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09 July 2004

Mr. Bob Lindsay
Illinois Department of Natural Resources
P.O. Box 67
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RE: Grant Agreement # 04-031W

Dear Bob,

Enclosed is the final report for Grant Agreement # 04-031W, Invasion of the exotic Japanese bush clover (*Kummerowia striata*) in Illinois shale barrens. This report marks the completion of the project. We appreciate the opportunity to work with your agency, and your support of research in the natural areas of Illinois.

Sincerely,

Natalie West

cc (letter only): Ms. Sonjie Schwartz
Dr. David Gibson

Invasion of the exotic Japanese bush clover (*Kummerowia striata*) in Illinois shale barrens

BY

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Final Report to the Illinois Department of Natural Resources: Grant Agreement # 04-031W

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Executive Summary

1. Shale barrens are among the rarest natural communities in Illinois. Encroachment of forest growth due to fire-suppression has further contributed to their scarcity.
2. This study focused on the invasion and distribution of *Kummerowia striata* (Japanese bush clover), a native of southeast Asia, in three southern Illinois shale barrens. *Kummerowia striata* has been recorded from three shale barrens from 1993 through 1998.
3. Permanent plots from previous studies were resurveyed, and surveys were expanded to include the whole barrens in 2003 and 2004. In 2003 and 2004 three individuals were located on Brown Barren but they were outside the permanent plots. *Kummerowia striata* was not recorded at either Berryville Shale Glade or McClure School Shale Glade in 2003 or 2004.
4. Sensitivity to fire and a preference for early successional conditions may have contributed to the near extirpation of populations of *Kummerowia striata* in these areas.

Key words: *Kummerowia striata*, forest opening, exotic species, shale barrens.

Introduction

Shale barrens are among the rarest natural communities in Illinois (White & Madany, 1978). These forest openings are maintained partly through edaphic conditions, but also by disturbances, including fire. Barrens have become even rarer in recent decades as fire-suppression has allowed an encroachment of woody species growth into the openings, resulting in a more mesic community structure (Heikens, 1991; Hutchison, 1994). Land managers have begun restoring these areas through a program of woody vegetation removal and prescribed fire. This has allowed a turnover from mesic forest growth to the xeric conditions that characterize barrens in the Brown Barrens site in Union County, Illinois (Bittner *et al.*, 1994).

There are three barrens included in the Illinois Nature Preserve system: Brown Barrens, Berryville Shale Glade, and McClure School Shale Glade, all located within a 4 km radius south of State Route 146 in Union County, Illinois. Past floristic studies in these three areas have examined different aspects of plant community structure, but none have focused on exotic species. Invasive species are viewed as one of the major threats to the biodiversity of natural communities (Zavaleta *et al.*, 2001). The goal of this project was to examine the distribution of *Kummerowia striata* (Thunb.) Schindl. (Japanese bush clover) in the shale barrens. This native of southeast Asia has been shown to reoccur persistently in all three areas (Table 1, Figure 1). It is listed as a Category 2 exotic with the U.S. Forest Service Southeast Exotic Pest Plant Council, defined as an exotic plant species suspected to be invasive or known to be invasive in limited areas of the Southern Region. Category 2 invasives will persist in the environment for long periods once established and may become invasive under favorable conditions (Southeast Exotic Pest Plant Council, 1996). Because this species was known to be consistently present on the barrens, there was a concern that if the right conditions were met, it may become a problem in these areas. This project sought to examine factors potentially limiting distribution of *K. striata* in the shale barrens, and to relate these factors to variations in plant fitness and recruitment among individuals in the population.

Methodology and Results

In summer, 2003, plots from previous studies (Bittner *et al.*, 1994; Ely, 2000) were relocated and surveyed at each of the three shale barrens where *K. striata* is known to occur. Each 50 m² plot was divided into 4 quadrats, which were surveyed using a modified Daubenmire cover scale (Abrams & Hulbert, 1987). To provide comparable values, cover categories were transformed to percent cover using cover scale mid-points. Upon examination, no plants of this species were found within these plots (Table 1), and the surveys were expanded to include the whole opening area. Three individuals were located in the Brown Barren site. These three plants were located in areas of bare soil in more shaded portions of the barrens. None were found at either Berryville or McClure in summer 2003. When the areas were resurveyed in summer 2004, *K. striata* was recorded in the same location as 2003 in Brown Barrens, but no other individuals were found. There were also no individuals located in either Berryville or McClure in summer 2004. Specimens of flowering individuals will be collected in late summer or early fall from Brown Barren and placed in the herbarium in the Department of Plant Biology at Southern Illinois University-Carbondale.

