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Quantifying granivory in a reconstructed prairie: affects of season, species, seed predators, sacrificial food, and the chemical deterrent capsaicin

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QUANTIFYING GRANIVORY IN A RECONSTRUCTED PRAIRIE: AFFECTS OF SEASON, SPECIES, SEED PREDATORS, SACRIFICIAL FOOD, AND THE CHEMICAL DETERRENT CAPSAICIN

An Abstract of a Thesis

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In Partial Fulfillment

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ABSTRACT

Floral diversity of reconstructed prairies is often low compared to remnant prairies. Studies have demonstrated it is feasible to increase forb diversity in these prairies through overseeding and mowing, but overall rates of seedling establishment range from 0.1% to 1% of sown pure live seed. One explanation may be the ubiquitous populations of granivorous animals eating much of the seed . In this thesis I measured the amount of granivory occurring in a reconstructed prairie. I also tested how season, seed species, seed predator, sacrificial food, and chemical deterrents affect granivory in the reconstructed prairie. I hypothesized that granivores remove significant amounts of seeds broadcast onto an established grassland, and vertebrate and smaller granivores would prefer different species of seeds. A third hypothesis was that granivores would influence seedling establishment and it would be possible to reduce granivory through the addition of a sacrificial food or a chemical feeding deterrent. To answer these questions I glued a known number of seeds to sandpaper cards, apply various treatments to the seeds or their surroundings, and count the remaining seeds over the following weeks. The first experiment to quantify levels of seed predation involved *Silphium integrifolium*. During the summer of 2006,seed cards were randomly placed in 16, 5 x 5-m plots. At the whole-plot level, the plots were treated with the addition of a sacrificial food (*Helianthus annus*). At the within-plot level, the seeds were treated with the chemical capsaicin. I assessed the rate of removal of these seeds over an 18 day period. During the fall of 2006, this experiment was repeated with modifications. The sacrificial food and capsaicin treatments were at the whole-plot level and one of three species (*Silphium integrifolium*, *Dodecatheon meadia*, and *Phlox pilosa*) were at the within-plot level.

Seeds of these species were broadcast during the fall of 2006. During the spring of 2007, seedlings were counted the following spring and analyzed to detect if the amount of granivory the previous fall affected seedling establishment.

Small wire mesh exclosures were built to test for the difference in granivory by vertebrate and invertebrate granivores. Seeds of *Ratibida pinnata*, *Sorghastrum nutans*, and *Dalea purpurea* were placed inside on seed cards and their rate of loss was recorded.

Seed losses across trials ranged from 60% to over 98%. Significant factors included the time of year, predators involved, and species of seed. It was possible to reduce granivory in some cases. Capsaicin-treated *D. meadia* seeds yielded 2.1x as many seedlings as untreated seeds. Addition of sacrificial food also significantly ($p=0.0006$) reduced the amount of seed loss in Summer 2006 but not Fall 2006. There were significant ($p<0.0001$) differences between the species studied during the Fall Trial as well as the exclosure study. Granivory can be a driving force in the establishment of new plant species as a significant ($p=0.01$) correlation between seed predation from the time of seeding and seedling emergence the following spring for *D. meadia* was detected.

From these results, I have concluded granivory is an important factor in plant establishment within reconstructed prairies. I also found it is possible to reduce granivory, possibly increasing the success of a seed addition.

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Entitled: Quantifying Granivory in a Reconstructed Prairie: Affects of Season, Species, Seed Predators, Sacrificial Food, and the Chemical Deterrent Capsaicin

has been approved as meeting the thesis requirement for the

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

The grassland biome of North America was the largest of the four major land biomes on the continent. This biome covered an estimated 3.5 million square kilometers, stretching from northern Mexico into Canada and from the Mississippi River west to the Rocky Mountains (Savage 2004). This study was performed in Iowa on what was the eastern edge of the historical 68 million hectare tallgrass prairie region. The original General Land Office surveys indicated that tallgrass prairie covered 79.5% of Iowa, translating into 28.6 million of the states 36 million total acres (Smith 1998). With less than 0.1% remaining, government agencies, not-for-profit conservation groups, and individuals are attempting to recreate of tallgrass prairies across the Midwest.

One concern of prairie restoration has been the difficulty in restoring the floral diversity that is characteristic of native remnant prairies (Palmer et al. 2006), if this level of achievement is even possible. Initially, many reconstructions may contain only a few dozen species compared to the 100-300 found in native prairies (Kindscher & Tieszen 1998, Sluis 2002, Martin et al. 2005). Sluis (2002) found an average of 72 species in 1-m^2 quadrats in remnant prairies, whereas an eight year-old reconstruction yielded 40 species at the highest composition. This difficulty in establishing new species not only affects species diversity, but population numbers as well. Williams et al. (2007) broadcast 350 seeds/m^2 of pure live seed onto a reconstructed prairie and never observed more than 52.4

seedlings/m^2. There must be one or more mechanisms at work reducing the number of emerging plants from otherwise viable live seed.

The initial plant composition is a critical factor in the future development of a reconstruction (Menninger & Palmer 2006). Restoring a tallgrass prairie is a test of how well we understand the processes involved in a prairie ecosystem (Bradshaw 1990). An analogy of this is would be taking apart a machine, describing each part and understanding the function of the parts in the machine. Ecology attempts to study the parts of the prairie and determine how each part functions in the prairie as a whole. Restoration is a means of testing our ecological understanding. If the pieces of the prairie can be put together in working order, we gain in our understanding of prairie ecology. Of course, a more thorough test would be to take a degraded prairie with missing pieces and restore a fully functioning ecosystem. (Bradshaw, 1990)

This present study seeks understanding the basic processes fundamental to the tallgrass prairie, particularly the role of granivory in shaping the plant community. This review will explore the impact granivory has on tallgrass prairie vegetation and the difficulty granivory poses to establishing new plant species in prairie reconstruction. This review will also review studies that manipulate seed predation occurring in a restoration or reconstruction project. First, the amount and source of granivory occurring in the tallgrass prairie will be explored. Studies describing how seed predation can influence the floristic composition of the prairie will also be reviewed. Next, techniques that have attempted to reduce granivory in a variety of systems are reviewed and this information will be synthesized to determine what techniques could have success in a tallgrass prairie.

Finally, I assess what research is still needed in prairie reconstruction and introduce the hypotheses guiding this present study.

One possible explanation for the relative lack of species in a reconstruction compared to a remnant may be the ubiquitous populations of granivorous and herbivorous small mammals (Howe et al. 2002). Because of small mammals' ubiquity, some researchers have suggested that rodents play a larger role in shaping the floral community than large ungulate grazers (Howe & Brown 1999, Howe & Brown 2001). Many rodents are granivores and have been found at densities of more than 49 animals/hectare (Borchert & Jain 1978). They have the potential to consume massive amounts of seed in grasslands.

The large input of seeds sown in a reconstruction can increase the population of rodents (Wolff 1984, Hulme 1994, Hulme & Hunt 1999). Increasing granivores would increase the potential damage to sown seeds. The problem is compounded by the fact many granivores are selective in what they eat (Louda 1989, Huntly 1991, Moles et al. 2003, Howe & Brown 2000). The selective removal of certain seeds leads to the depression of some species while allowing others to flourish. In the Chihuahuan desert using fine mesh fences to exclude kangaroo rats, Heske et al. (1993) found that the rodents significantly suppressed the cover of several annual grasses by eating their seeds as well as physical disturbance of the soil. With the rodents excluded, these species expanded their cover. Howe & Brown (2000) found that *Microtus pennsylvanicus* significantly reduced the abundance of *S. integrifolium* seeds in a reconstructed Wisconsin prairie. The absence of this physically large seed and the resulting plant reduced plant competition and allowed an increase of several smaller seeded species, including, *Aster laevis, Ratibida pinnata,* and *Astragalus canadensis*. By eliminating or at least reducing the amount of seed predation occurring in a tallgrass prairie, reconstruction could be improved by increasing the amount of seeds germinating and thus increasing the amount reaching the mature flowering stage.

Amount and Source of Granivory in Prairie Reconstructions

Seed predation is a process caused mainly by small mammals and granivorous insects such as ants and beetles (Mares & Rosenzwieg 1978, Auld & Denham 1999). Many species have adapted to exploit granivores as a seed dispersal vector (Janzen 1971). Evidence of this can be seen with edible fruits containing toxic or distasteful seeds (Harper 1977), and seeds that require passage through the digestive tract of a granivore to germinate (Harper 1977). Seed predation may be the price paid by the parent plant to ensure successful dispersal and placement of seeds by granivores (Janzen 1971). The problem with seed predation related to reconstruction is the lack of seed input over time. Some plant species may rely on seed dispersal by granivores and typically experience heavy seed predation in most years. Typically, in a seed planting there is a one-time input of a large number of seeds. If the vast majority of a species' seeds are consumed, the establishment of that species can be impeded. Furthermore, seeds that germinate often do not reach maturity (Williams et al. 2007). In an existing prairie, with a large diverse population of flowering plants, however, there is the potential for annual additions of seed. Over the course of several years some viable seeds will eventually escape predation.

Although the amount of seed predation varies across spatial and temporal scales, the chance is there for the near elimination of all seeds in a prairie reconstruction. Anderson (1989) measured a seed loss of between 93% and 97% of four species of long-lived perennials in southern Australia woodlands. Heithaus (1981) also confirmed high levels of predation when he lost up to 82.5% of unprotected seeds in an eastern U.S. deciduous forest. This was a combined loss from both rodents and ants. Heithaus (1981) tested for the source of seed removal by placing seeds within a wire cage to exclude rodent predation or placing them on a pedestal that ants were unable to climb. Ants alone removed 51.6% of seeds, whereas rodents alone removed 58.1% of seeds. This is consistent with the no loss of seeds of *Sanguinaria canadensis* in dishes protected from both rodents and ants. In a species-poor grassland in the U.K., seeds were placed in Petri dishes and exposed to rodents for ten days. After that period, the dishes were collected. Seed loss ranged from 6% for dishes protected from rodents, but allowing insect access, to 85% loss in dishes open to rodents (Edwards & Crawley 1999).

Granivore Selectivity

Numerous studies have indicated that predation is not uniform across all species, but can have a selective effect on which species are removed and which species remain (Borchert & Jain 1978, Reader 1993, Howe & Brown 2000, Howe et al. 2002, Hoffman et al. 1995). Much of this selectivity is for larger seeds with more calories (Inouye et al. 1980, Howe et al. 2002), or seeds lacking defensive mechanisms, chemical or physical (Traba et al. 2006, Chambers & MacMahon 1994, Kelrick & MacMahon 1985).

Prairie seeds vary in size from the near dust of *Veronicastrum virginicum* (28,219 seeds/g) to the thumbnail sized *Silphium laciniatum* (23 seeds/g) (Prairie Moon Nursery 2007). Typically, granivores prefer larger seeds, as the granivore obtains more calories and nutrients per unit time spent collecting the seed (Whitford 1978, Kelrick & MacMahon 1985). For example, if a small mammal or ant is going to spend 10 minutes searching for a seed, it is much more beneficial to eat a large, calorie rich seed than smaller, less energy packed seed. This strategy has been supported in several studies on individual foraging behavior (Kelrick & MacMahon 1985, Janzen 1971, Chambers & MacMahon 1994, Auld & Denham 1999). Although some species, such as *V. virginicum* are too small (Heredia & Detrain 2005) to be detected by granivores, thus escaping predation, many other species fall within a size range that could be detected by ants or rodents or both. Seeds smaller than 0.4-mg were undetectable by the ant species *Messor barbarus* (Harvester ant) (Heredia & Detrain 2005), indicating a lower limit of seed size these ants were capable of harvesting. One could also assume then, the upper limit of seed size is determined by the individual granivore's ability to carry a large seed. This strategy must end with a net caloric benefit. Although smaller seeds can still be consumed, the granivore must have a net energy gain to remain reproductively fit. If foraging uses too much time with little return, the organism will eventually starve. Therefore, the organism must maximize each calorie spent foraging by getting the best caloric return possible in order to maximize fitness (Kelrick & MacMahon 1985, Traniello 1989). This cost/benefit can be extended to include other characteristics such as seed appendages. Many seeds have pappi or awns. This creates an extra inedible layer a granivore must work through to get to the endosperm. The extra work lowers the caloric reward per time spent for that seed (Kelrick & MacMahon 1985, Whitford 1978). This result ultimately makes that particular type of seed less desirable.

