Final Report for:

Center for Invasive Plant Management

Seed Money Grant

Landscape-Level Impact of Invasive Smooth Brome on a Native Prairie Plant, *Spartina pectinata* and Native Invertebrates

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Proposal

Invasive plants, once established, have the potential to significantly alter the distribution and abundance of native floral and faunal species. Historically, research related to the impacts to native faunal communities has focused on small, single-scale observations and experiments. Very little research has focused on the impacts of invasive plants on native communities across a range of spatial scales. The few studies that are available all suggest that spatial scale can strongly influence the strength and nature of invasive species effects on native communities. Therefore multiple spatial scales studies have become a critical issue when developing a comprehensive understanding of how invasive species affect native communities. Also, when assessing the impacts of and control methods for invasive plants, it is critical to understand the mechanisms that allow them to become invasive in the first place.

Research was conducted in the tallgrass prairies of eastern North Dakota in the Kelly Slough National Wildlife Refuge. In order to determine what biotic and/or abiotic mechanism influence the successful establishment and spread of invasive species we (my PhD student, Forrest Dillemuth, and I) conducted a seedling establishment experiment using native prairie cordgrass (*Spartina* pectinata), a dominant grass species, and invasive smooth brome (*Bromus inermis*). If brome is highly invasive, we hypothesized that (1) brome would have higher germination rates than cordgrass under a wide range of habitats (i.e. cordgrass dominated, brome dominated and a mixture of native grass species) and abiotic conditions (i.e. soil elevation, moisture, and nitrogen); (2) after initial germination, brome would outcompete and displace native cordgrass; and (3) brome would have greater reproductive success and produce significantly more viable seed than cordgrass. In a second experiment, we examined the impact of brome on the prairie arthropod community at three different spatial scales -- within a prairie fragment, among prairie fragments within a watershed and among watersheds. We know from past research that brome can have significant negative effects on native cordgrass specialist and their predators. Although all of our previous work focused on small scale ($< 10\ m^2$) and we have not clear assessment how brome may affect these species at larger scales. The following hypotheses were evaluated in order to get a clear grasp on the effects of smooth brome across this region: (1) densities of the cordgrass specialists, *Prokelisia crocea* and *Ischnodemus falicus*, would decrease with increasing coverage of brome, whereas and the densities of generalists would increase with an increase in coverage of brome; (2) the effects of smooth brome on arthropod (generalist and specialist) assemblages would decrease as fragment size increases and fragment isolation decreases; and (3) effects of smooth brome on arthropod assemblages would be reduced as the densities of prairie fragments increase.

The goal of our proposed research was to collect preliminary data for a long term project that will help researchers and/or land managers understand what characteristics of a habitat make it vulnerable to invasion and what are the biological aspects of an invasive plant that allow for the successful invasion into non-native communities. Finally the proposed research took a multi-scale approach to understand the ecological effects that an invasive plant has on the native arthropod community.

Results

Biotic and/or abiotic mechanisms responsible for the establishment and spread of smooth brome

Hypothesis 1: Brome will have higher germination rates than cordgrass under a wide range of habitats (i.e. cordgrass dominated, brome dominated and a mixture of native grass species) and abiotic conditions (i.e. soil elevation, moisture, and nitrogen).

