Ecological Impacts of Invasive Reed Canary Grass (Phalaris arundinacea)

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Introduction

Exotic or invasive species, including plants, have been identified as one of the most serious threats to native flora and fauna (Wilcove et al. 1998). Invasive plants in particular can become a major ecological problem when they displace native flora and dominate the local vegetation, thereby earning the reputation for negatively affecting community and landscape level biodiversity and ecological integrity. Negative reputations for decreasing biodiversity are largely attributable to anecdotal observations of highly visible, monoculture-forming invaders (Ortega and Pearson 2005). However, even for these most conspicuous invasions, biodiversity effects in any given habitat remain largely unquantified in systematic or comprehensive ways (Parker and Reichard 1998; Parker et al. 1999; Levine et al. 2003).

In Illinois, an aggressive cultivar of reed canary grass (Phalaris arundinacea) (RCG) is one of the most pervasive non-native species in wetlands, especially in northern and central parts of the state (Spyreas et al. 2004). Once reed canary grass invades a site, it tends to dominate the ground cover to the detriment of other wetland plant species. Although the negative effects of this invasive cultivar on native wetland plants are well known, ecological effects likely cascade through other trophic levels as well. The ecological costs of reed canary grass on phytophagous arthropods, birds, and small mammals have not been substantially investigated.

Few studies have measured the effects of invasive plants on multiple taxa and other trophic levels (Sax et al. 2005, Parker et al. 1999). In particular, the effects of invasive plants on insect/arthropod diversity have not been extensively investigated (Tallamy 2004); most observations are anecdotal or focus on how native insect herbivores affect the plants. If sites that are dominated by reed canary grass have lower productivity of arthropods than sites with more diverse cover of native plants, or reduce the local diversity of arthropods (e.g., Siemann et al. 1998), these effects also could harm higher trophic levels. Songbirds, for example, typically rely on insects to raise their nestlings, and studies have linked the quality and quantity of insect food supply to nest success (e.g., Burke and Nol 1998, Zanette et al. 2000). Availability of arthropods also could affect insectivorous small mammals such as shrews and mice. Although reed canary grass provides ample cover, it is not known whether dominance by this species affects the abundance of herbivorous small mammals such as voles and bog lemmings. Small mammals, in turn, are important prey for many carnivorous species such as hawks, owls, snakes, and carnivorous mammals. These potential ecological costs of dominance by reed canary grass have not been examined. Given the pervasiveness of reed canary grass in Illinois and the speed by which it continues to spread and replace native vegetation, assessing the potential ecological impacts to wildlife should be a priority.

Objectives

This study will have three main objectives:

1) To compare abundance and diversity of arthropods in areas dominated by reed canary grass versus areas with more native vegetation
2) To compare bird use of reed canary grass dominated areas to that of areas with more native vegetation
3) To compare abundance and species composition of small mammals in patches dominated by reed canary grass versus patches dominated by more native vegetation

Study Areas

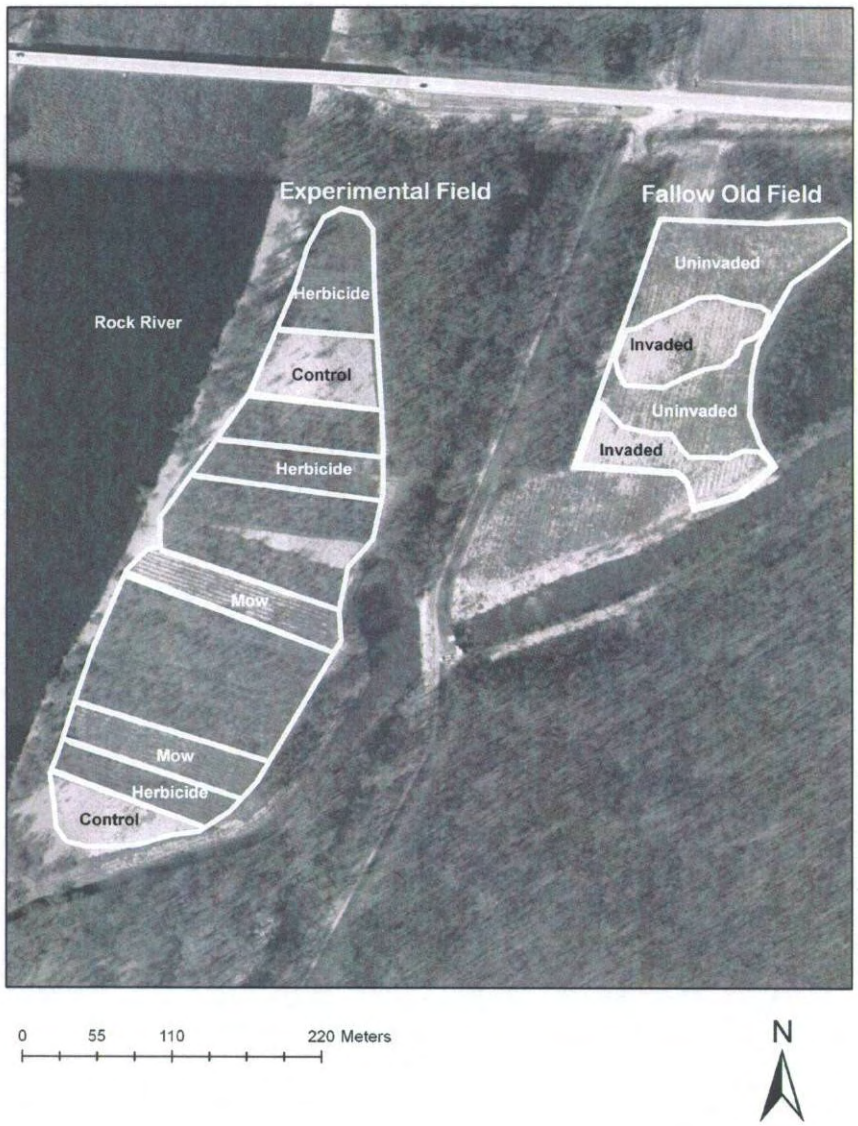
The experimental portion of the study was conducted in the summer and fall of 2005 on two former agricultural fields in the floodplain of the Rock River, Henry County, Illinois (41.5542°N, 90.1835°W) (Figure 1). The fields are the subject of two different approaches to investigating reed canary grass invasion, comparative plots (i.e. invaded vs. uninvaded) and experimentally manipulated plots. Semi-annual floods regularly submerge part or all of these fields, which are entirely underlain by hydric soils (Sawmill silty clay loam and Milford silty clay loam).

The first field (6.1-ha) was in crop production until 1997 when treatments were established from bare soil. This experimental field (EXP) comprises parallel strips (≈0.4-ha each) directly abutting the river channel (Figure 1).The strips were assigned to one of two treatments or a control. Seven of the original 15 strips were selected for use in this study: two control strips, three mowed/herbicided strips and two mowed strips. Mowed/herbicided blocks were mowed and herbicided twice annually with glyphosate from 1997 to spring 2004, and during sampling in 2005 reed canary grass was essentially absent from these strips. The mowed strips were intermittently mowed a total of three times until 2004, but they were not sprayed with herbicide. Reed canary grass was present in a patchy distribution in these. The control block was allowed to revegetate without mowing or herbicide application. They supported almost 100% reed canary grass cover, as is common in moist, fertile, wetlands with a history of disturbance in the region. All reed canary grass was volunteer.

The second field (FOF) (≈4.3-ha) is near the EXP field but further from the river channel. This fallow old field (FOF) was cropped until 2001 when it was allowed to re-vegetate naturally from bare soil. It was mowed annually in early fall (after sampling in 2005). At the onset of the study in 2005 it consisted of mixed, herbaceous vegetation with two large, discrete, patches of reed canary grass interdigitating within it. Because these patches are discrete and are evidently contiguous with a larger colony of reed canary grass outside the study area, it appears that these colonies appear are invading rhizomatously into the FOF. Because the reed canary grass within the FOF comprises a clear boundary or "front" of invaded (≈100% cover) vs. uninvaded vegetation (RCG tillers absent or sparse), we were able to delineate perpendicular strips of similar

vegetation through the FOF to sample. The two strips not dominated by reed canary grass were directly adjacent to and alternating with two strips characterized by complete reed canary grass cover.