The chemical composition can play a large role in determining whether a seed is a good food choice (Murray & Dickman 1994, Kelrick & MacMahon 1985). Granivores in different regions will select different seed traits for their food choice. When given a choice of seeds in cafeteria-style array rodents in areas such as the arid deserts of Australia, selected seeds with a higher water content over seeds with more fat or protein content (Murray & Dickman 1994). This differed from rodents in the wetter prairies of North America where the percentage of soluble carbohydrates was the leading influence of seed choice, as water was not as limiting of a resource (Kelrick & MacMahon 1985).

In addition, an important adaptation to avoid granivory is the plant's ability to produce an array of toxic or distasteful secondary compounds, especially in their seeds (Janzen 1971, Epple et al. 2004). Many plants protect their offspring by producing an array of cyanides, alkaloids, or saponoids as feeding inhibitors (Janzen 1971). These compounds make even the most nutritious and easily consumed seeds something to actively avoid.

Effects of Granivory on Plant Composition

If granivory is selective, the resulting plant community structure should be affected by granivory. There can be long-ranging effects incurred by rodent granivory. Seed predation can even direct the course of succession in reconstructions (Howe & Brown 2000). Sirotnak and Huntly (2000) found rodents altered nutrient dynamics by selectively feeding on legume seeds and plants. Through long-term monitoring Brown & Heske (1990, Heske et al. 1993) concluded the lack of heteromyid rodents in the Chihuahuan desert can be responsible for converting desert shrubland into grassland deserts through seed predation and physical disturbance. This change took place over a 13-year period beginning in 1979 when 24, 0.25-ha plots were fenced with a fine wire mesh to inhibit rodent movement. Within in the first ten years, some large-seeded winter annuals had increased by several thousand times within the exclosures. These changes in the plant community led to changes in the rodent community, as well as changes in bird behavior.

In established tallgrass prairies, plant recruitment is often <1 seedling/m^2, unless disturbance (fire, grazing, mowing) stimulates germination from seeds (Howe & Brown 2000). Rodents capable of removing 50-95% of seeds (Heithaus 1981, Sullivan & Sullivan 1982, Edwards & Crawley 1999, Nolte & Barnett 2000) have the potential to drastically reduce the amount of plant recruitment in a restoration or reconstruction. The plants we see on the prairie may be the leftovers of what rodents and other granivores do not eat.

Adapting Natural Seed Defenses for Reconstruction: Chemical Deterrence

If we understand how some species are able to escape seed predation and can apply this information to more vulnerable, one-time input seedings in a reconstruction, the survival of seeds and success of a seed establishment can be increased. Seeds containing toxic and distasteful compounds are actively avoided by most seed predators (Janzen 1971). Capsaicin is chemical derived from several species of plant in the genus

Capsicum. It performs as a powerful feeding deterrent towards invertebrates and mammals, while having no damaging effects on the granivores. Currently capsaicin is classified by the U.S. EPA as a biochemical pesticide for use as a repellent against deer, rabbits, squirrels, and insects. When in contact with mammalian tissue capsaicin binds to pain receptors triggering the same pathway as any other painful stimuli. Capsaicin is, however, especially painful when ingested. Capsaicin is a viable option as a feeding deterrent as capsaicin causes no permanent damage to the animal ingesting the chemical. (Curtis et al. 2000, Jensen et al. 2003)

Capsaicin has been shown effective as a feeding deterrent in a number of systems. Nolte and Barnett (2000) used a mixture of kaolin clay, latex, water, and oleoresin capsaicin to coat longleaf pine seeds. Applied at a concentration of 0.6-ml of capsaicin to 100-ml of water resulted a in similar SHU rating (Scoville Heat Units) as a habenero pepper. In a four-day laboratory test, mice damaged a significantly ($p=0.014$) smaller proportion of the capsaicin treated seeds compared to untreated pine seeds. How long the protection capsaicin could provide in a real world setting with seeds exposed to rain, wind, and humidity remained untested. However, this study did support the hypothesis that capsaicin could deter granivory.

In a 2003 study, Jensen and others dissolved capsaicin in blended fat and added to a standard poultry feed. Norway rats as well as mice significantly reduced their consumption of capsaicin treated feed. With feed at a rate of 2000 SHU, the consumption dropped from 109.8-g to 6.0-g overnight. This depressed feeding rate remained over the two-week trial with the treated feed. Over that period, on average, rodents consumed 97%

less treated feed than untreated feed. Within one day of returning to untreated feed, rodent consumption jumped back to 103.8-g. This is interesting as it indicated the rodents continually visited the feed and would turn away during the capsaicin trial, but could very quickly identify when untreated feed was returned. This is similar to findings found by Curtis et al. (2000). A birdfeeder was filled with a commercially available capsaicin treated birdfeed. This treatment reduced squirrel and chipmunk consumption from 215-g out of 600-g to 166-g out of 600-g after one week. Although showing convincing evidence of capsaicin deterring rodent granivory, the seeds were protected from the elements. They indicated nothing towards how well capsaicin protects after exposure to rain or other abiotic factors.

Capsaicin is biologically benign towards the seeds themselves. Gosling & Baker (2004) created a 0.05% solution of capsaicin in diethyl ether and applied 1-ml of the solution per 75-mg of seeds. Seeds were lab germinated according to the International Rules for Seed Testing. Capsaicin had no affect on the final seed viability of any of the species used (The concentration of capsaicin was not given in Scoville Units. Making comparisons to the concentration of capsaicin in previous studies is difficult since the studies used a different method of application). The results of these studies provides sufficient evidence to further explore the possibility of using capsaicin as a feeding deterrent.

Adapting Natural Seed Defenses for Reconstruction: Sacrificial Food

Many species of nut producing trees ensure survival of seeds by producing a large quantity of seeds in some years that granivores are satiated (Janzen 1971). As the granivores are unable to eat any more seeds, some seeds will survive. If this masting behavior could be mimicked using an inexpensive sacrificial food to satiate the seed predators, more seeds would be available to germinate in a planting. Kelly & Sullivan (1997) determined the New Zealand grass genus *Chionochloa* produced an overabundance of seeds in some years for satiating seed predators. During a ten-year study, they found seed predators were capable of coping with a moderate increase in seed production, keeping predation rates similar to lower producing years. At approximately a 20-fold increase in seed production, however, seed predators could no longer keep up and thus consumed a smaller proportion of the seed crop.

Work done by Sullivan (1979) explored this idea in a northern conifer forest. By mixing a ratio of seven sunflower seeds to one Douglas fir seed, he was able to increase the number of surviving seeds by ten times compared to broadcasting Douglas fir seeds alone. Several different ratios of sunflowers to oats (another choice of sacrificial food) to Douglas fir all provided some protection to the Douglas fir seeds. In this study, Sullivan tracked the loss of the sacrificial foods along with the loss of fir seeds. It was interesting to note the loss of the sacrificial foods happened at a much more precipitous rate indicating the granivores were favoring the sacrificial food, while leaving the fir seeds alone. In 1982 Sullivan & Sullivan seeded 1-ha plots with 45,000 lodgepole pine seeds along with 90,000 sunflower seeds. The addition of the sunflower seeds in this study led to five times as many pine seeds remaining undamaged when compared to plots seeded with only the pine seeds.

The study described in this thesis adapted methods used to test and improve planting success in other fields such as forestry and agronomy to prairie restoration (Sullivan 1979, Sullivan & Sullivan 1982, Westermann personal comm.). I wanted to accurately and reliably quantify the amount of granivory occurring in a prairie reconstruction and determine whether granivory did influence the number of seedlings emerging. I also wanted to investigate different techniques for reducing granivory. Reconstruction projects typically involve a few select forb (non-grass, herbaceous flowering plant) species due to the expense of the seed. Seed mixes may contain two dozen species and cost over $3,200/hectare (Prairie Moon Nursery 2007). Discovering a technique to improve the survival of seeds can increase the number of seedlings and the eventual number of mature flowering plants. If we can increase the number of surviving plants using fewer seeds, we can save money and effort at improving the diversity of a planting. Increased diversity may speed recovery after disturbance such as drought or help improve resistance to weed invasion (Tilman and Downing 1994, Tracy et al. 2004).

Granivory is a significant force in several types of ecosystems, possibly driving the succession in some situations (Brown & Heske 1990, Heske et al. 1993, Howe & Brown 2000). It is possible to reduce the amount of granivory via chemical deterrents and sacrificial foods. Studies cited here have quantified the amount of seed predation in natural areas and have successfully improved seed survival through varying techniques.

On the strength of these studies, I hypothesized that granivory may be an important cause of reduced plant numbers, species diversity, or both in prairie reconstructions. I hypothesized I can deter rodents and other granivores from eating prairie seeds by coating the seeds with the chemical capsaicin or divert granivore's attention from my prairie seeds by adding a sacrificial food source for them to consume. I also compared the amount of granivory occurring from spring to fall. I also had an objective to compare the seed preference by granivores as well as explore the differences between vertebrate and invertebrate seed predators. I also hypothesized that granivory is important in predicting seedling establishment and difference in species preference by granivores may lead to varying ease of species success. Finally, I began a pilot study exploring the impact seedling predation may have on reconstruction success. With this study, I intend to fill in some of the gaps in our knowledge regarding the fate of plant species in prairie reconstruction. The more of these gaps in our knowledge we can fill in, the more we can accurately determine the success. If the present study yields the desired results, land managers could apply these techniques to improve the efficiency and success of their restoration projects.

CHAPTER 2

METHODS

Site Description

The study was conducted on the reconstructed University of Northern Iowa tallgrass prairie preserve (42° 30' 30" N; 92° 27' 00"W) in Cedar Falls, Iowa. The average temperature during the two-year study was 9.61C for 2006 and 2007. The average precipitation per month for 2006 was 70.53mm (Figure 1, NOAA 2007).

The prairie is approximately 6-ha located on a small alluvial bench along the University branch of Dry Run Creek. The soils are classified as a Saude loam with prairie vegetation as the native plant type (USDA & NRCS 2006). Prior to 1973, the site was managed as a cool-season hayfield dominated by *Bromus inermis* (Smooth brome), *Agropyron repens* (Quack grass), and *Poa pratensis* (Kentucky blue-grass). Then in 1973, the hayfield was plowed and planted with a mixture of cultivated varieties of warm-season grasses: *Andropogon gerardii*(Big blue-stem), *Schizachyrium scoparium* (Little blue-stem), *Sorghastrum nutans* (Indian grass), *Panicum virgatum* (Switchgrass), and *Bouteloua curtipendula* (Side-oats grama). Management has consisted of a rotating burn plan consisting of several units each burned every 2-3 years. In 1999, 23 species of forbs were added (Williams et al. 2007). Seven additional species have been added in subsequent years (Carolan 2006). With the onset of this project in 2006, *Andropogon gerardii*, *Sorghastrum nutans*, and *Panicum virgatum* along with C3 grass component (*Poa pratensis*) were dominant with major forb components of *Solidago rigida*, *Echinacea pallida*, *Eryngium yuccifolium,* and *Parthenium integrifolium.*