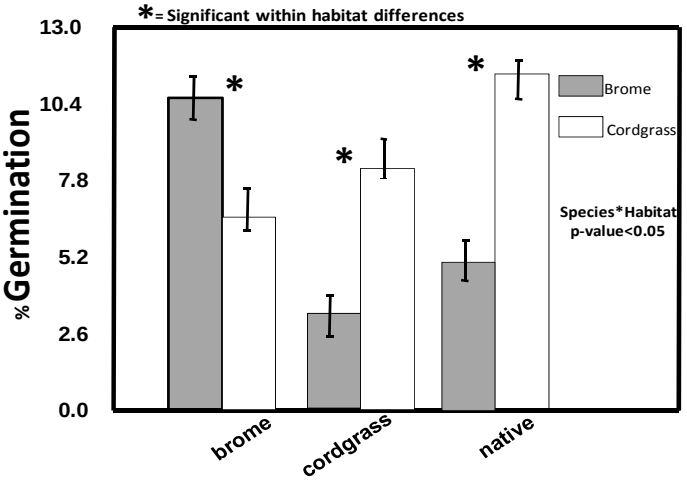

Figure 1: Results from ANOVA testing for plant species and habitat differences in the percent germination (i.e. dependent variable) of brome and cordgrass. There was a significant species*habitat interaction (F = 37.008, p< 0.05) indicating that percent germination varied by habitat for these two species.

There was a significant species by habitat interaction in all habitats indicating percent germination of each species differed between habitats (fig 1). Cordgrass seeds had higher percent germination in cordgrass and native habitats whereas brome only had higher germination in brome dominated habitats. These results are inconsistent with our initial hypothesis and indicate that successful brome establishment into previously uninhabited areas is not contingent on it having higher germination rates than cordgrass.

Hypothesis 2: After initial germination, brome will outcompete and displace native cordgrass.

After 1.5 growing seasons there was a significant species* habitat interaction indicating that the average number of stems for each species was dependent on habitat type (fig 2). Again, our results did not support the hypotheses - brome did not outcompete and displace cordgrass in any habitat type. Brome had stem densities equal to cordgrass in cordgrass and native-dominated habitats, but it performed far better than cordgrass in brome-dominated habitats. We note here, however, that this experiment is still on-going, and that results may change in the future.

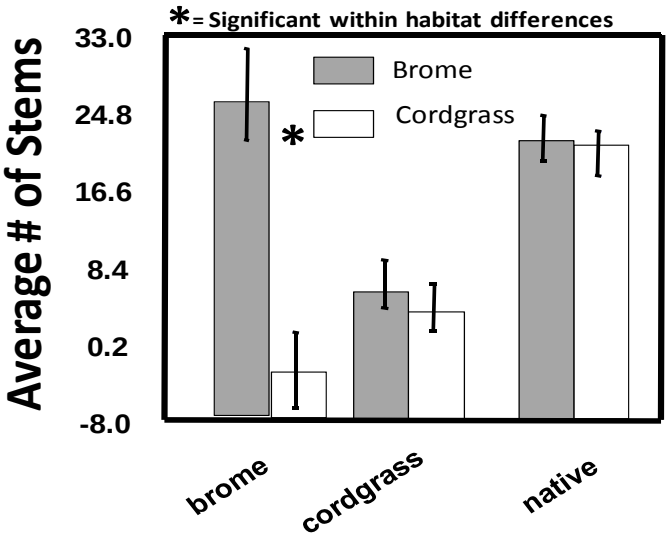

Figure 2: Results from ANOVA testing for species and habitat differences in the average number of stems. There was a significant species*habitat (F = 9.866, p, 0.05) interaction indicating that stem densities varied by habitat for these two species. There was also a significant elevation effect (F = 4.447. p< 0.05).

Hypothesis 3: Brome will have higher reproductive output than cordgrass.

By the end of the second growing season there was a highly significant difference in flower production between cordgrass and brome in all habitats (fig 3). Brome was capable of flowering in all habitats but cordgrass did not flower during the course of this experiment. These results indicate that brome is capable of higher seed production than cordgrass across all habitat types (at least early in the establishment phase). This high level of fecundity compared to the native species may contribute to brome's ability to establish into new areas.