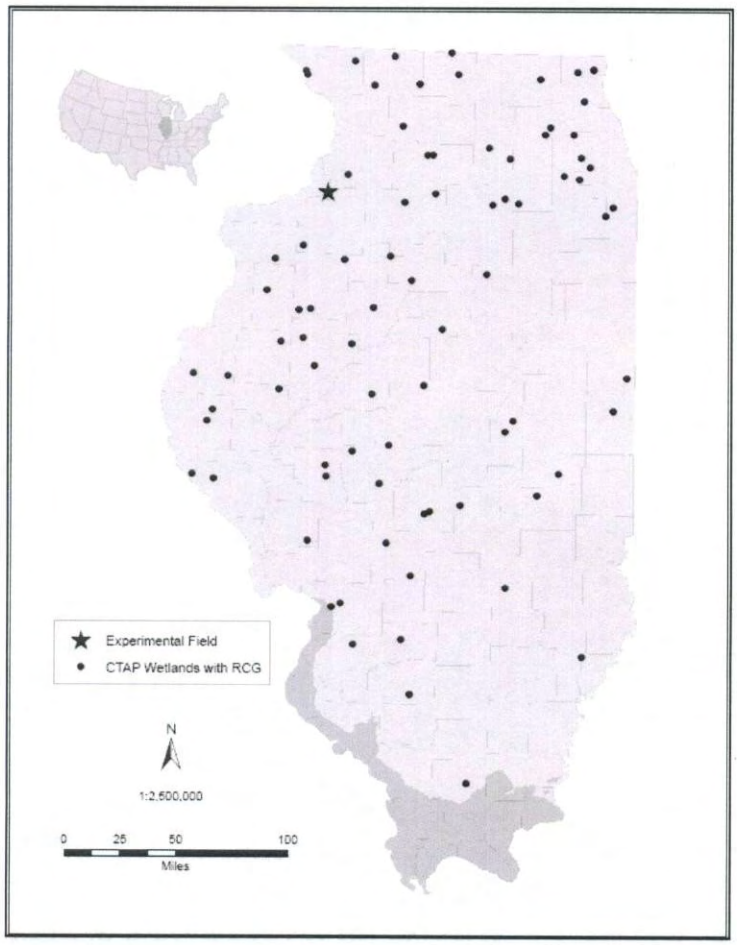
Figure 1. Aerial photograph of local study site taken in 2005. Borders of the experimental plots (EXP) and the fallow old field (FOF) are outlined, along with lines demarcating sampling units through which transects were run. RCG invaded areas clearly stand out as white.



In addition to the experimental portion of study, selected data from the Critical Trends Assessment Program (CTAP), an ongoing statewide habitat monitoring project

(IDNR 2001), was used for comparative purposes. CTAP data is collected from across Illinois (Figure 2), however to ensure a level of physiographic and biogeographic similarity to experimental fields, only CTAP wetland study sites in the glaciated, prairie region of Illinois containing reed canary grass and having arthropod data were used. A subset containing 57 CTAP sites was used.

Figure 2. Distribution of 82 wetlands containing RCG used in CTAP landscape. Experimental field location for local study is also shown. Darkened southern portion of the state which is outside of the tallgrass prairie region was excluded from analysis because of its dissimilar floristic community.



Methods

Vegetation Sampling

Vegetation sampling occurred over two site visits. Summer sampling was done from June 28th through June 30th, and the fall sample from September 8th through September 10th. Two or three transects (depending on the patch length) were established in parallel lines through the treatment strips (EXP) and patches (FOF) (bearing approximately east-west, perpendicular to the river channel). These were separated from each other by at least 15m. From seven to 15 sample points were placed along transects at 20m intervals, the first point being 10m from the transect beginning to avoid edge. The southwest corner of a 1-m^2 quadrat was placed at the sample point; from which percent cover of each plant species, and total plant cover for all stems rooted inside the quadrat was recorded. Woody vegetation greater than 1m tall was excluded. Botanical nomenclature follows Mohlenbrock (1986).

Reed canary grass cover and plant species richness comparisons were made using plot means and simple summary statistics. Pearon's product moment correlations of reed canary grass cover and plant species richness were conducted on both the EXP and FOF combined.

Arthropod Sampling

Arthropods were sampled by making 100 sweeps with a standard sweep net through the middle of each patch. Sweeps were conducted concurrent with vegetation sampling. Arthropods were transferred from the sweep nets into PTOIE's (Photo Tactic Optimal Insect Extractors) and allowed to sit for between 45-60 minutes in the shade to allow arthropods to separate themselves from duff (leaves, seeds, sticks, etc.). Those attracted to light drop into a small collection bag (whirl-pac®) filled with 70% ethyl alcohol. Samples are then transferred to vials of fresh alcohol to await processing.

Arthropods were sorted and identified using the "morphospecies" or "morphotype" approach. Using this approach, specimens are sorted based on distinctive morphological characteristics, generally corresponding to the order level (e.g., grasshoppers, beetles, lepidopterans, spiders, mites), and then distinctive looking specimens within the orders are totaled to come up with an abundance and richness measure. Because these putative characteristics remained unnamed, the morphospecies approach disallows positive species identification limiting true comparisons of community compositions. However, morphospecies counts do provide a convenient means for estimating and comparing species richness and diversity among sites (Burger et al. 2003).

Comparisons of total arthropod and individual "morphospecies" abundances and species richness were made using sampled means and simple summary statistics. Correlations between reed canary grass cover and total arthropod and Homopteran abundances and species richness were made using Pearson's product moment correlations for both the experimental data and CTAP data. Homotera was the selected focal "morphospecies" because of corresponding available CTAP data.

Bird Censuses

Birds within the EXP and FOF fields were censused three times during 2005, 22 June, 29 July and 30 August. For each census day, each patch was scanned with binoculars during the morning at ten minute intervals for two hours. All birds encountered were identified to species and enumerated. Any nests encountered were also recorded.

Small Mammal Sampling

Small trapping occurred concurrent with vegetation sampling during the fall only. Each patch was live trapped for 2 nights with fifty Sherman live traps set along vegetation transects, 5 m apart, and baited with sunflower seeds. Traps were set on the afternoon of September 7th, checked the following morning and reset if necessary, checked the afternoon of day 2, and checked a final time and removed on the morning of day 3. Captured small mammals were marked by a small fur clip to identify recaptures and released at the capture sites after being identified.

Abundances in the two dominant mammal groups (voles and white footed mice) were grouped, and along with total mammal abundance, these values were correlated with patch RCG cover using Pearson's product moment correlations. Recaptured animals were ignored in the analysis.

Results and Discussion

Vegetation

As was assumed for the basis of this study, reed canary grass was most prevalent in the control area of the EXP field and in the invaded portion of the FOF (Figure 3). Within the control area of the EXP field, RCG cover was a very high, exceeding 90%. The invaded portion of the FOF had RCG cover of about 70%. The uninvaded area of the FOF had virtually no reed canary grass.

As expected, plant species richness was highest in the uninvaded portion of the FOF and lowest in the control area of the EXP field (Figure 4). Within the control area, RCG has virtually formed a monoculture, very few other plant species are present. This pattern is to be expected and is commonly known and previously reported from other studies (Morrison and Molofsky 1998, Galatowitsch et al. 1999, Perkins and Wilson 2005, Apfelbaum and Sams 1987). Data from this study show a strong negative correlation between plant species richness and reed canary grass cover (Figure 5). As reed canary grass cover increased within parts of the study area, plant species richness decreased. Although this relationship has been well documented in the past, it is nonetheless of great importance. Here in Illinois, reed canary grass is particularly prevalent across the northern half of the state, dominating a large percentage of the wetlands in this region (Spyreas et al. 2004). This prevalence of reed canary grass, has,

undoubtedly, already had a tremendous negative impact on wetland plant communities. Continued spread of this exotic, invasive grass will only cause more serious problems.

Figure 3. Reed canary grass cover (+/- 1 SE) in both the EXP and FOF fields, 2005.