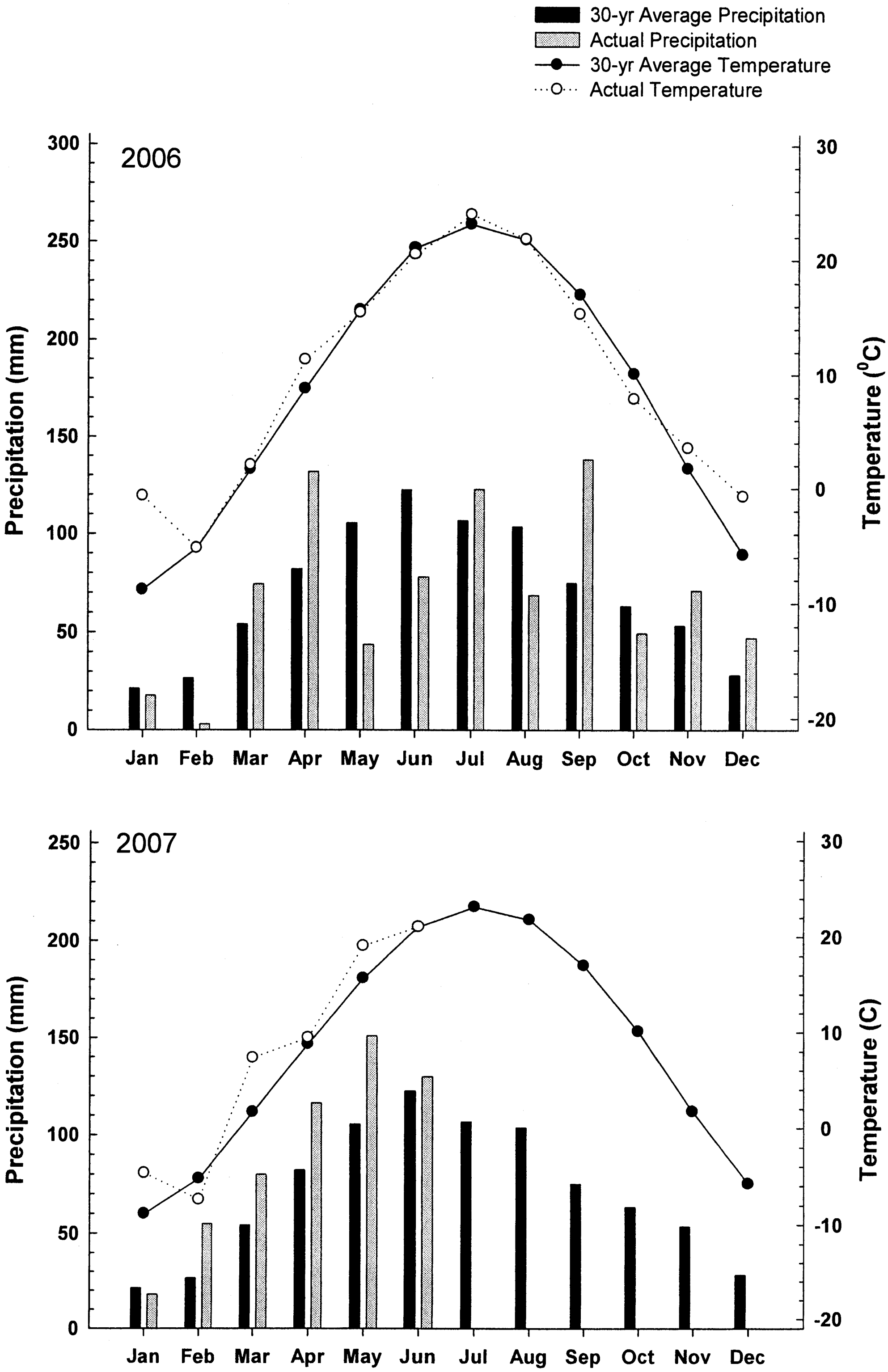

Figure 1. Mean monthly temperature and precipitation for the two years of study (NOAA 2007).

The questions asked in this study were addressed with several approaches. First, I investigated the role of vertebrate granivores in seed predation and tested the applicability of two different methods in reducing granivory. These were tested in the experiment titled Seed Predation of *Silphium integrifolium*. To further test the effectiveness of capsaicin as a feeding deterrent, capsaicin treated seeds were subjected to an artificial rain treatment. This was to determine how well the chemical would persist on broadcast seeds. In an experiment titled Invertebrate Role in Prairie Granivory, the influence of invertebrates (mainly ants, along with beetles and other animals <1-cm) and vertebrate granivores were compared. Seeds were contained in two different exclosures. One allowed the entrance of both invertebrate and vertebrate seed predators, while the other excluded vertebrates and allowed invertebrates to enter. A fourth experiment titled Feeding Deterrent and Sacrifice Food: Fall Trial was begun to repeat the two deterrent treatments in fall season. This trial also would answer the question of seed preference for granivores. The last experiment titled Granivory Protection by Capsaicin on Conservative, Showy, & Expensive Seeds tested the ability of capsaicin to improve the success of establishing two prairie species considered very showy, but hard to establish in a prairie restoration.

Seed Predation of *Silphium integrifolium*

Experimental Design and Treatments

The experiment consisted of a randomized block design with two, 25x60-m blocks, each containing eight 5x5-m plots (Figure 2).

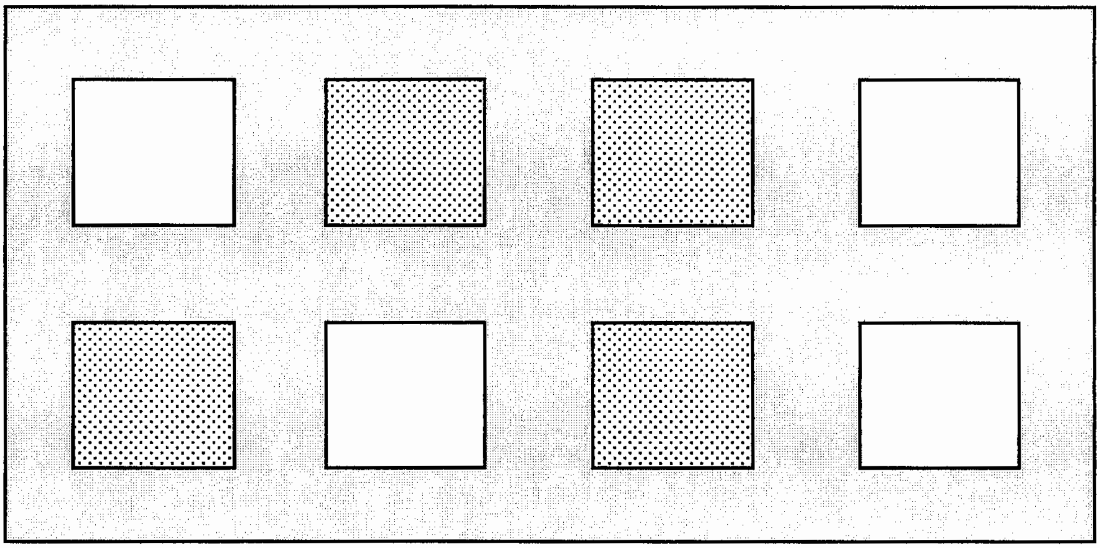

Figure 2. Representation of the experimental block. [ ] - 25x60-m mowed block [ ] - 5x5-m Sacrifice food treatment [ ] - 5x5-m Capsaicin treatment

The entire block was mowed at a height of approximately 15 centimeters preceding the beginning of the trial. The mowing maintained uniform cover for each trial throughout the growing season. The eight plots were spaced equally across the block with a 5-m buffer between each plot. To reduce edge effects, I left a 5-m mowed buffer around the block. The plot size and buffer areas remained the same. See Figure 2

Half of the plots in each block, were randomly assigned to receive the sacrifice food treatment. The remaining half were left as control plots. The sacrifice food treatment consisted of adding an additional food source, that is more desirable than the selected prairie species. The sacrifice food also needed the ability to persist on the ground over time, allowing rodents to feed on the food up to several weeks. I added black-oil sunflower (*Helianthus annus*) achenes as the sacrifice food. They are large, desired by rodents, and will not degrade quickly. Each sacrifice plot had 430 seeds/m^2 broadcast onto the plot. This amount was ten times the effective seeding rate the plots received solely from the seeds glued to cards, described below.

Determining Rate of Seed Removal

To measure seed loss, I adapted a seed card method developed by agronomists at Iowa State University (Westerman personal comm. not referenced). Having seeds fixed to a specific substrate allowed me to accurately identify consumed seeds, while minimizing losses to rain or wind. However, with the seeds glued onto an artificial substrate, some granivores may have been turned away which could have underestimated our results. The cards also kept seeds on the surface of the soil for what could be an unnaturally long time. This could have overestimated the amount of predation. The cards do provide for the most similar conditions to a broadcast reconstruction or naturally dispersing seed. The positives in this method outweighed negative consequences of using a seed card to measure granivory. This is the best method with the most confident results for a seed removal measure. The seed cards measured 11x14-cm and were made of 120-grit sandpaper.

Thirty *Silphium integrifolium* seeds were glued onto the card using 3M® spray adhesive. *Silphium integrifolium* is a large Asteraceae seed, common in native plantings. Previous research (Howe & Brown 2001) suggested *S. integrifolium* is a highly desirable food item for rodents. Prior to gluing, I coated seeds assigned to the capsaicin treatment with Squirrel Away® (Scrypton Systems, Annapolis, MD), a commercially available rodent deterrent containing capsaicin. Seeds were treated following the manufacturer's directions. Each kilogram of seed received 14-g of Squirrel Away powder. This equaled 150,000 SHU.

Each plot contained seven untreated cards and seven capsaicin treated cards. The cards were randomly placed throughout the plot using a random number table to determine the card's location. Litter and debris were cleared from the spot for the card to provide a uniform contact between the card and ground. Roofing nails 5-cm in length were pushed through the corners of the card to affix the card to the ground. A unique number was assigned to each card, allowing the rate of loss to be followed on individual cards. Small aluminum tags with the number embossed on them and were held to the card using one of the nails. Once affixed to the ground, the cards remained in place until the completion of each trial.

During the first week of the trial, we recorded the number of seeds remaining on each card daily. During the second week, the remaining seeds were counted on an every other day basis, with a final recording at the end of week three. At that time the cards were removed and discarded. Seeds partially consumed were removed and considered eaten. I removed seed fragments and other debris on the card as to not interfere with counting accuracy. I also recorded other observations such as rodent droppings. Care was taken to minimize trampling of the vegetation by walking different directions through the blocks.

Granivore Survey

During the trial, a combination of mammal trapping and walking bird surveys was utilized to determine what seed predators were present on the site. Early morning bird surveys were performed three days a week. The survey consisted of walking around the perimeter of the UNI Campus Prairie watching for birds entering or leaving one of the two blocks. The surveys were stopped after three weeks, as there was no evidence of birds eating the added seed.

Sherman live traps were used to capture small mammals within the two blocks. The traps were baited with the same sunflower seeds used for the additional food source. Twenty traps were placed along the perimeter of each block. They were opened in the evening and closed in the morning. I set traps on four randomly selected days each week during the trial. Captured animals were identified, their location recorded, and released. Any accidental deaths were kept for possible future analysis.

Above Ground Biomass Sampling

To determine a possible correlation between vegetative cover and granivory, I collected samples of the above ground biomass during the third week of the trial. Using 0.1-m^2 circular quadrats, two sites were randomly selected within each plot. All of the above ground biomass within the quadrats was collected and bagged. The biomass was dried until a constant mass was reached and then recorded.

Effects of Simulated Rain on Capsaicin Treated Seeds

Experimental Design and Treatments

One possible drawback of using a chemical treatment to deter granivory is the possibility that the chemical will be washed off by rain. To test the longevity of capsaicin as a feeding deterrent, capsaicin treated seeds were exposed to a series of simulated rain events of various durations. The mean rainfall amount per rain event for Cedar Falls, Iowa, USA was calculated for the months of May, June, and July. From these data, four different treatments for various amounts of rain were used. A garden watering can was used to simulate the rain. Using a rain gage, I calibrated the rate at which the watering can poured the water. That rate was then used to calculate the time needed to expose the seeds to the water to receive the proper amount of simulated rain. All seeds were treated identically with the capsaicin powder. The treated seeds were then exposed to differing amounts of simulated rain: no rain, 93-mm of rain (10 times the average rain event), and 0.93-mm of rain (0.1 times the average rain event). Control cards of seeds receiving no capsaicin and no rain were also used.

Seed Removal

Raw whole sunflower kernels were used as the test seed. This seed would give me a better idea of how effective capsaicin is at deterring granivory, as sunflowers are a highly desirable food source. Once the seeds were treated with both capsaicin and the selected simulated rain treatment, 30 seeds were counted and glued to sandpaper cards as described previously. Fifteen plots were randomly placed across a 60x20m area of the prairie. The plots were 5x5-m and had two cards of each of the five treatments placed within the plot. Seeds remaining were counted on a daily basis until all of the seeds had been removed.

Invertebrates' Role in Prairie Granivory

Experimental Design and Treatments

This experiment used fifteen randomly placed split-split plots throughout a 60x60m area. There was one combination of treatments at the whole-plot level: enclosed and open cages. Each plot contained one exclosure open to vertebrates and insects and another excluding rodents while allowing insects. This was to test the role of both vertebrates and invertebrates in seed granivory. These exclosures were placed four meters apart. Another treatment was split within each exclosure to test if capsaicin is able to deter granivory. Two, ten-cm plastic Petri dishes were places within each exclosure. One dish contained capsaicin treated seeds and the other dish held untreated seeds. The same capsaicin powder and method of application was used with this experiment. Each dish was marked accordingly to identify the treatment. A third level of treatment was split within each Petri dish. Three species of seeds were glued on a seed card glued inside the dish: a legume (*Dalea purpurea*), a grass (*Sorghastrum nutans*), and a composite (*Ratibida pinnata*). This variety allowed us a limited test for seed preference of both vertebrates and insects. I recorded the numbers of remaining seeds at frequent intervals over the course of one month.

