-	-	-	-	4	158	4	158
Juniperus virginiana	-	-	1	3	1	-	2	3
Malus ioensis	-	1	4	10	30	6	34	17
Morus rubra	-	-	-	84	2	105	2	189
Platanus occidentalis	-	-	-	2	-	-	-	2
Populus deltoides	-	-	1	13	-	2	1	15
Prunus americana	-	-	-	-	-	2	-	2
Prunus serotina	-	2	44	45	38	92	82	139
Quercus imbricaria	-	-	-	-	-	1	-	1
Rosa carolina	84	-	-	-	-	-	84	-
Rubus allegheniensis	97	-	776	-	276	-	1149	-
Rubus flagellaris	426	-	-	-	-	-	426	-
Rubus occidentalis	1	-	16	-	216	-	233	-
Sassafras albidum	-	-	-	2	-	-	-	2
Tilia americana	-	-	-	15	-	-	-	15
Toxicodendron radicans	38	-	9	-	1523	-	1571	-
Ulmus americana	-	-	20	33	440	890	460	923
Vitus spp.	7	-	37	-	29	-	73	-
Totals	653	7	913	260	2623	1383	4189	1650
Alien Species								
Acer ginnala	-	-	1	3	-	-	1	3
Cornus stolonifera	33	49	29	56	26	236	88	341
Elaeagnus umbellata	-	11	-	4	-	-	-	15
Lonicera japonica	-	-	-	-	1	-	1	-
Rosa multiflora	-	-	4	10	-	261	4	271
Ulmas pumila	-	-	13	15	-	-	13	15
Totals	33	60	47	88	27	497	107	645