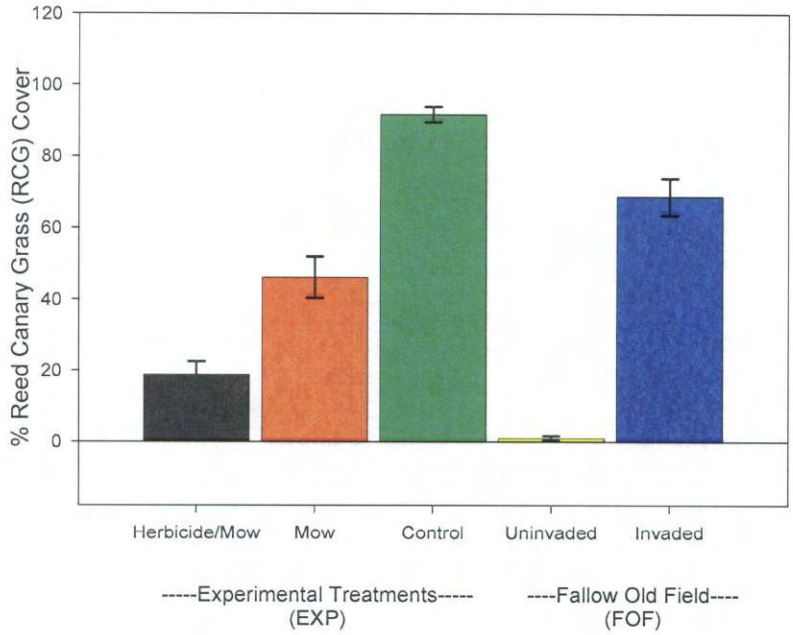


Figure 4. Plant species richness (+/- 1 SE) in both the EXP and FOF fields, 2005.

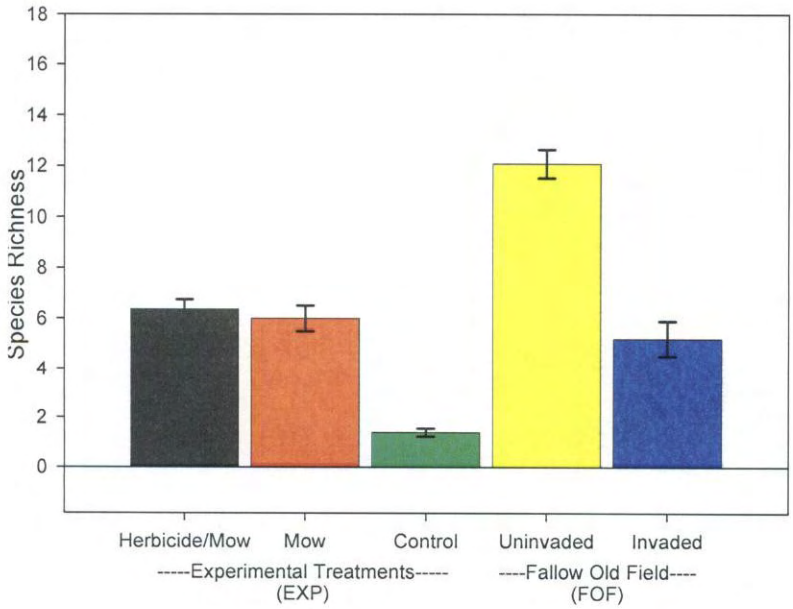
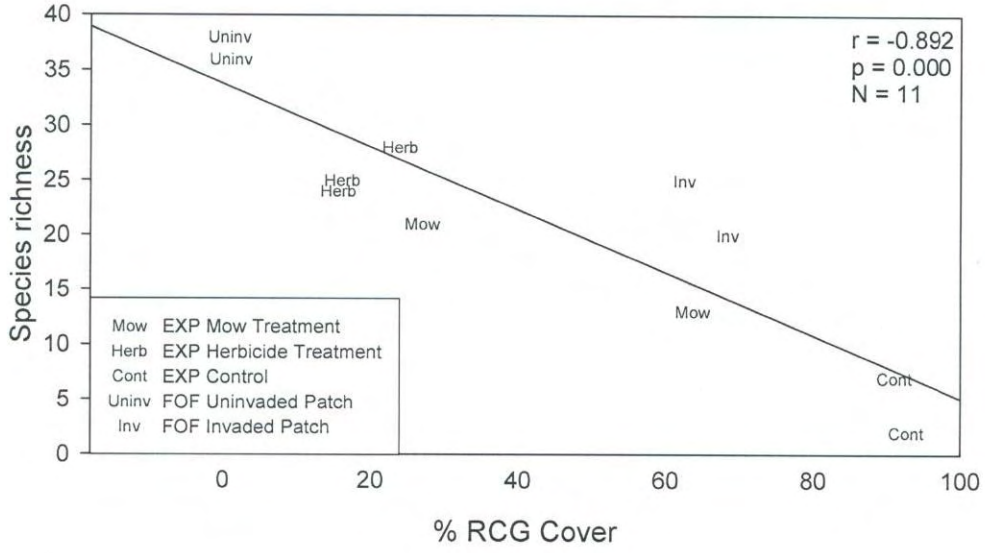


Figure 5. Pearson's product moment correlation of reed canary grass cover and plant species diversity in both FOF and EXP fields combined. Lines of best fit are shown.



Arthropods

Highest overall total arthropod abundance and richness were both found in the area with the most native vegetation (and the least RCG), the univaded portion of the FOF (Figure 6). The invaded portion of the FOF, although dominated by reed canary grass, showed greater total arthropod abundance and richness than any parts of the experimental field. Homoptera (leafhoppers and treehoppers) (Figure 6), as well as several of the other arthropod "morphotypes", showed a similar pattern (Figure 7). Within the RCG-dominated areas, abundance and richness of individual "morphotypes" varied greatly between the control areas of the EXP field and the invaded portions of the FOF (Figure 7). In the RCG-dominated control areas of the EXP field Coleoptera (beetles) showed the highest abundance and richness, followed by Hemiptera (true bugs). Hymenoptera (ants, wasps and bees), Diptera (flies), and Homoptera were most prevalent in the RCG-invaded portion of the FOF. Although these two areas are both dominated by reed canary grass, the control area of the EXP field was virtually a monoculture of RCG; this was not the case in the invaded portion of the FOF, where RCG was less dominant and the plant community more native and more diverse.

When looking at total arthropod abundance and richness within both the EXP field and the FOF, however, a clear trend was evident. As reed canary grass cover increased within the study area, both total arthropod abundance and richness decreased (Figure 8). The same pattern is evident when look solely at Homoptera in this study, decreasing abundance and richness with increasing reed canary grass (Figure 9). Comparing Homoptera data in this study to those observed for Homoptera in 57 CTAP wetlands from around Illinois, the same trend is seen, decreasing abundance and richness

with increasing prevalence of reed canary grass (Figure 10). The correlations are not as strong in the CTAP data as are in this study, but the same trend is evident. No significant trend, however, was found when comparing total arthropod numbers with reed canary grass cover in the CTAP data.

Based on results from this study, and partly supported by data from CTAP, an overriding trend appears evident, as reed canary grass increases within a plant community, arthropod abundance and richness decrease. This result is not unexpected, especially with reed canary grass invasions causing major plant community composition changes. As noted earlier in this report, results from this study and others indicate a decrease in plant species richness with increasing prevalence of reed canary grass. This is especially obvious when RCG forms virtual monocultures, displacing virtually all other vegetation. In these situations in particular, it seems obvious that RCG would negatively impact the arthropod/insect community. Some individual insect or arthropod species, or even an individual "morphotype" might showed increase numbers in reed canary grass dominated communities. Some insects or arthropods may be specialists on RCG, similar to certain agricultural insect pests. However, it seems clear that as a general trend, dominance of reed canary grass within a plant community and the corresponding displacement of other native plant species has a deleterious effect on the overall arthropod/insect community. This can be of particular importance to wildlife who depend on these arthropod/insect communities. Included among these animals, are small mammals (particularly shrews), amphibians, reptiles, and songbirds. Although most songbirds rely heavily on seeds for food throughout much of their life, arthropods/insects are vital for reproduction. Songbirds rely heavily on arthropods/insects as a high calorie, high protein food source for egg laying and reproduction. These animals are also a vital food source for nestlings after hatch as well. Large-scale changes in the wetland arthropod/insect community in Illinois due to loss of the native wetland plant community to reed canary grass could have serious deleterious affects on all of these wildlife groups.