Exclosure Design and Construction

The exclosures were constructed using 1.27-cm hardware cloth measuring 8 x 30 x 15-cm. Two types of exclosures were used, open and closed. The exclosures were modified from methods described by Hulme (1999, 1994). The first type was fully enclosed on all six sides, preventing larger vertebrate granivores from entering while allowing smaller granivores (<1-cm) access. The second type kept the two longest sides (8x30cm) open, allowing larger vertebrate granivores and smaller insect granivores access into the exclosure. The exclosures were held together using light-gauge wire ties and held to the ground with heavy wire stakes. To protect the seeds from rain or wind from dislodging the seeds, a sheet of clear plastic was tied to the top of all exclosures.

Each exclosure housed two, 10cm plastic Petri dishes. A piece of 220 grit sandpaper was fitted and glued inside the Petri dishes. Each piece of sandpaper was marked into thirds using a felt marker, and then coated with 3M® spray adhesive. Fifteen seeds of each of the three species were glued onto the card in their respective third of the dish. The combination of the glue, Petri dish, and plastic cover all helped in reducing seed loss (that could be problematic using smaller seeded species such as the species used) from rain and wind. Once I placed the exclosures in the prairie, they remained in the prairie until the completion of the trial. Sticky tape style insect traps were placed near the exclosures to capture any possible invertebrate seed predators visiting the exclosures.

Rate of Seed Removal

I collected data over a period of 3.5 weeks. The data collection ended at this time as nearly all the seeds were eaten. (Data was collected on days 1, 2, 5, 12, and 22 after commencement) The multiple days allowed us to plot the pattern of change over time (not just compare before and after amounts). Each day I collected data, I removed the Petri dishes to obtain a closer inspection. The numbers of seeds remaining were recorded, along with observations such as the presence of rodent droppings, ants, etc.

Feeding Deterrent and Sacrifice Food: Fall Trial

Experimental Design and Treatments

This experiment consisted of a randomized block design with three treatments at the whole plot level (capsaicin, sacrifice food, untreated control) and three treatments at the within-plot level (*S. integrifolium*, *Dodecatheon meadii*, and *Phlox pilosa*). Each block consisted of nine, 5x5-m plots. The plots were then randomly assigned one of the three plot-level treatments. The treatments consisted of the sacrifice food (*Helianthus annus*), capsaicin treated seeds, or a control with neither the sacrifice food nor capsaicin. Within each plot, there were 15 total cards, five of each species (*S. integrifolium*, *P. pilosa*, or *Dodecatheon meadii* seeds).

Along with the seed cards, additional seed of the three species was broadcast onto all the plots. I used the following seeding rates to broadcast the three species: *S. integrifolium* broadcast at 100 seeds/m^2, *P. pilosa* at 250 seeds/m^2, and *Dodecatheon meadii* at 300 seeds/m^2. *S. integrifolium* was seeded at a lower rate because this species is considerably larger than *P. pilosa* and *D. meadia*. I did not want to overwhelm the plots with a high volume of one species. Due to lack of seed availability, the rates used for *P. pilosa* and *Dodecatheon meadii* were the maximum density possible.

The trial began on November 2nd, and lasted weeks. Data was collected about once every ten days. The procedure of placing the cards and recording the seeds was the same as for the summer trial.

Seed Rain

Seed inputs from the surrounding prairie had could possibly add additional seed to the research and possibly skew the amount of available seed for consumption. Seed traps were used to measure the amount of seed dispersal from the surrounding. The traps were constructed following the design detailed in Schott (1995). Using a random number table, I placed one trap in each plot and checked for the presence of seeds on a weekly basis.

Determining Granivory's Influence on Seedling Emergence

From May 23rd to June 5th, 2007, I counted the number of seedlings present from the Fall 2006 trial. Three 0.5-m transects were randomly selected across each 5 x 5-m plot. All seedlings from the three species seeded in Nov. 2006 were identified and recorded.

Granivory Protection from Capsaicin on Conservative Species

Experimental Design and Treatments

This experiment used a randomized block design with four treatments in a 2 x 2 factorial. A 15x20-m area with a high density of warm season grasses and low density of forbs was burned in the fall of 2004. This was done to remove all above ground biomass in preparation for seeding to begin in 2005. Twenty, 3x5-m blocks were then established in the area. Half of the blocks were designated for the addition of Midland shooting star (*Dodecatheon meadii*), while the other half was designated for Prairie phlox (*P. pilosa*). Both species are considered to be very difficult to establish. Each block was divided into four plots, one for each treatment, measuring 1.5 x 0.5-m.

All plots were seeded at a rate of 1.33 seeds/cm^2 (13,333 seeds/m^2). The experimental area was mowed throughout the growing season to keep the established vegetation at a height of 15-cm. Two different planting times as well as two different pre-planting seed treatments were used. The planting times include a spring planting (April 5th, 2006) and a fall planting (October 19th, 2006). The pre-planting seed treatments include capsaicin treatment (Squirrel Away®) or untreated. Beginning May 2006, seedling censuses began on all planted plots (2005 and 2006 plantings). Using a 50x25-

cm quadrat broken into a grid of 5x10-cm rectangles, the entire plot planted with *P. pilosa* was counted. Due to the high number of *D. meadia* seedlings, five randomly chosen grid points from each quadrat were sampled. The effectively sampled 20% of the plot. Censuses were performed once each spring (May 15-22nd, 2006 & May 16-22nd, 2007).

Data Analyses

All data collected in this experiment were analyzed using Systat v11 (Systat Software Inc. 2004). Residual versus predicted value plots for each analyses were inspected for homoscedasticity by looking for a random distribution of the data points. Data sets deemed not normal were arcsine or arcsine squared transformed to create a more normal data distribution. All data were back transformed for reporting.

In the Summer 2006 Seed Predation experiment, differences in means over time were determined using a split-plot, two-way repeated measures analysis of variance with seven sources of variation(Table 1): block, sacrifice, capsaicin, sacrifice x capsaicin, capsaicin x block, sacrifice x block, and block x sacrifice x capsaicin.

Table 1. Sources of variation for the Summer 2006 Seed Predation experiment

Source	d.f.	Error term for F-test
Block	1	Error
Sacrifice	1	Plot(Sacrifice)
Capsaicin	1	Capsaicin x Plot(Sacrifice)
Block x Sacrifice	1	Plot(Sacrifice)
Block x Capsaicin	1	Capsaicin x Plot(Sacrifice)
Sacrifice x Capsaicin	1	Capsaicin x Plot(Sacrifice)
Block x Sacrifice x Capsaicin	1	Capsaicin x Plot(Sacrifice)
Plot(Sacrifice)	12	
Capsaicin x Plot(Sacrifice)	12	

All ANOVAs were inspected to determine that there were no block x treatment interactions before assessing main effects. Different error terms were needed to analyze the split-plot design (Table 1). In addition, I calculated a regression comparing the seed survival to the biomass of the surrounding vegetation to test for a relationship between the two factors.

Determining Granivory's Role in Seedling Emergence utilized a simple correlation to determine if a significant relationship existed between the amount of granivory recorded in the Fall 2006 trial and the seedlings emerging during the Spring of 2007.

The Invertebrate Role in Prairie Granivory experiment utilized a split-split plot repeated measures analysis of variance with seven sources of variation (Table 2): exclosure, capsaicin, species, exclosure x capsaicin, exclosure x species, capsaicin x species, and exclosure x capsaicin x species. Three different error terms were used in the analysis (Table 2).

Table 2. Sources of variation for the Invertabrate Role in Prairie Granivory experiment

Source	d.f.	Error
Exclosure	1	Plot(Exclosure)
Capsaicin	1	Capsaicin x Plot(Exclosure)
Species	2	Species x Capsaicin x Plot(Exclosure)
Capsaicin x Species	2	Species x Capsaicin x Plot(Exclosure)
Exclosure x Capsaicin	1	Capsaicin x Plot(Exclosure)
Exclosure x Species	2	Species x Capsaicin x Plot(Exclosure)
Exclosure x Capsacin x Species	2	Species x Capsaicin x Plot(Exclosure)
Plot(Exclosure)	28	
Capsaicin x Plot(Exclosure)	28	
Species x Capsaicin x Plot(Exclosure)		

Analysis of the study testing conservative and showy species utilized a two-way ANOVA where the planting time, seed treatment, and their interaction were sources of variation. The 2005 and 2006 plantings were analyzed separately due to the differences in treatments.

All of the analysis procedures are part of the GLM analysis in the Systat program.

CHAPTER 3

RESULTS

Seed Predation of *Silphium integrifolium*

I hypothesized granivory could be reduced by adding a sacrifice food source as well as applying a chemical deterrent to specific prairie seeds. The sacrifice food treatment significantly reduced the mean number of seeds remaining ($p = 0.0006$) and the rate of decline in remaining seeds over time ($p = 0.0189$) (Figure 3, Table 3).

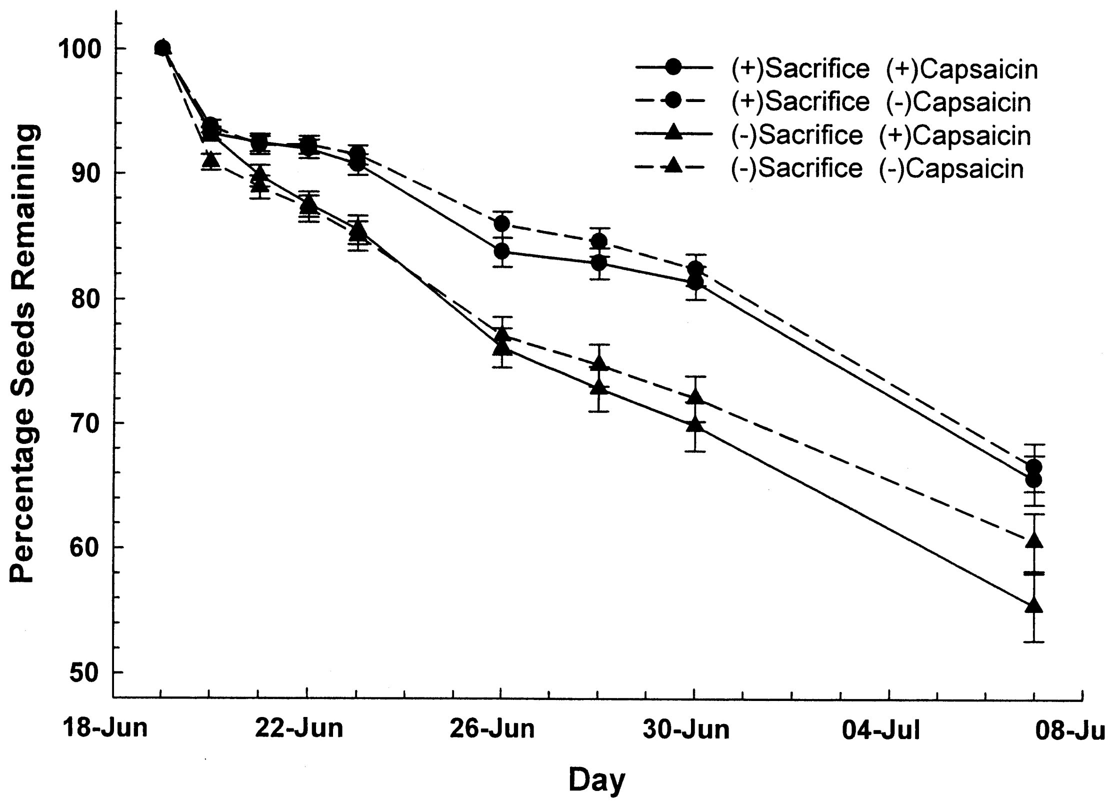

Figure 3. Predation of *S. integrifolium* during the June 2006 trial. June 19th was the day the seed cards were added to the plot. Removal counting began June 20th. The sacrifice food treatment significantly reduced predation over the course of the trial.

Table 3. Repeated measures ANOVA results for the June 2006 trial. Dates of data collection are June 20th, 21st, 22nd, 23rd, 26th, 28th, 30th, and July 7th.

Source	**d.f.**	**Between Subjects p**	**d.f.**	**Within Subjects p**
Block	1	0.62	7	0.75
Sacrifice Treatment	1	0.0006	7	0.019
Capsaicin Treatment	1	0.77	7	0.12
Sacrifice x Capsaicin	1	0.75	7	0.31
Block x Sacrifice	1	0.43	7	0.17
Block x Capsaicin	1	0.42	7	0.69
Block x Sacrifice x Capsaicin	1	0.23	7	0.53

This was most evident during the second week of the trial (Days 7-11), when there was an average of 83.5% of seeds remaining for the sacrifice treatment, compared to 73.9% remaining for the plots not receiving the sacrifice food treatment. I observed several seed cards with empty sunflower hulls, while the *S. integrifolium* seeds remained untouched.