Multi scale effects of smooth brome on native arthropod communities

For this study, we initiated an arthropod sampling program for 15 different prairie fragments divided among three different watersheds. These fragments varied in their relative abundances of brome and cordgrass. The first two censuses were obtained in June and August of 2007. Currently, the arthropods in these collections are being sorted and identified. This is a long tedious process that will take several months to complete. An additional pair of samples will be collected next summer. We believe that this work will provide much needed information on the impact that brome has on arthropod communities

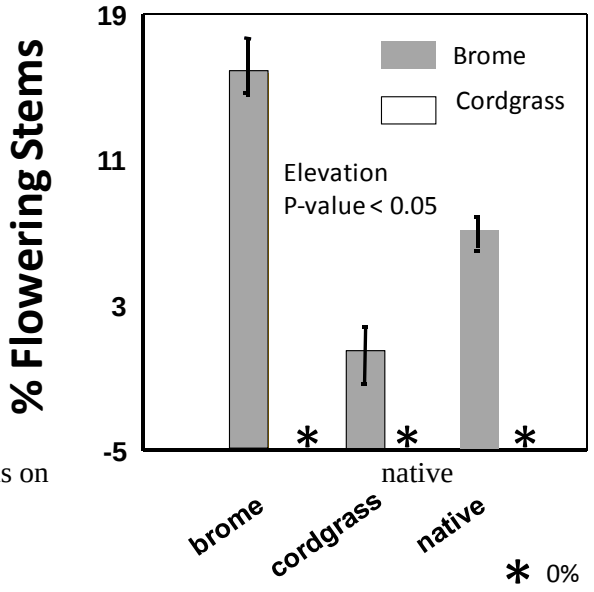

Figure 3: Results from ANOVA testing for species and habitat differences in the percent flowering stems. Again we did find a significant species*habitat interaction (F = 15.442, p<0.05).

Publications and Presentations

To date we have written one manuscript on this research and anticipate at least two more manuscripts will be written in the next year. The completed manuscript focuses on the biotic and abiotic mechanisms influencing the successful establishment and spread of invasive smooth brome. Our plan is to submit this manuscript to *Ecology* before the end of this year. Findings from this study also were recently presented by Forrest Dillemuth at the annual meeting of the Ecological Society of America (August 2007, San Jose, CA). The second manuscript is expected to be completed by late fall 2008 and submitted to *Biological Invasions*.

Long-term objectives for this research

Our long-range goal is to quantify the spread and impact of brome on native prairie-plant communities at a regional spatial scale. This will be accomplished by using spatial imagery to build a GIS database that incorporates infested areas and areas free from brome invasion. Along with insight gained from the research outlined in this report, we hope to develop a risk-assessment model for brome invasion, and pinpoint areas where management efforts may be most effective.

This is an important issue because the Midwestern United States currently has millions of federal dollars spent every year in the Conservation Reserve Program (CRP). Land that is protected under CRP is left

idle and not farmed in order to protect the integrity of the soil and water quality (Hydrologic integrity). Since its inception, CRP has become one of the largest potential sources of conservation for tallgrass prairies within the United States. Unfortunately, because much of the land is left idle and is not actively managed, it has left the door open for many agriculture crops to invade native prairie remnants. We feel that it is critical to understand how current land use policies and practices are influencing native communities. This information should assist in the development of ecologically sound management practices that will protect the hydrologic integrity of the region and allow native floral and faunal communities to flourish.

Benefits of seed money

Funds from the Center for Invasive Plant Management were critical to the successful completion of this research project. These funds enabled us to purchase a D-ac insect vacuum system which was needed for obtaining standardized arthropod samples. These samples will be used to explore how invasive species impact native communities from a small scale (i.e. within prairie) to a regional level (among watersheds), and to determine which prairie fragments are in critical need of management action. Furthermore, funds from this grant were used to analyze soil samples. These data were a necessary component of our studies on the abiotic tolerances of brome.

This project also benefited from the assistance of three undergraduate students at LSU. These research \assistants included two minority students (1 African-American and 1 international student from Africa) and 1 veteran of the United States Coast Guard attending college on the GI Bill. Each of these students participated in the field work in North Dakota and in the laboratory research at LSU, and has earned a co-authorship on manuscripts that will derive from this work. This research project provided the students with an opportunity to develop skills in experimental design, data collection, data analysis and manuscript preparation, all of which will be critical in their future careers as biologist. Seed money from CIPM played no small role in allowing us to initiate this project, and therefore, providing research opportunities for these students.