Figure 6. Abundances and richness for total arthropods and the Homoptera "morphotype" from both the EXP and FOF fields, 2005.

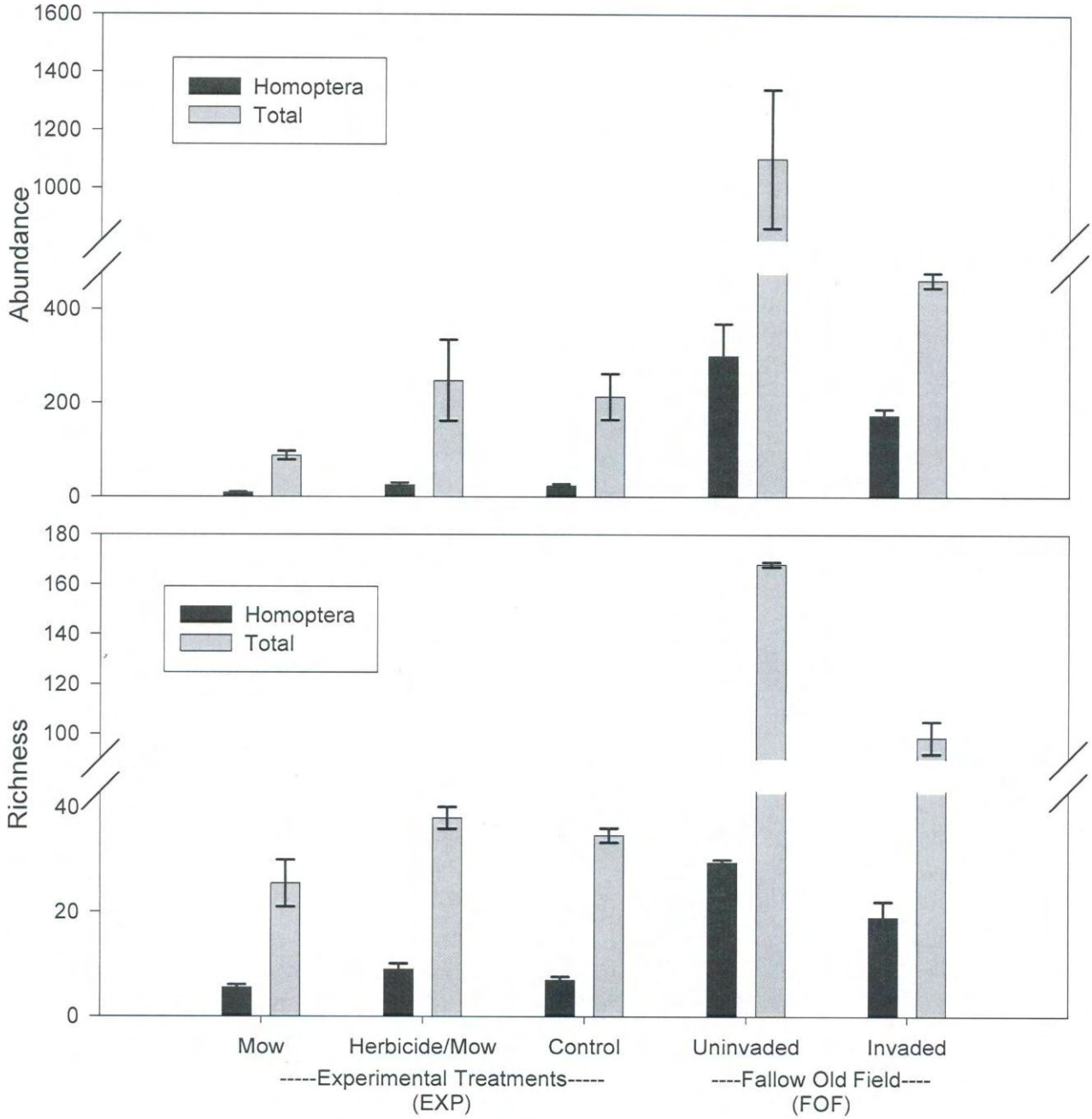


Figure 7. Abundances and richness for arthropod "morphotypes" from both the EXP and FOF fields, 2005.

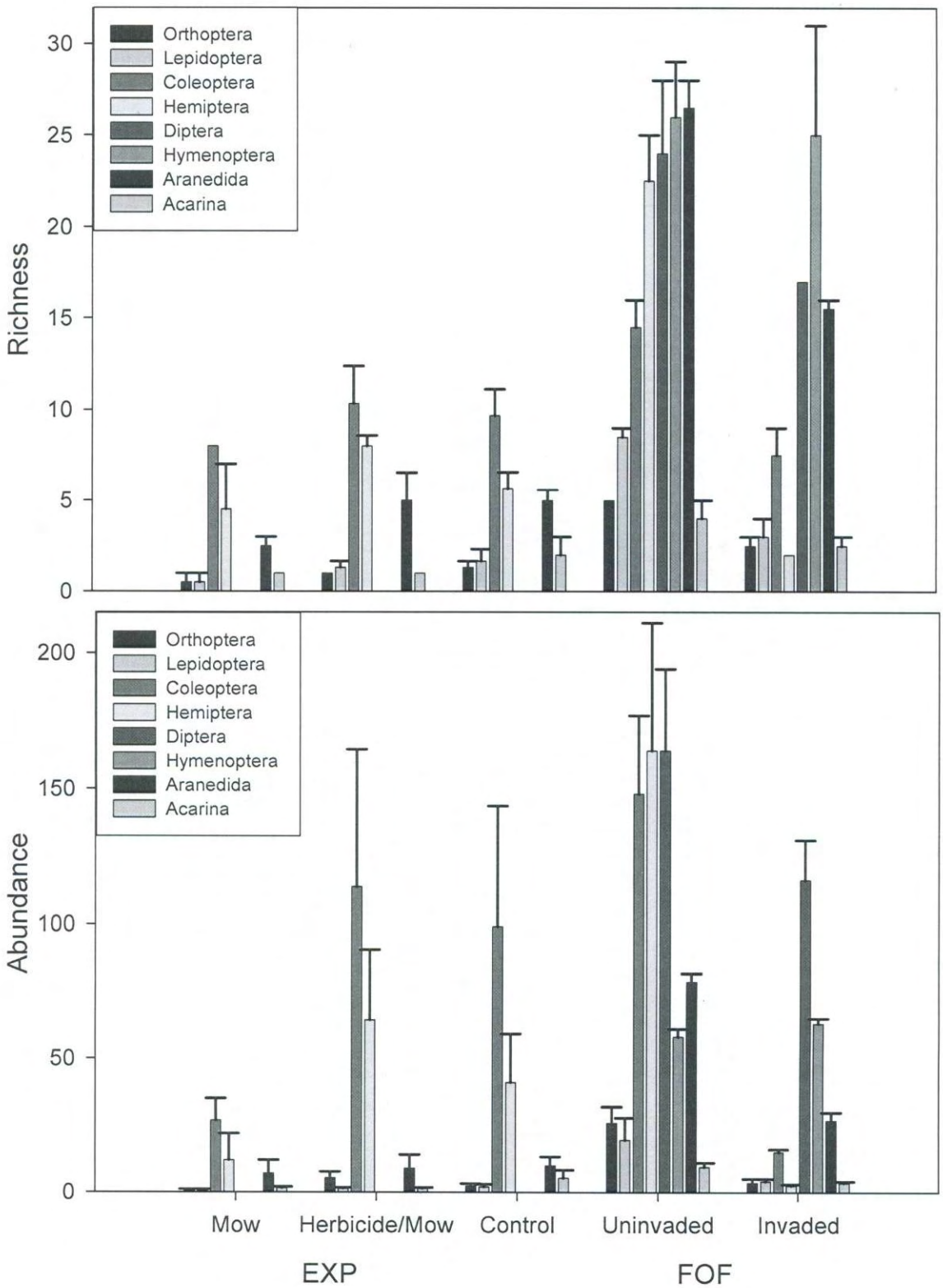


Figure 8. Pearson's product moment correlation of RCG cover and insect community measures in both FOF and EXP fields combined. Richness determinations are based on morphospecies groupings. Totals are for all insect and two Arachnid orders. Lines of best fit are shown. Correlation coefficient's (r) are as follows: total arthropod abundance -0.586, p= *0.058*; total arthropod richness -0.697, p= *0.017*. N= 11.