The capsaicin treatment produced no significant effects ($p = 0.77$ mean predation between subjects and $p = 0.091$ over time) (Table 3). There was 39.1% ±1.6% S.E. of seeds remaining for capsaicin treated seeds compared to 36.8% ±1.5%S.E. for the untreated seeds, by the end of the trial. Throughout the trial, I consistently observed many partially consumed seeds on the capsaicin treated cards, whereas untreated seeds were more wholly consumed. The rates of loss for the capsaicin treatments paralleled the rates of decline very similar to the corresponding sacrifice treatment (Figure 3).

Granivore Survey

I had a total of 17 captured animals over the course of nine nights. Sixteen captures were meadow voles (*Microtus pennsylvanicus*). One thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) was also captured. I did make several daytime observations of *S. tridecemlineatus* tunnels within the research blocks. Ground squirrels were also observed running through and on one occasion eating seeds directly from the seed card. Other observations of granivore presence included rodent droppings on the cards and chewing of the sandpaper. Early morning bird surveys revealed no evidence of birds preying upon the experimental seeds. Motion cameras aimed at a seed card captured an image of what appears to be a *M. pennsylvanicus* feeding on the card. This added to our evidence of rodents feeding on my cards.

Effects of Simulated Rain on Capsaicin Treated Seeds

I hypothesized rain would have the ability to wash off capsaicin from treated seeds. This would reduce the chemical's ability to deter granivory. Capsaicin was able to significantly ($p = 0.015$) deter granivory compared to untreated raw sunflower kernels for the first day (Figure 4).

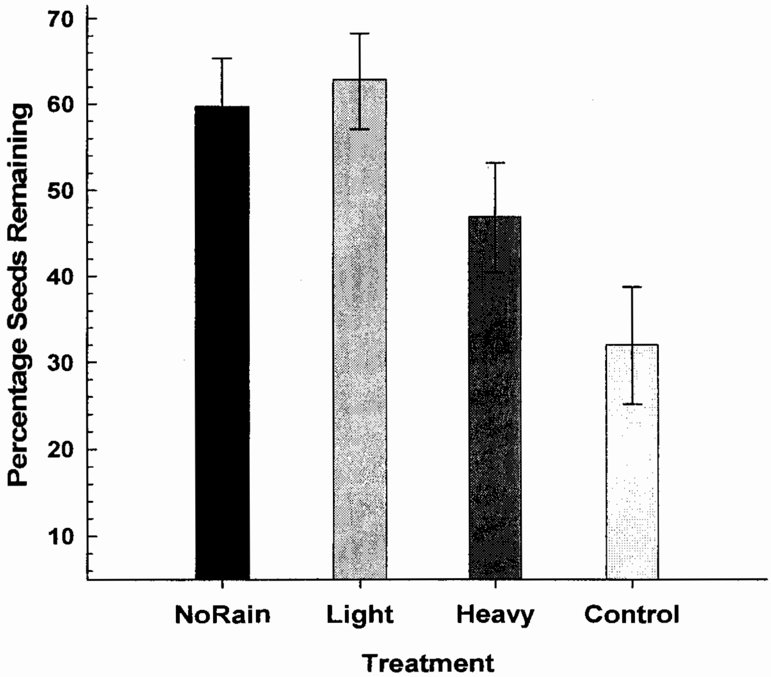

Figure 4. Means +/- 1 S.E. of remaining sunflower seeds treated with varying amounts of artificial rain after one day. One-way ANOVA revealed seeds treated with capsaicin and receiving no rain, or light rain significantly reduced predation compared to the untreated control p=0.013 & p=0.004, respectively.

The protection was short lived though; all kernels from all treatments were consumed by the third day. The ability of water to wash off capsaicin was consistent with our hypothesis. Kernels receiving the heaviest rain (least capsaicin remaining) were consumed more similar to the untreated kernels. In addition, the kernels receiving light rain (most capsaicin remaining) were consumed most similar to the kernels treated with capsaicin and receiving no rain.

Feeding Deterrent and Sacrifice Food: Fall Trial

Seed Removal

In this trial, I hypothesized I could reduce granivory using a sacrifice food source, as well as the chemical deterrent capsaicin. I also hypothesized that different species of seeds would have different rates of predation. Finally, I hypothesized the fall season would produce a different pattern of granivory compared to the summer. Significant differences in the means ($p < 0.0001$) as well as the rate over time ($p < 0.0001$) were observed between the two blocks (Table 4).

Table 4. Repeated measures ANOVA results for the Fall 2006 trial. Dates of data collection are Nov. 7th, 16th, 21st, 28th, Dec. 13th, and 29th.

Source	**d.f.**	**Between Subjects p**	**d.f.**	**Within Subjects p**
Block	1	<0.0001	5	<0.0001
Treatment	2	0.1302	10	0.2628
Species	2	<0.0001	10	<0.0001
Treatment x Species	4	0.173	20	0.0141
Block x Species	2	<0.0001	10	<0.0001
Block x Treatment	2	0.6944	10	0.8519
Block x Treatment x Species	4	0.3751	20	0.3691

Apparent granivore seed preference made a significant ($p < 0.0001$) difference in rates of predation (Figure 5).

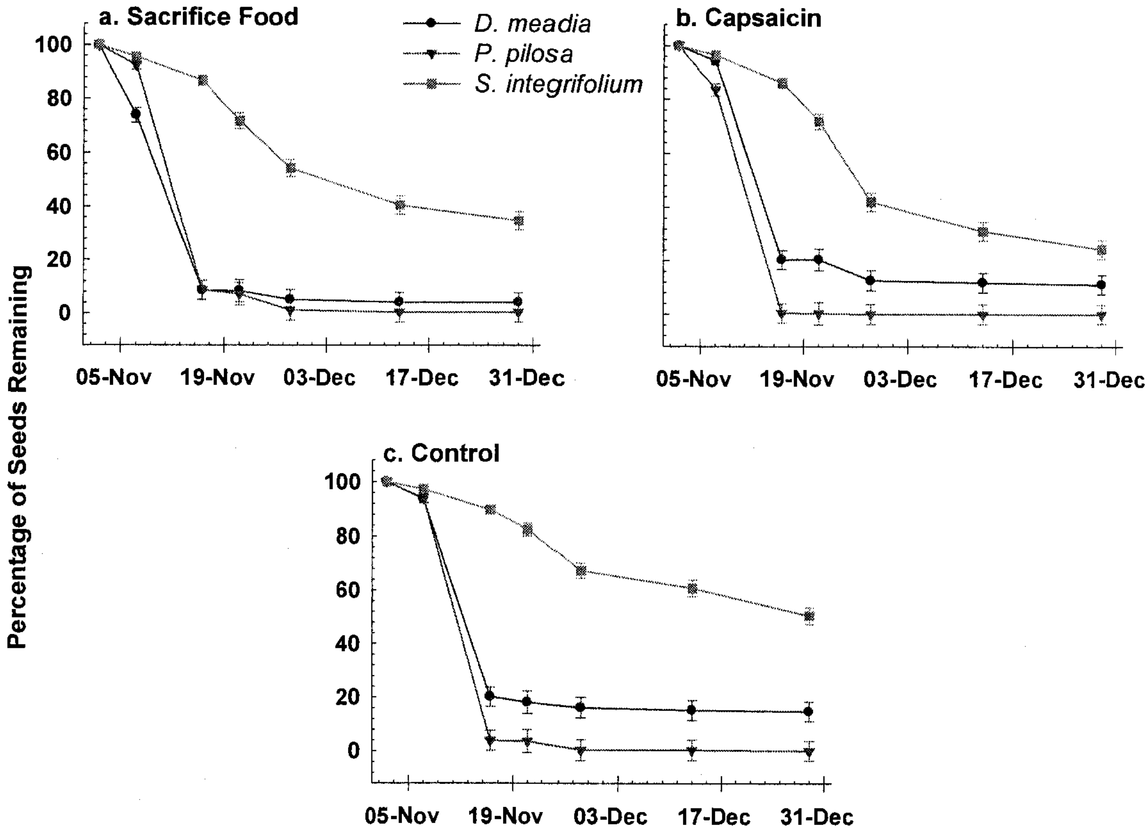

Figure 5. Predation recorded during the Fall 2006 trial. There were significant differences in the amount of predation between species. A treatment x species interaction was detected for *S. integrifolium*.

P. pilosa and *D. meadia* had 95.7% ±2.1% and 83.7% ±2.07% seed loss 14 days into the trial, compared to 12.4% ±1.1% loss for *S. integrifolium* over the same time. By the end of the trial across treatments and blocks, *P. pilosa* had 99.8% ±2.1% predation; *D. meadia* had 89.9% ±2.1% predation; and *S. integrifolium* only had 73.9% ±1.9% predation (Figure 5).

Block 1 had a higher rate of predation with an average loss of 1.58% per day compared to Block 2's 1.37% per day (Figure 6).

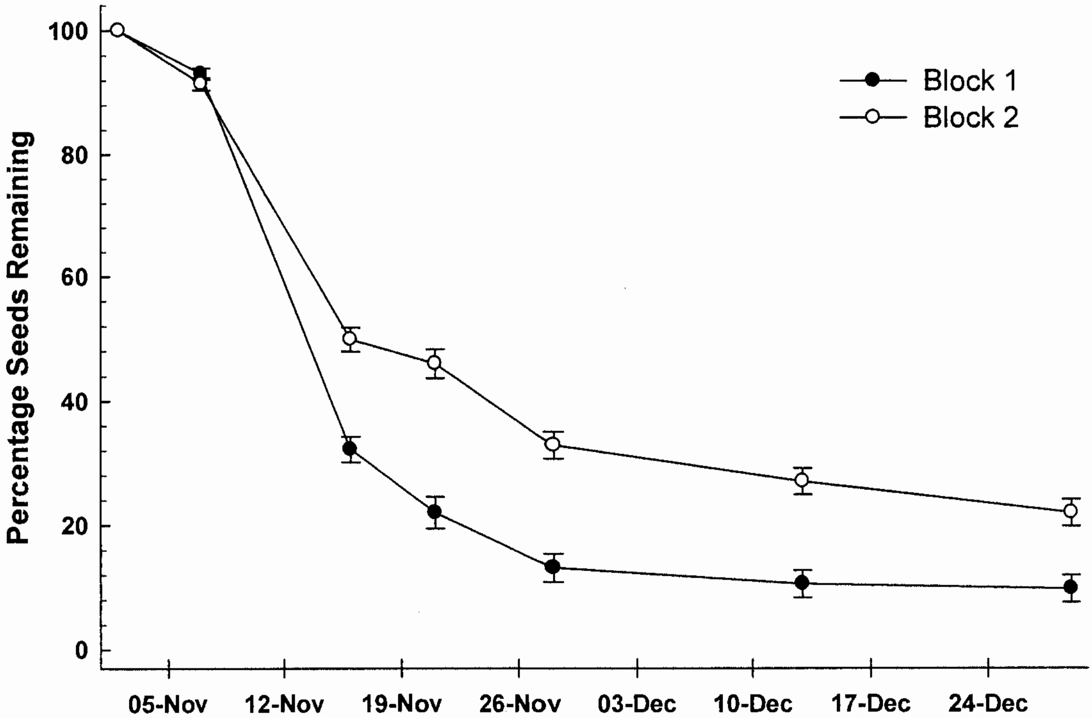

Figure 6. Differences between blocks during the Fall 2006 trial. All treatments and species are combined.

This resulted in Block 1 having an average of 30.14% survival at the end of the trial, whereas Block 2 held a 44.88% average survival.

Much of the difference in blocks comes from the large difference in *S. integrifolium* predation between the two blocks (Figure 5, Table 4). The difference in blocks along with differences in seed preferences led to a block x species interaction ($p < 0.0001$) and an interaction over time ($p < 0.0001$).

None of the three seed treatments showed any difference ($p = 0.13$) in predation. This was also true for the treatments over time ($p = 0.26$). However, there was a significant ($p = 0.014$) treatment x species interaction for their effect over time. The data did indicate a trend of the sacrifice food treated plots having slightly higher rates of predation (Figure 5). The sources of the interactions were the *S. integrifolium* cards. There was an average survival of 48.2% ±3.2% for Block 1, whereas Block 2 remained at 79.6% ±2.06% average survival.

I also recorded 71.68-mm of rain during the month of November, with 50.4-mm falling before November 14th.

Seed Rain

Throughout the entire trial, three seeds were collected in all of the seed traps. All three seeds were collected in Block 2 and were winged fruits dispersing from a nearby maple tree (*Acer spp.*).