Discussion

There are several factors that could have contributed to the absence of previously occurring populations of *K. striata* in the barrens. In the case of Brown Barrens, it is currently being restored through a combination of prescribed fire and woody species removal. Campbell (1927) states that *Kummerowia striata* is an early colonizer of abandoned fields and disturbed areas, but eventually declines to very low numbers with advanced succession. Though it is quick to invade recently disturbed areas, reseeding is limited by competition, and in fertile conditions it is often crowded out by higher yielding grasses and legumes (Ball *et al.*, 1991; Hoveland & Donnelly, 1985). Also, though *Kummerowia striata* has been shown to increase after prescribed fire in an Illinois grassland (Anderson & Van Valkenburg, 1977), Landers (1981) found that cool fires killed *K. striata*, and Martin & Cushwa (1966) found that exposure to dry heat above 84 °C severely reduced germination. Thus, though increased disturbance could have allowed invasion by *K. striata* into the barrens, fire and an increase in herbaceous species

brought about by the canopy opening could have reduced the competitiveness of *K. striata* leading to its local extirpation. Campbell & Gibson (2001) found *K. striata* in the seedbank along horse trails in a state forest in southern Illinois, suggesting that seed may remain dormant in the soil until a disturbance allows suitable germination conditions. Natural reseeding of this species will occur if competition is not too severe (Ball *et al.*, 1991; Hoveland & Donnelly, 1985). However, it was not invading the forest interior in that study, and *Kummerowia striata* was not found in the seedbank of Brown Barrens in a study on the regeneration potential of this area (McCall & Gibson, 1999). It is possible that the continual deposition of seed by horses may have allowed *K. striata* to persist in the seedbank along trails in the Campbell & Gibson study, but that normal barrens conditions are not conducive for persistence in the seedbank over long periods of time.

In the case of the two unrestored areas, Berryville and McClure School, it is possible that they have also reached a point of limitation in succession for that species. It is also possible that some factor, such as seasonal drought or low temperatures, resulted in an unsuccessful seed set. It is in its northern range limit in southern Illinois, and this as well as an extended dry season could have negative effects on the population (McGraw & Hoveland, 1995). Without a reintroduction of this species into these areas, it could be that the established populations foundered.

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Table 1. Canopy cover (%) of *Kummerowia striata* in 50 m² permanent plots from Ely (2000) with added 2003 and 2004 survey data. Cover values represent the midpoint of cover scale categories. Asterisks indicate absence from the plot.

Site	Plot	1993	1994	1995	1996	1997	1998	2003	2004
Brown Barrens	1	*	*	*	0.5	*	*	*	*
	2	*	*	*	*	0.125	0.25	*	*
	3	*	*	*	0.5	*	1.125	*	*
	4	0.125	*	0.125	*	*	*	*	*
	5	*	*	*	0.5	*	*	*	*
	6	*	*	*	0.5	*	*	*	*
	7	*	*	*	*	*	*	*	*
	8	0.125	*	*	*	*	*	*	*
Berryville Shale Glade	1	*	*	*	*	*	*	*	*
	2	*	*	*	*	*	*	*	*
	3	*	*	*	*	*	*	*	*
	4	*	*	*	*	0.125	*	*	*
	5	*	*	*	*	0.25	*	*	*
	6	*	*	*	*	1.25	0.125	*	*
	7	*	*	*	*	*	*	*	*
	8	*	*	*	*	0.125	*	*	*
McClure School Shale Glade	1	*	*	*	*	*	*	*	*
	2	*	*	*	*	*	*	*	*
	3	*	*	*	*	*	*	*	*
	4	*	*	*	*	*	*	*	*
	5	*	*	*	4	0.125	0.25	*	*
	6	*	*	*	7	*	*	*	*
	7	*	*	*	1.375	*	*	*	*
	8	*	*	*	4	*	*	*	*

Figure 1. Number of permanent plots containing *Kummerowia striata* by sampling year.