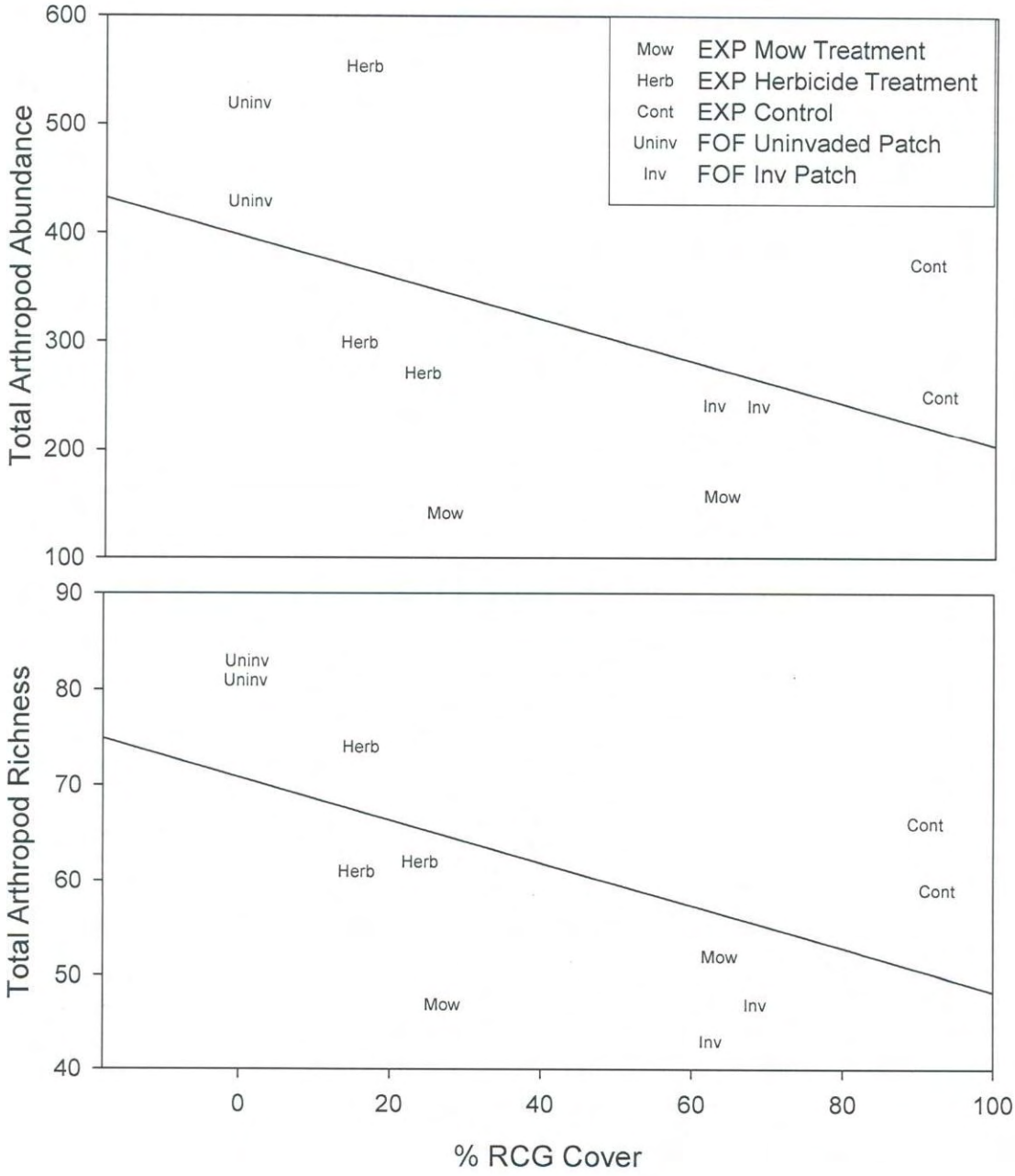


Figure 9. Pearson's product moment correlation of RCG cover and Homopteran community measures in both FOF and EXP fields combined. Lines of best fit are shown.

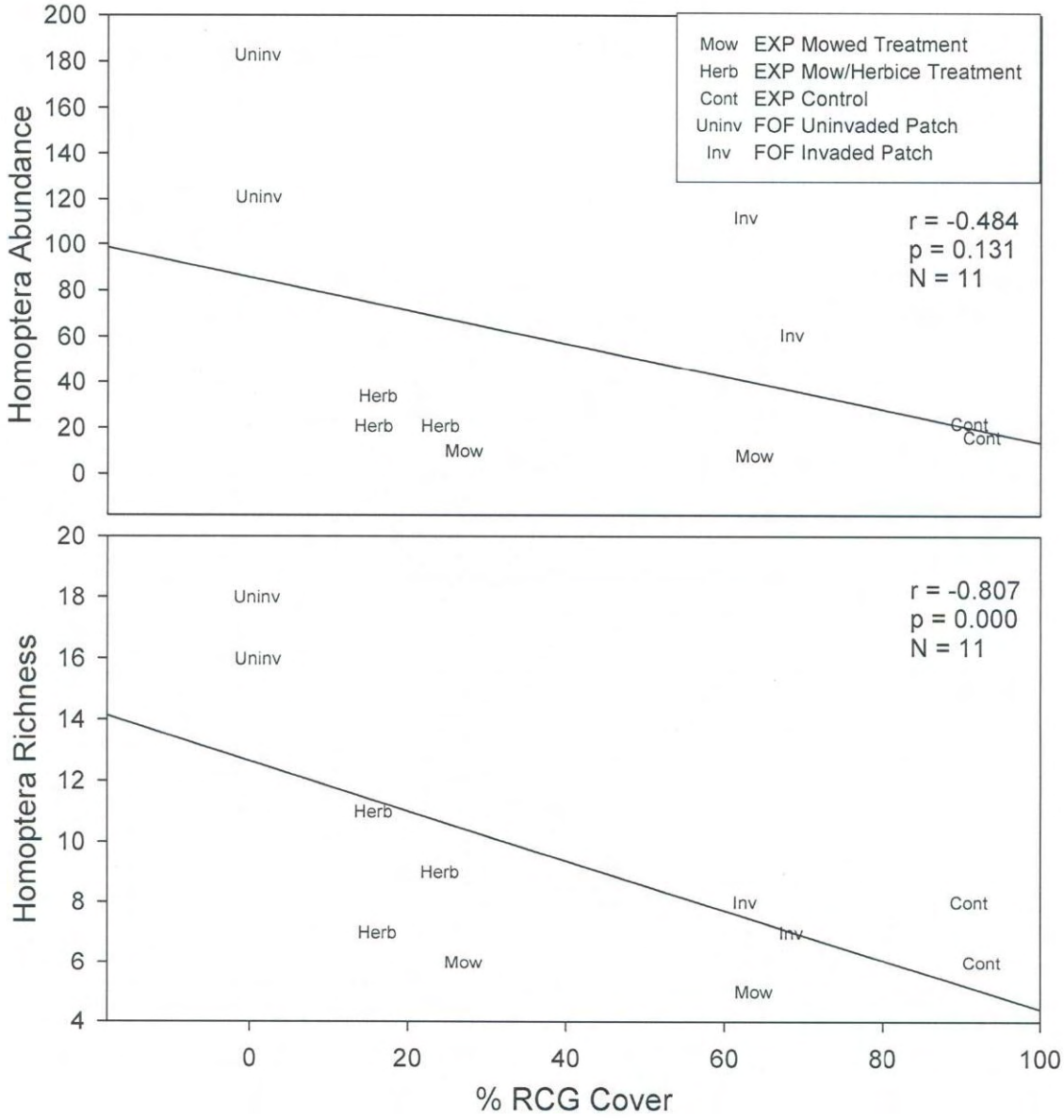
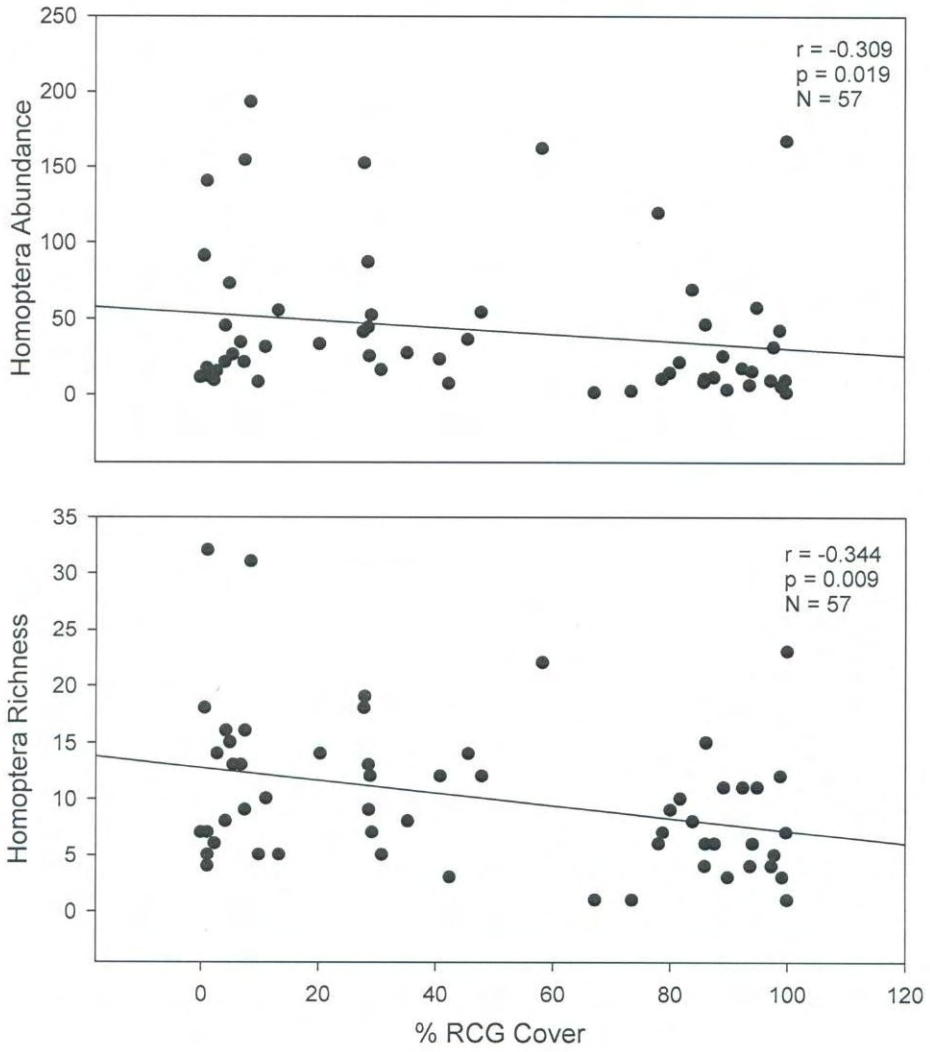