Determining Granivory's Influence on Seedling Emergence

During May and June 2007, seedlings from all three species of the Fall Trial were counted. In this trial, I hypothesized that the seed treatments would increase the amount of seedlings germinating. I also hypothesized that the amount of seed predation recorded in the Fall Trial would influence the number of seedlings observed during the following growing season. There were significant ($p<0.0001$) species differences occurring between *P. pilosa* and both *D. meadia* and *S. integrifolium*, but no treatment differences (Table 5, Figure 7, Table 6).

Table 5. ANOVA results from the seedling census conducted in June 2007.

Source	d.f.	p
Block	1	0.067
Treatment	2	0.17
Species	2	<0.0001
Treatment x Species	4	0.78
Block x Treatment	2	0.47
Block x Species	2	0.28
Block x Treatment x Species	4	0.98
Error	3	

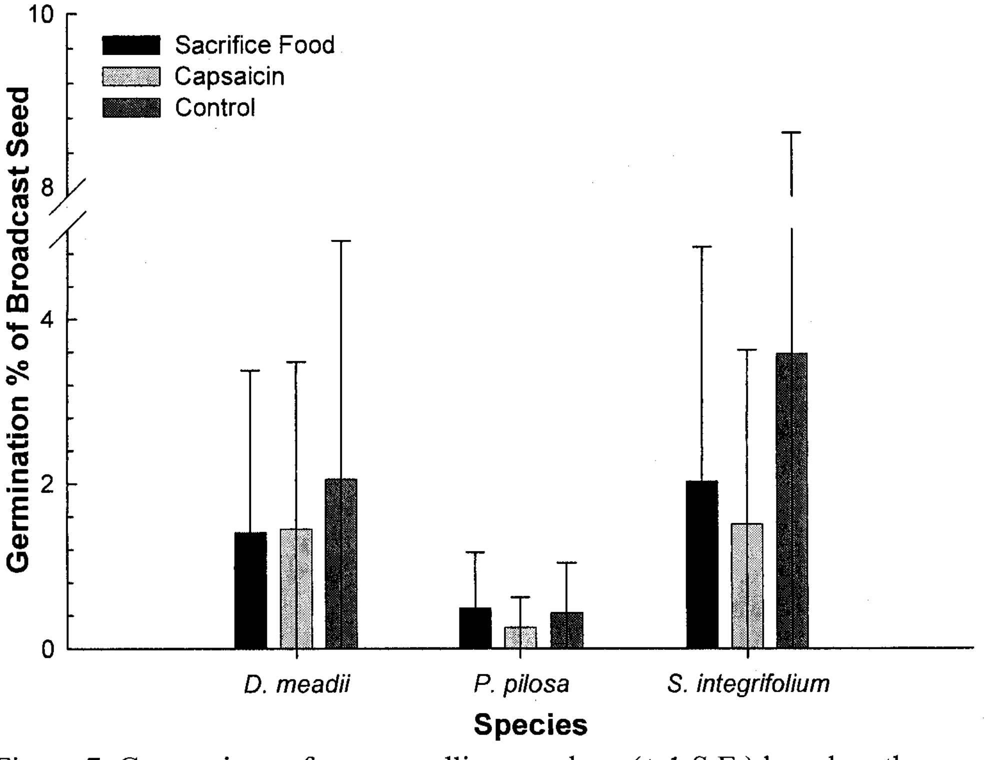

Figure 7. Comparison of mean seedling numbers (± 1 S.E.) based on the percentage of broadcast pure live seed, sown in Nov. 2006.

Table 6. P values of pairwise species comparisons of Seedling number in June 2007.

	D. meadia	***P. pilosa***	***S. integrifolim***
D. meadia	1.000		
P. pilosa	0.042	1.000	
S. integrifolium	0.997	0.024	1.000

P. pilosa averaged 0.59 seedlings/1000 pure live seed (PLS) planted compared to 2.28 and 2.82 seedlings/1000PLS for *D. meadia* and *S. integrifolium*, respectively. There were no differences between either seed treatment or their interactions with species or block (Table 5).

There was a significant (r^2=0.59, p=0.01) correlation between *D. meadia* predation recorded in the Fall Trial and the number of seedlings present (Figure 8).

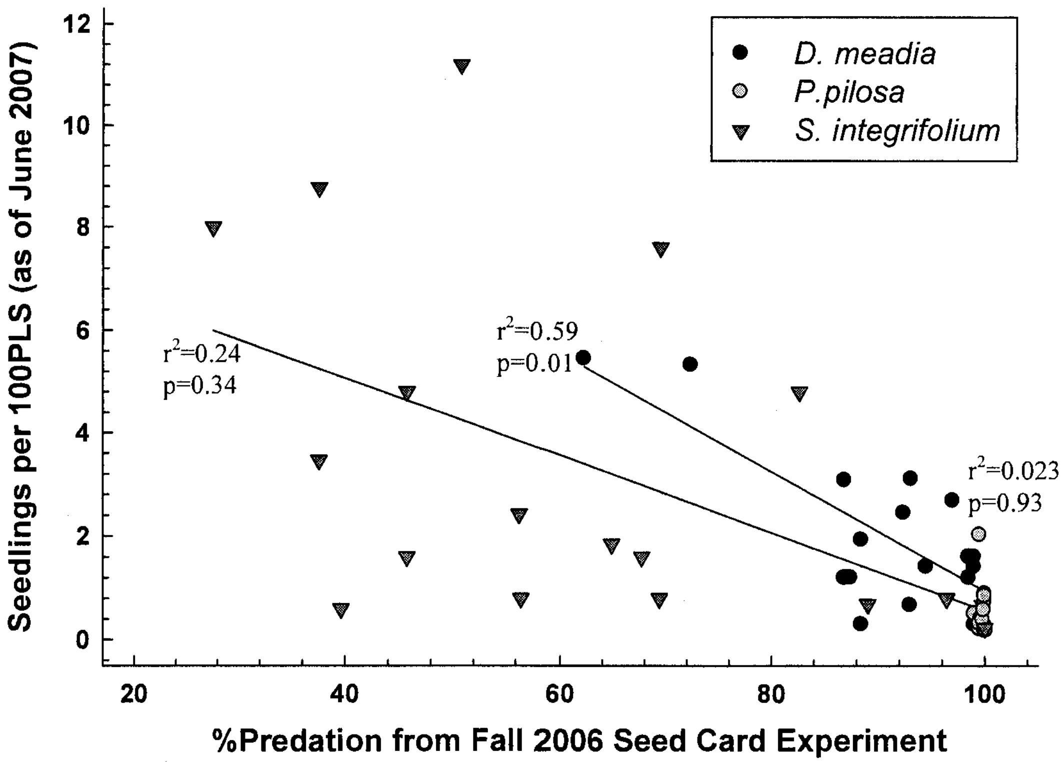

Figure 8. A significant correlation was found for the seed predation and seedling emergence relationship of *D. meadia* (r^2=0.59, p=0.01). No other significant correlations were present.

This correlation was not present in either *S. integrifolium* or *P. pilosa*. *Silphium integrifolium* did not have a significant correlation (r^2=0.24, p=0.34).

<u>Invertebrates' Role in Prairie Seed Granivory</u>

I hypothesized that vertebrate and invertebrate granivores would differ in their impact on granivory in a prairie reconstruction. Another hypothesis was that both types of granivores would have different seed preferences. A final hypothesis was that granivory would be reduced for both vertebrates and invertebrates by treating the seeds with capsaicin. There were significant ($p < 0.0001$) and different seed preferences for both vertebrate and invertebrate granivores. This was evident in the exclosure x species interaction as well as the species effect. *Ratibida pinnata* was the most consumed species by vertebrates (93.3% consumed after one day), while both *Sorghastrum nutans* and *Dalea purpurea* were being consumed at a much slower rate (33.1% and 31.2% respectively after one day). In contrast, the invertebrate-only exclosures saw a much different pattern of removal with 23.8% ±2.3% removal of *Ratibida pinnata*, 17.8% ±2.1% removal of *Sorghastrum nutans*, and 22.5% ±2.3% removal of *Dalea purpurea* after one day. The species preference was also shown in the exclosure x capsaicin x species interaction ($p = 0.059$).

Denying vertebrates access to the seed cards significantly ($p < 0.0001$) reduced predation for the exclosures (Table 7, Figure 9). The invertebrate-only exclosures had less consumption after the first day with 78.6% ±1.3% seeds remaining compared to 49.8% ±1.82% remaining for the open exclosures. This trend continued until day 22 when the invertebrate only exclosures still held 26.6% ±2.0% of the seeds compared to the open exclosures' 3.7% ±2.1%. Ants were the only invertebrate granivore observed in this study, although other species of granivorous invertebrates such as slugs and beetles may have been present.

Table 7. Invertebrates Role in Granivory Repeated measures ANOVA results

Source	d.f.	Mean p	d.f.	Over time p
Exclosure	1	<0.0001	4	0.0016
Capsaicin	1	0.15	4	0.15
Species	2	<0.0001	8	<0.0001
Capsaicin x Species	2	0.022	8	0.23
Exclosure x Capsaicin	1	0.27	4	0.41
Exclosure x Species	2	<0.0001	8	<0.0001
Exclosure x Capsaicin x Species	2	0.059	8	0.16

There were significant ($p = 0.022$) differences in means for a capsaicin x species interaction. This difference was not observed in regards to the slopes ($p = 0.23$). This can be observed in Figure 9b and 9d with the variation between *Sorghastrum nutans* and *Dalea purpurea*.

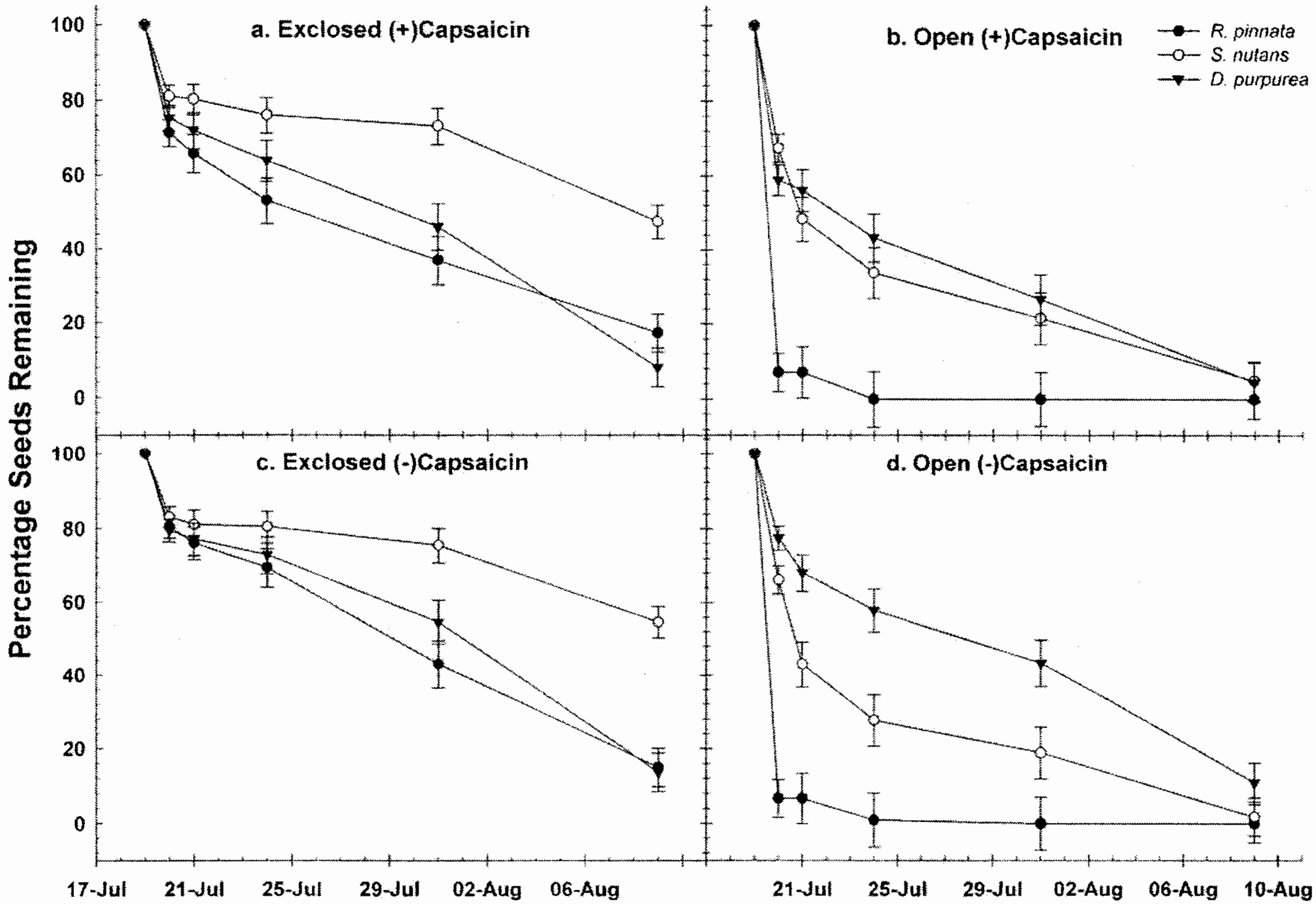

Figure 9. Comparison of exclosure type, seed type, and capsaicin treatment. Significant ($p<0.0001$) interaction of exclosures x species were observed along with significant ($p=0.02$) interaction of capsaicin x species. As well as significant ($p<0.0001$) differences between exclosures and species.