Figure 10. Pearson's product moment correlation of RCG cover and Homopteran community measures for CTAP wetlands across Illinois. Lines of best fit are shown.



Birds

Seventeen species of birds were observed during the three sampling periods (Table 1). Red-winged blackbirds (*Agelaius phoeniceus*) were the most numerous species observed. Other common species, in descending order of prevalence, were house wren (*Troglodytes aedon*), indigo bunting (*Passerina cyanea*), song sparrow (*Melospiza melodia*), American goldfinch (*Carduelis tristis*), and common yellowthroat (*Geothlypis trichas*). Because sampling did not occur for the first time until late June, a true evaluation of bird nesting could not be determined; several observations were noted however. Red-winged blackbirds were the most common nester. The only other nesting species observed was the Baltimore oriole (*Icterus galbula*), identified from a single nest. Several unidentified old nests were also observed. Overall, nests were common, found in

both the experimental field and the FOF. Within the experimental treatment area, nests were scattered among various treatments, but were particularly common in the control area heavily dominated by reed canary grass. All of these nests appeared to be red-winged blackbird nests, a common marsh nesting species, even in marshes dominated by reed canary grass (Cunningham 2005, Ozesmi et al. 2006). The thick stands of reed canary grass provided very good cover for the nesting blackbirds.

No patterns in bird use based on the prevalence of reed canary grass could be determined. Based on observations during field sampling, it was determined that individual treatment patches within the experimental treatment field (EXP) and individual patches within the fallow old field (FOF) were too small to legitimately evaluate bird use. Birds freely flew between patches and observing them in a given patch at any given time was often little more than a random occurrence. Much larger patches would be needed to truly comparatively evaluate bird use.

Table 1. Total birds observed during avian censuses, June-August, 2005.

Common Name	Scientific Name	Number Observed
Mallard	*Anas platyrhynchos*	1
Wild Turkey	*Meleagris gallopavo*	1
Mourning Dove	*Zenaida macroura*	3
Ruby-Throated Hummingbird	*Archilochus colubris*	2
Northern Flicker	*Colaptes chrysoides*	1
House Wren	*Troglodytes aedon*	35
American Robin	*Turdus migratorius*	1
Gray Catbird	*Dumetella carolinensis*	1
Common Yellowthroat	*Geothlypis trichas*	7
Field Sparrow	*Spizella pusilla*	2
Song Sparrow	*Melospiza melodia*	10
Nothern Cardinal	*Cardinalis cardinalis*	4
Indigo Bunting	*Passerina cyanea*	32
Red-Winged Blackbird*	*Agelaius phoeniceus*	60
Baltimore Oriole*	*Icterus galbula*	4
American Goldfinch	*Carduelis tristis*	10
House Sparrow	*Passer domesticus*	1

* - indicates observed nesting species

Small Mammals

Six species of mammals were captured during our trapping session for small mammals in September 2005 (Table 2). White-footed mice (*Peromyscus leucopus*) were the most commonly captured species, followed by prairie voles (*Microtus ochrogaster*)

and northern short-tailed shrews (*Blarina brevicauda*). Within the experimental field (EXP), the largest numbers of captures occurred in the control, RCG-dominated plots (Figure 11), although these were not significantly greater than numbers captured in mowed plots. Fewer captures occurred in mowed/herbicided plots. This pattern was principally attributable to the abundance of voles (*Microtus*) in the RCG-dominated plots. In the fallow old field (FOF), the numbers of captures of all small mammals were highest in the uninvaded plots where there was very little or no reed canary grass (Figure 12). High numbers of white-footed mice principally accounted for this pattern. As in the EXP plots, voles were prevalent in the invaded, RCG-dominated patches, but their numbers were lower than in the RCG-dominated patches of the EXP plots.

Table 2. Total small mammal capture results, 2005.

Common Name	Scientific Name	Number Captured*
Shorttail Shrew	*Blarina brevicauda*	28
Longtail Weasel	*Mustela frenata*	1
White-Footed Mouse	*Peromyscus leucopus*	142
Prairie Vole	*Microtus ochrogaster*	76
Meadow Vole	*Microtus pennsylvanicus*	8
House Mouse	*Mus musculus*	1

* - excludes recaptures

Species composition of small mammal assemblages responded clearly to the presence of RCG. As the percent cover of RCG on a plot increased, the abundance of voles (*M. ochrogaster* and *M. pennsylvanicus*) increased (Figure 13). These species are grassland specialists (Hoffmeister 1989), and RCG provided thick vegetative cover and a bed of thatch that is very attractive to voles (Lin and Batzli 2001). The lower density of voles in the FOF plots compared to the EXP plots is likely due to the old field being drier, as indicated by the shorter stature of the RCG present and sparser, less lush herbaceous cover overall. *M. pennsylvanicus* in particular prefers more mesic grassland habitats, and this species was only captured in the EXP plots. Whether monocultures of RCG provide good quality forage for herbivorous voles and can support populations year round remains to be determined. Our study plots were small, so access by small mammals to surrounding vegetation would be possible, and our study also represents a single snapshot in time. Abundance and persistence of voles in larger wetlands with more extensive areas that have become dominated by RCG should be examined before conclusions are drawn that RCG provides good habitat for voles. However, areas of RCG certainly were not a "biological desert" as far as small mammals were concerned at the time of our survey.

White-footed mice, in contrast, were most abundant in the plots where RCG cover was lowest (Figure 13). These plots offered vertical cover but more open space at ground

level (i.e., no dense cover by thatch). White-footed mice are habitat generalists, but prefer woody, brushy, or weedy habitats and typically do not occur in grasslands in substantial numbers unless these areas are near woody habitats or are invaded by shrubs and saplings. Our study plots were all close to woody habitats, and all had some invasion by shrubs or saplings, thus white-footed mice were captured on all plots. The greater abundance of white-footed mice in plots with greater cover of native plant species could be due to habitat selection based on type of cover, but could also reflect differences in resource availability. White-footed mice eat mainly seeds, fruit, and arthropods, and rely much less than voles on green vegetation. Arthropods were more abundant in the plots with lower cover by RCG, and the greater diversity of native plants in those plots probably offered a greater variety of seeds and fruit as well. Voles are competitively dominant to *Peromyscus* mice as well, so aggressive interactions between these species may also play a role in the habitat segregation that we observed.

The response of northern short-tailed shrews to RCG was less clear. Greater numbers of short-tailed shrews were captured in plots with more RCG in the EXP areas, but this pattern was not repeated in the FOF plots. Perhaps the more xeric FOF fields were less preferred habitat for shrews in general, and an influence of RCG was only observable in the more mesic EXP plots where overall abundance of shrews and voles was greatest.

Thus, in our study, invasion by RCG produced a trade-off in small mammals: white-footed mice decreased in abundance, but this was compensated for by an increase in voles. How this change in species composition might affect foraging success of carnivorous mammals, birds, or snakes in extensive areas of RCG invasion would be a good subject for future study.

Figure 11. Small mammal abundances (mean +/- 1 SE) in experimental blocks (EXP), 2005.

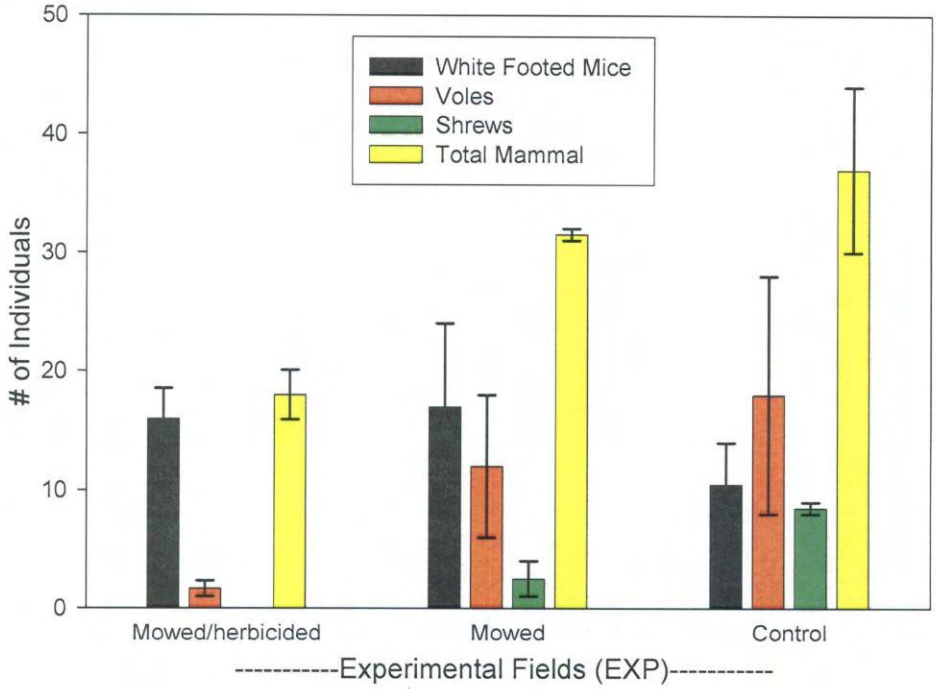


Figure 12. Small mammal abundances (mean +/- 1 SE) in fallow old field patches (FOF), 2005.

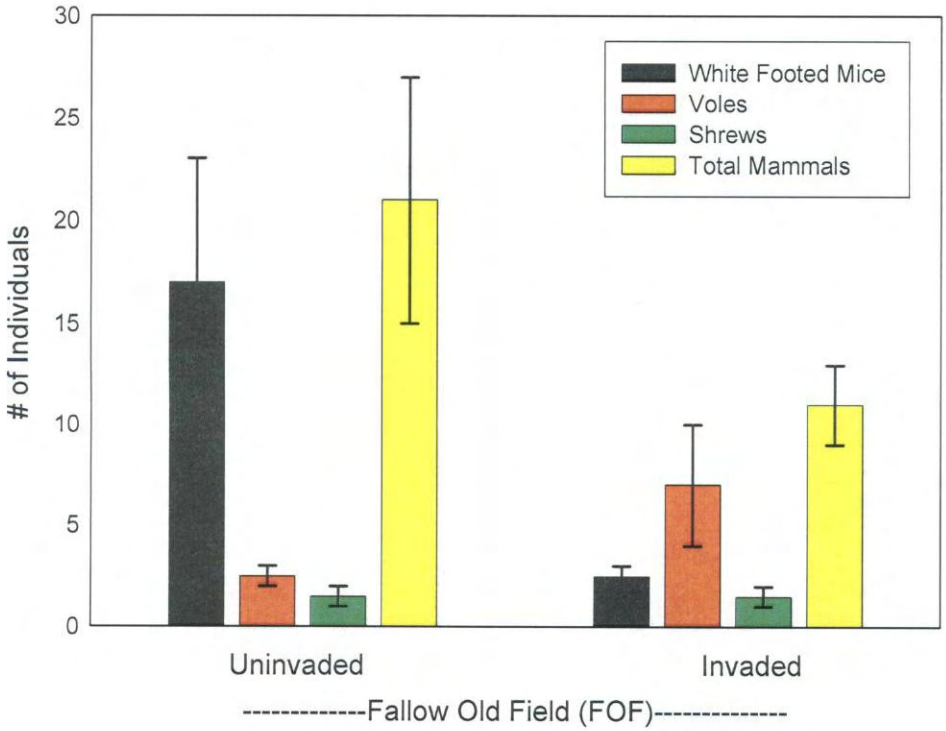
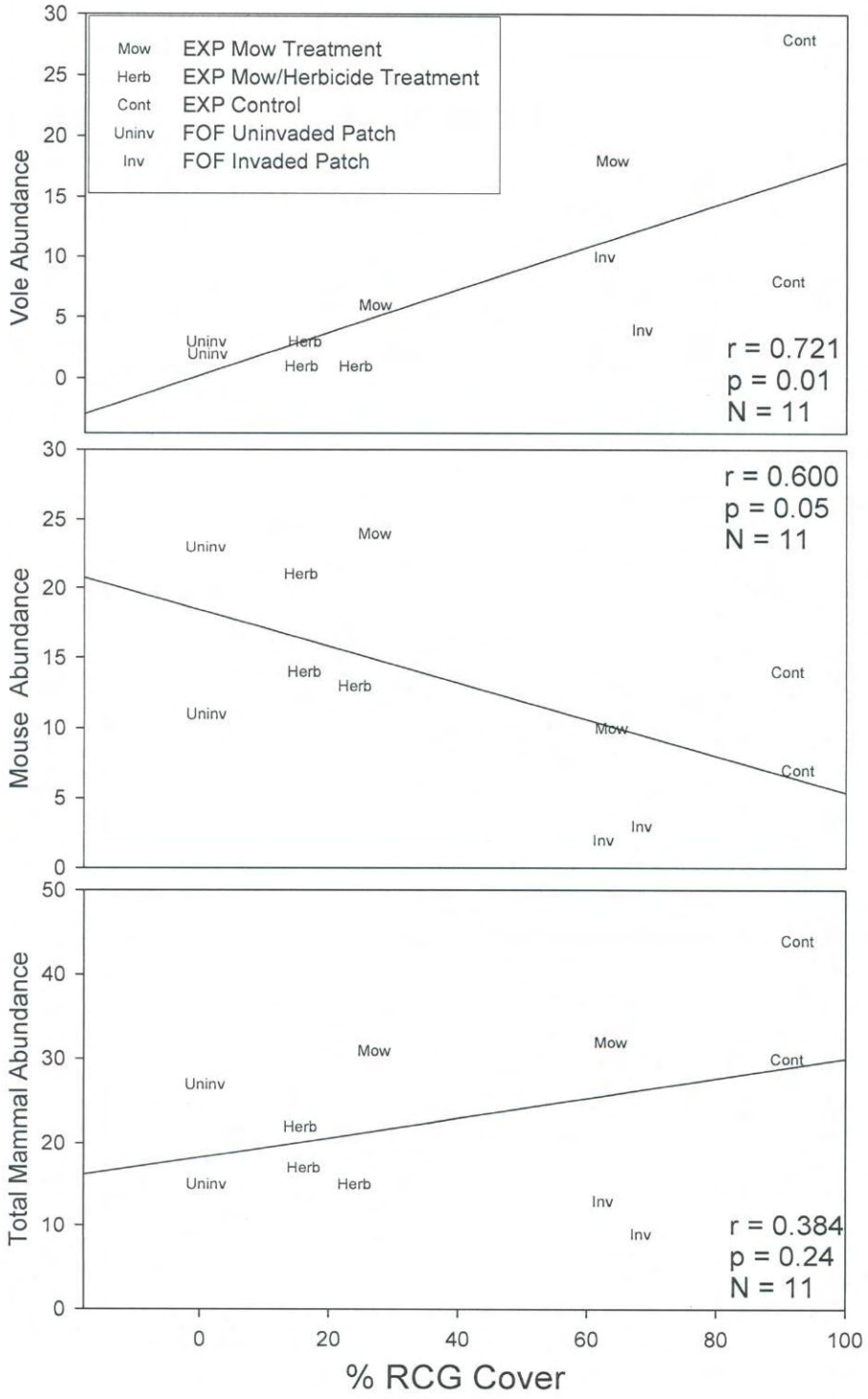