Granivory Protection From Capsaicin on Conservative Species

I hypothesized that both the planting season and the application of capsaicin would affect germination rates of *D. meadia* and *P. pilosa*. Seedlings were counted in May 2006 and May 2007 from the March 2006 and October 2006 planting. There was a significant difference (p=0.002) in capsaicin treatment for *D. meadia* for the 2006 and 2007 counting dates (Table 8).

Table 8. *D. meadia* ANOVA results. P-values reported from the seedling censuses conducted in May 2006 and May 2007.

Source	**2006 d.f.**	**p-value**	**2007 d.f.**	**p-value**
Block	4	0.186	4	0.497
Treatment	1	0.002	1	0.005
Planting Time	--	--	1	0.979
Planting Time x Treatment	--	--	1	0.412
Error	4		12	

For the 2006 counting, the capsaicin treated plots averaged 376.9 seedlings/m^2 compared to 176.9 seedlings/m^2 for the control plots. There were no other significant findings during the 2006 growing year (Table 8, Table 9).

Table 9. *Phlox pilosa* ANOVA results. P-values reported from the seedling censuses conducted in May 2006 and May 2007.

Source	**2006 d.f.**	**p-value**	**2007 d.f.**	**p-value**
Block	4	0.14	4	0.173
Treatment	1	0.56	1	0.125
Planting Time	--	--	1	<0.0001
Planting Time x Treatment	--	--	1	0.162
Error	4		12	

In May of 2007, I again counted seedlings from the spring 2006 planting and counted the fall 2006 planting for the first time. Capsaicin treated *D. meadia* plots had significantly (p=0.005) more seedlings than the control. The capsaicin treated plots averaged 833.8 seedlings/m^2, compared to 274.7 seedlings/m^2 for the untreated control for 2007 (Figure 10).

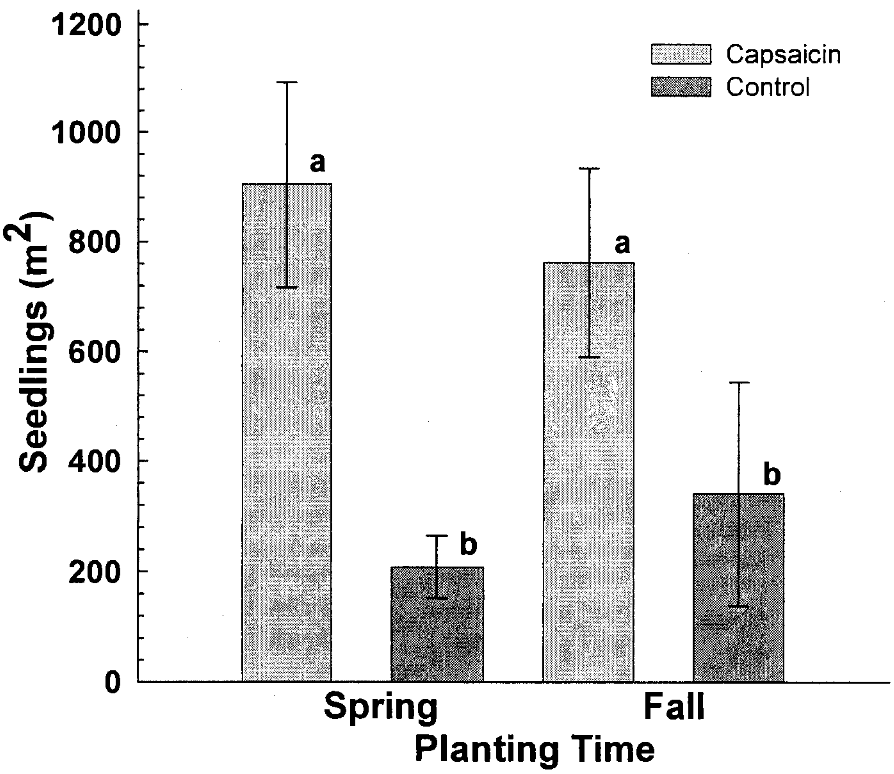

Figure 10. *D. meadia* seedlings recorded during May 2007. Capsaicin significantly increased the number of seedlings present. Planting time had no effect on seed germination.

Planting time had no effect on the germination of *D. meadia*. Spring planted plots averaged 556.4 seedlings/m^2 and fall planted plots averaged 552.0 seedlings/m^2 for 2007 counting. Planting time did significantly ($p<0.0001$) affect the germination of *P. pilosa*. Spring planted plots averaged 113.6 seedlings/m^2, whereas fall planted plots averaged 4.09 seedlings/m^2 (Figure 11) for the 2007 counting.

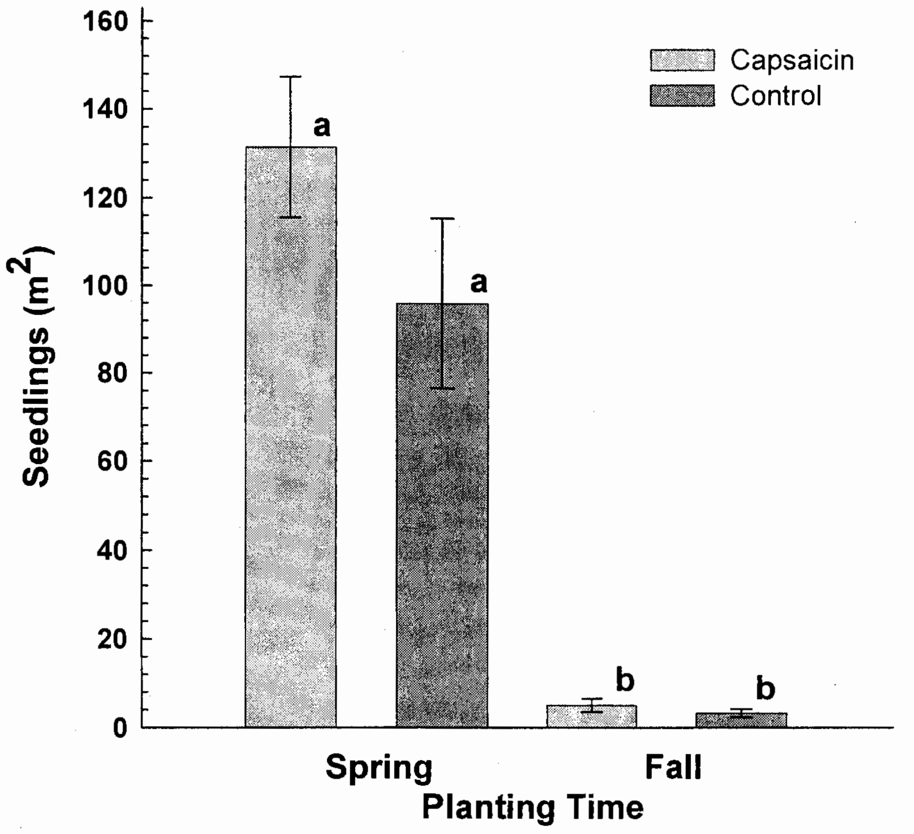

Figure 11. *Phlox pilosa* seedlings recorded in May 2007. The spring 2006 planted plots had significantly higher seedling densities. Treating the seeds with capsaicin had no effect on seed germination.

Treating the seeds with capsaicin had no effect on seed germination. Capsaicin treated plots averaged 68.2 seedlings/m^2 compared to control plots averaging 49.51 seedlings/m^2.

CHAPTER 4

DISCUSSION

Results from this study support the hypothesis that granivory is an important factor in enhancing an established grassland planting and can limit the number of seedlings germinating from broadcast seeds. During the Fall 2006 trial, predation rates exceeded 98% for *P. pilosa* within a timeframe of two months. The results also support the hypothesis that it is possible to reduce the amount of granivory occurring on broadcast prairie forb seeds. However, these results may not apply to reconstructions across ecological systems. Since each seed has different characteristics, nutrition, ease of handling, secondary compounds, the granivore may respond differently to each individual seed species. It does appear possible to have some reduction in granivory, which would increase the success of a reconstruction project.

Addition of a Sacrificial Food to a Reconstruction Seeding

At the end of the June 2006 trial, the sacrificial food treatment had a loss of 34.64% compared to 49.8% loss for the plots not receiving the sacrifice food (Figure 3). This makes it possible to accept the hypothesis that a sacrificial food can reduce granivory.

This is different from the results of the Fall 2006 trial where the sacrificial food showed a trend to increase the incidence of predation (Figure 5). The plots not receiving the sacrifice food had 18.4% of the seeds remaining compared to the sacrifice food's 11.7% remaining. Although not a significant difference, this trend does not support the hypothesis. The increased density of food in the sacrifice food plots during the fall season may have attracted more rodents, in turn increasing the predation (Taitt & Krebs 1981).

Use of Capsaicin to Reduce Seed Predation

Capsaicin treated seeds had no effect on reducing granivory in the Summer 2006 and Fall 2006 trial. There is convincing evidence in previous literature on capsaicin's ability to reduce mammal granivory. This study did not support that claim. Jensen et al (2003) as well as Curtis et al (2000) treated seeds that were protected within a feed storeroom or a bird feeder. Both of these systems would protect the capsaicin from rain. The nature of this study required the seeds to be exposed to these abiotic factors, as seeds would be in a reconstruction project. Data from this study indicates rain has the ability to wash away capsaicin and reduce the effectiveness of the treatment. When capsaicin-treated sunflower kernels were exposed to 93-mm of simulated rain, the kernels were predated in a similar fashion to kernels not receiving any capsaicin treatment. In the Summer 2006 and Fall 2006 trials, 54-mm and 52-mm of rain, respectively, were recorded within the first three days of each trial. This would have been enough rain to reduce capsaicin's ability to protect the seeds from granivory. Due to the rain events immediately following the start of each trial, capsaicin may not have had a full test of its ability to reduce granivory in a prairie reconstruction.

Another interesting observation made during the trials was the amount of partially consumed seeds found on the capsaicin treated seed cards. Numerous seeds were noted as half-eaten with small bits of endosperm removed, apparently by a small mammal. This phenomenon was not noticed on the non-capsaicin treated cards, where the seeds were consistently removed in entirety. This intriguing observation possibly indicates that granivores would begin consuming one seed, then move to another once the burning effect of the capsaicin started. Unfortunately, with this qualitative data I cannot confirm or reject the consistency of this phenomenon.

However, the results from the high density planting of showy & conservative species did show capsaicin treated *D. meadia* seeds had two to three times as many seedlings compared to untreated seeds. Seedling emergence data in 2006 and 2007 showed that *D. meadia* averaged 376.9 seedlings/m^2 for capsaicin treated seeds in 2006. This is 2.13 times more seedlings than the 176.9 seedlings/m^2 observed in the untreated plots. Again, in 2007, the capsaicin treated plots averaged 833.8 seedlings/m^2, compared to 274.7 seedlings/m^2 for untreated plots (Figure 10). These results were consistent across the two planting times of spring and fall. Both planting times received very little rain (<1cm) in the two weeks following planting. This is in contrast to the abundant rainfall immediately following the commencement of both the Summer 2006 and Fall 2006 trials of *S. integrifolium* predation. This does indicate there is a possibility of using capsaicin in some form to increase seed survival.

As with the Summer 2006 and Fall 2006 seed removal trials, capsaicin had no effect on preventing seed removal in the Invertebrates Role in Prairie Granivory study. The exclosures used for this study helped protect the seeds much more from rain and wind, so the washing away of the capsaicin should not have been a problem. The capsaicin used in this study is a commercially available product in a powder form for use in deterring squirrels from bird feeders. The powder is tested to have a rating of approximately 100,000 SHU, comparable to a very hot pepper, whereas pure capsaicin has a rating of 16 million SHU. Jensen et al. (2003) found a minimum of 2000 SHU was needed to significantly reduce rodent consumption in a controlled lab experiment. Jensen's lab results are in stark contrast to the exposed outdoor experiment described here. In addition to this minimum heat value, small mammals exposed to the capsaicin were able to acquire a tolerance to the capsaicin. The minute amount of capsaicin powder able to attach to small seeds such as *D. meadia* used in this study may not have been sufficient to cause a lasting effect. Ants do not typically consume a seed on site, but instead carry the seed back to the colony for consumption (Traniello 1989). If this is the case, although the seeds were removed in this study the seed may have survived consumption. The ant could have discarded the seed away from the Petri dish, after being affected by the capsaicin. To improve capsaicin's effectiveness, a more concentrated form of capsaicin may be needed to cause the painful sensation in granivores.