Figure 13. Pearson's product moment correlations for reed canary grass cover and mammals in both the fallow old field (FOF) and the experimental fields (EXP) combined. Lines of best fit are shown.



Summary and Conclusions

Reed canary grass impact on various trophic levels within a community was investigated in this study with mixed results. As expected, reed canary grass appeared to have a strong negative affect on plant species community composition. Areas dominated by reed canary grass showed the lowest plant species richness. Also, a significant trend of decreasing plant species richness with increasing reed canary grass cover was found. These results are not new and similar results have been reported in other studies (Morrison and Molofsky 1998, Galatowitsch et al. 1999, Perkins and Wilson 2005, Apfelbaum and Sams 1987). This subsequent alteration in the native wetland plant community due to the presence and prevalence of reed canary grass is the underlying cause of other potential affects on arthropods, birds, and small mammals.

Highest arthropod abundances and richness were found in the univaded area of the fallow old field (FOF). This area had the greatest amount of native vegetation and almost no reed canary grass. The invaded portion of the FOF, although dominated by reed canary grass, showed greater total arthropod abundance and richness than any parts of the experimental field. This pattern was also true for several individual arthropod "morphotypes". True comparisons involving the experimental field (EXP) are difficult given the disturbed nature of the habitats there. Mowing and herbicide treatment in the past have resulted in a plant community unlike that which would naturally occur. Many non-native, exotic, annual species, many of them common agricultural weeds, are prevalent throughout these disturbed communities. Therefore, it is likely not just the amount of reed canary grass that is present that is driving the composition and population of the arthropod community. However, even given this issue, there was a definite negative correlation between total arthropod abundance and richness and the amount of reed canary grass. As RCG cover increased within the study area, both total arthropod abundance and richness decreased. This trend was also noted for the focal "morphotype", Homoptera. Comparing these results to those from the statewide CTAP data set, Homopterans also showed a similar trend, decreasing abundances and richness with increasing levels of reed canary grass. No trend, however, was evident when looking at total arthropod abundance and richness versus RCG cover in the CTAP data set. Although results from this study cannot be considered definitive, results indicate at least supportive evidence that reed canary grass prevalence has negative impacts on the arthropod community.

Patterns in bird use within the study area could not legitimately be determined, due to the small size of individual areas within both the EXP and FOF fields. Birds were observed freely flying between patches and observation within a given patch was almost a random occurrence. Simple censuses revealed red-winged blackbirds to be the most common species in the study area and they were commonly observed in areas dominated by reed canary grass. Within the reed canary grass patches, red-wings were common nesters as well, as reported in other studies (Cunningham 2005, Ozesmi et al. 2006). Although statistical analysis and general comparisons were not possible in the study, it was apparent that red-winged blackbirds thrived in reed canary grass patches. However, the effect of RCG on other bird species was not so readily apparent. Given the RCG-

associated, large-scale changes in the native plant community normally found in wet meadows and marshes across the northern half Illinois, undoubtedly impacts to the avian fauna have occurred. Unfortunately, because of the small patch sizes in our study, impacts to the bird community could not be evaluated.

Results from the small mammal trapping and analysis were mixed for the three most prevalent groups of animals. Voles, grassland specialists, were most prevalent in areas dominated by reed canary grass. White-footed mice, more of a habitat generalist, were most common in the patches with the least amount of reed canary grass. Northern short-tailed shrews were more often captured in plots with high amounts of RCG in the experimental field, however, this pattern was not observed in the FOF. One confounding factor may have been that the FOF appeared to be significantly drier than the EXP field. This moisture difference definitely could have affected small mammal populations and may possibly explain the conflictive pattern of habitat use apparently shown by shrews. Another confounding factor was once again patch size, particularly within the EXP field. Patches were small enough that significant movement between differing areas likely occurred on a regular basis. Although no overall trend in small mammal populations as a whole could be found in this study, it was apparent that even thick patches of reed canary grass were significantly utilized by small mammals.

Although results found in this study are far from conclusive, significant insight into the effects of reed canary grass on varied animal taxa was reached. Results from this study have already been presented at the American Society of Mammalogists' national meeting and are scheduled for presentation and the Natural Areas Conference. Presentation is also expected at the Society of Wetland Scientists annual meeting, the annual conference on Ecosystems Restoration and Creation, and the annual Environmental Horizons conference held at the University of Illinois. A scientific manuscript is also in preparation. Much additional research on this subject is, however, needed. The prevalence of reed canary grass, often as a near monoculture, in wetland areas across the northern half of Illinois is a serious ecological problem. Drastic alterations of wet meadow and marsh plant communities have assuredly had impacts on associated animal groups. Unfortunately, limitations in our study area, particularly the small patch sizes, limited our results. Obviously, larger sample sizes would be greatly beneficial as well. A large-scale study of large RCG dominated wetlands in Illinois compared to remaining relatively natural wetlands of similar size would be of great value. Undoubtedly, impacts to arthropods, birds, and mammals have occurred as a result of RCG-caused plant community change that were not apparent, or at least not verifiable, in this study. This research is strongly needed, particularly here in Illinois where we have lost well over 90% of our historical wetland acreage (Suloway and Hubbell 1994). Now, as much the remaining wetland area is being degraded and altered by reed canary grass, this research is of paramount importance.

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Appendix A. Photographs of study area, Henry County, Illinois.

Figure A. Control area of experimental field (EXP) - almost 100% reed canary grass.

Figure B. Mowed and herbicided area of experimental field (EXP) - low reed canary grass cover.

Figure C. Mowed area of experimental field (EXP) - moderate reed canary grass cover.

Figure D. Uninvaded area of the fallow old field (FOF) – almost 0% reed canary grass.

Figure E. Invaded area of the fallow old field (FOF) – high reed canary grass cover.

Project Benefits and Outcomes

Numerous wildlife species and plant species valued from this research on the highly invasive, exotic reed canary grass (Phalaris arundinacea). Specifically, all of the arthropods/insects, birds, and small mammals discussed in this report benefited, as did all other animals or native plants occurring in wet meadows, wet fields, and marshes in the northern half of Illinois, the habitats under threat because of the invasion of reed canary grass.

This research is of use to land managers and wildlife managers throughout Illinois or anyone potentially dealing with the problem of reed canary grass. Even for the general public, it is important that word be spread about the issues of reed canary grass and its degradation of the limited wetland habitat in Illinois and its possible impacts on wildlife. Knowledge to the general public could help result in mobilization against the reed canary grass problem.

Outcomes of this study have already included a presentation at the American Society of Mammalogists national meeting and another is scheduled at the Natural Areas Conference. Several other presentations are anticipated and a scientific manuscript is in preparation.