Experimental Effects on Seed Predation: Fall 2006 Trial

During the Fall 2006 trial, a block effect was uncovered, as well as a block x species interaction. Of the three species used, *S. integrifolium* had a lower incidence of loss in Block 2 (61.1% loss) compared to Block 1 (69.4% loss). *Phlox pilosa* and *D. meadia* had very similar amounts of predation to each other across blocks (Figure 5). Both blocks were contained within the UNI Prairie Preserve, but Block 2 was located adjacent to a riparian woodland whereas Block 1 was located in the interior of the prairie preserve. These results agree with work done by Nickel et al. (2003). Nickel's study found that herbivory decreased at the edge of wooded habitat compared to herbivory in the interior of a prairie. This was due to the behavior of meadow voles (most common seed predator observed) being influenced by the proximity to the woods. Block 1 in the interior of the preserve was also closer to a population of *S. tridecemlineatus* that may not have entered hibernation at the beginning of the trial. Actual data on seed predator numbers is unavailable for the Fall 2006 trial. Due to cold November temperatures, trapping was avoided during the Fall 2006 trial to eliminate the risk of mortality to the captured animals. However, trapping conducted during the Summer 2006 trial indicated similar numbers of granivores in both blocks (9 captured in Block 1 vs. 8 in Block 2).

<u>Seedling Population in Relation to Seed Predation</u>

Seed limitation from seed predation has been suggested as an important factor in shaping plant communities (Orrock et al. 2006, Turnbull et al. 2000). There is limited evidence from this study to support this hypothesis (Figure 8). The significant correlation between predation and seedlings for *D. meadia* demonstrates how high incidence of predation restricts seedlings to a very low proportion of the pure live seed added to the prairie. *Silphium integrifolium* was highly varied, with germination rates ranging from 11% to <1% of pure live seed. Other factors could be playing a role in further reducing the success of live seeds capable of germination. Although largely unstudied, fungus and bacteria can directly kill a seed by direct attack or production of toxic substances. Other factors such as failed germination from variable weather conditions can decrease seed survivorship and lessen the success of a reconstruction. (Chambers & MacMahon 1994)

Seedling herbivory is another factor that may reduce the success of a reconstruction. During the summer of 2007 I began a pilot study (not discussed in detail in this thesis) to test the effect of small animal herbivory on the establishment of new species in an existing grassland. My preliminary results do indicate that through seedling herbivory rodents may be partly responsible for depressing the number of seedlings surviving throughout the growing season.

Invertebrates' Role in Prairie Granivory

The results from this experiment do support the hypothesis that small mammals and invertebrates are responsible for seed loss in a prairie reconstruction. While they are both responsible for granivory, each group has different preferences in what is preyed upon. This was evident in the exclosure x species interaction in this part of the study. Predators in the open exclosures preferentially preyed upon *Ratibida pinnata* (93.11% ±3.6% removed after one day), with both *Sorghastrum nutans* (33.02% ±2.7% removed after one day) and *Dalea purpurea* (31.11% ±2.61% removed after one day) consumed at a much slower rate. This is different in the closed exclosure treatment, where *Ratibida pinnata* and *Dalea purpurea* were removed in similar fashion, and *Sorghastrum nutans* was the slowest removed species (Figure 9). All three species were of similar size, leading to the conclusion that seed shape or composition were the main factors in determining palatability. Traniello (1989) determined ants prefer more rounded seeds as this shape is easier to carry in their mouthparts. The data obtained from this study is consistent with his conclusion. *Ratibida pinnata* and *Dalea purpurea* are more rounded seed when compared to *Sorghastrum nutans*. Rodents, on the other hand, prefer a seed with an elongated or oblong shape (Janzen 1978). The data from my study also supports Janzen's conclusion, as the longer *Sorghastrum nutans* was predated more quickly than

Dalea purpurea. *Ratibida pinnata* was removed the quickest. This seed is more odd-shaped and may be the easiest to pick up and carry away or is the most attractive nutritionally.

By the end of this study, the combination of small mammals and invertebrates were able to remove 96.27% of the seeds. With invertebrates responsible for up to 79.4% of that removal (amount of seeds removed from closed exclosures). Both invertebrates and vertebrate granivores appear to have a considerable impact on the survival of prairie seeds in an established grassland.

Planting Time

Season of planting did have a strong effect on the success of *P. pilosa* (Figure 11). Spring 2006 planted seeds germinated much better than Fall 2006 planted seeds did when counted during the 2007 growing season. *Phlox pilosa* may have some type of secondary dormancy (Baskin & Baskin 1998) where an entire cycle of warm and cold seasons is needed to break the dormancy and induce germination. The extreme difference in outcomes of this experiment illustrates how complex prairie reconstruction can be and how difficult it will be to create a broad protocol to successfully introduce a variety of species into a reconstruction.

Conclusion

Evidence in this study supports the conclusion that granivory is at least partially responsible for the difficulty in the establishment of plant species broadcast into an established prairie reconstruction. Seed losses ranged from 60% to over 98%. Factors including the time of year, predators involved, and species of seed influence the amount of granivory. Although not tested for, I suspect larger predators such as owls, canines, and snakes may also influence granivore behavior. In addition, it is possible to reduce granivory of some species, which could increase the success of the planting. Capsaicin protected *D. meadia* seeds yielded 2.1x as many seedlings as untreated seeds. The sacrificial food treatment also significantly ($p=0.0006$) reduced the amount of seed loss during the Summer 2006 trial. One of the more interesting aspects of this study's findings is the preferential selection by granivores of some species over others. There were significant ($p<0.0001$) differences between the species studied during the Fall Trial as well as Invertebrate Role in Granivory study. Some species were nearly eliminated after a seed addition and others remaining in high numbers, suggesting that granivores could have a major influence on the floristic composition of a reconstruction. The plants that established are at least partly a reflection of the seeds granivores failed to eat. Evidence for this can be seen with the significant ($p=0.01$) correlation between seed predation and seedling emergence for *D. meadia*. For a reconstruction to become as similar as possible to a remnant area, difficult to establish species will need to be successfully introduced into the reconstruction.

Implications for Future Work

If granivory could be reduced from 98% loss to 96%, it would double the number of seeds available for germination. The two methods explored in this study have potential as a viable option for land managers. They are economical and easy to implement. With further work, these two methods can be improved upon and introduced as a part of pre-planting protocol for reconstructions. Capsaicin was chosen as a chemical deterrent due to its history of granivory deterrence and availability of the chemical. There are many other chemicals with potential feeding deterrent capabilities, some of which may be much better suited as a granivore deterrent than capsaicin. The same could be said for the use of a sacrificial food. Other food types or methods may prove more feasible and successful than the two studied here.

This study is the first step in the development of a method to increase the survival of seeds broadcast onto an established grassland. However, many questions remain unanswered. The amount of variation observed in this study suggests many factors can influence granivory. Differences in the blocks suggest the locality may shape the amount of granivory, as well as the time of year the seed is sown. The seed preferences of granivores could lead to more work looking at the natural history of prairie species to determine which ones are prone to granivory. The hope is that through continued research in this field we will be able to improve what was begun here and restore a prairie community much more reminiscent of the original tallgrass prairie.

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APPENDIX 1

SUMMER 2006 TRIAL DATA

Control									
Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
A	10	30	30	29	28	28	28	29	25
A	11	5	1	1	1	0	0	0	0
A	12	30	29	28	28	25	25	25	24
A	13	29	29	30	30	26	26	26	23
A	14	1	1	0	0	0	0	0	0
A	15	30	30	27	26	21	21	21	10
A	16	8	8	7	5	4	4	3	3

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
C	10	30	29	28	29	26	19	6	0
C	11	30	30	30	29	28	18	4	0
C	12	25	25	25	25	21	20	7	0
C	13	30	30	30	30	26	26	26	24
C	14	30	30	30	30	26	26	26	9
C	15	26	9	7	7	7	0	0	0
C	16	30	30	30	30	27	27	14	0

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
E	10	30	29	29	29	25	25	25	17
E	11	30	30	29	29	28	28	26	24
E	12	30	28	29	29	28	28	28	25
E	13	30	29	29	29	27	26	24	21
E	14	30	30	29	29	29	29	29	29
E	15	30	28	29	29	28	28	28	26
E	16	30	30	29	29	26	26	26	22

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
H	10	30	30	30	30	27	27	27	27
H	11	30	30	30	30	28	28	26	24
H	12	30	30	27	27	27	27	27	27
H	13	30	30	30	30	29	28	28	26
H	14	20	30	30	30	28	28	28	26
H	15	29	29	29	29	28	28	28	29
H	16	30	30	30	28	28	28	28	16

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
J	10	28	27	27	26	26	26	25	4
J	11	30	30	30	30	29	29	28	22
J	12	29	29	29	29	25	25	22	15
J	13	30	30	27	27	26	26	26	25
J	14	29	29	30	29	26	26	24	22
J	15	29	28	29	28	27	25	25	20
J	16	28	27	27	27	22	21	21	19

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
L	10	28	24	24	24	20	20	19	12
L	11	30	26	25	25	24	24	24	21
L	12	30	30	28	26	25	25	25	20
L	13	30	30	30	29	29	28	27	24
L	14	30	29	29	25	24	22	21	21
L	15	29	29	28	28	26	25	24	19
L	16	29	29	29	29	27	23	23	20

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
M	10	28	22	18	18	17	17	17	1
M	11	30	30	30	29	29	27	27	20
M	12	30	30	30	28	28	28	26	4
M	13	29	29	28	28	25	22	21	9
M	14	26	18	18	18	17	13	12	1
M	15	27	27	27	27	22	22	20	4
M	16	28	27	27	27	27	26	26	16

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
O	10	30	29	29	27	22	21	21	20
O	11	30	30	30	30	28	28	26	22
O	12	29	29	29	29	28	25	26	19
O	13	30	21	20	20	17	17	14	12
O	14	30	30	29	29	24	24	27	20
O	15	30	30	29	13	7	4	4	2
O	16	30	30	30	30	27	27	27	26

Sacrificial Food									
Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
B*	10	30	28	30	30	29	29	29	23
B*	11	29	29	29	29	29	29	28	27
B*	12	30	30	30	29	28	28	27	26
B*	13	30	29	29	29	29	29	29	25
B*	14	29	29	29	28	28	28	28	28
B*	15	30	30	29	29	29	29	29	26
B*	16	30	29	30	30	30	30	30	20

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
D*	10	30	30	29	29	26	26	26	19
D*	11	30	30	30	30	30	30	29	25
D*	12	29	29	30	29	27	26	26	22
D*	13	30	30	29	29	23	23	23	25
D*	14	29	29	29	29	27	27	27	27
D*	15	30	30	30	30	28	14	13	10
D*	16	30	30	30	30	28	28	28	25

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
F*	10	29	29	30	30	26	26	26	20
F*	11	30	30	30	30	28	27	25	17
F*	12	30	29	29	29	28	28	28	22
F*	13	30	30	30	30	27	27	25	8
F*	14	30	30	30	30	29	28	28	26
F*	15	24	23	22	22	12	11	9	9
F*	16	30	30	30	30	30	30	25	3

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
G*	10	30	30	30	30	30	30	30	27
G*	11	30	30	30	30	28	28	28	27
G*	12	30	30	30	30	26	26	26	22
G*	13	30	30	30	30	28	28	28	17
G*	14	30	30	30	30	30	30	30	26
G*	15	30	30	30	30	26	26	26	5
G*	16	30	30	30	30	29	29	29	8

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
I*	10	30	30	30	29	27	27	27	25
I*	11	30	30	30	30	30	29	26	25
I*	12	30	28	27	27	24	24	24	21
I*	13	30	28	30	29	24	21	21	19
I*	14	30	30	29	29	27	27	27	27
I*	15	30	30	28	27	23	22	22	20
I*	16	29	29	26	26	22	21	21	18

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
K*	10	30	30	30	30	29	28	27	26
K*	11	30	27	29	29	23	23	21	21
K*	12	30	29	29	29	28	27	27	21
K*	13	29	28	26	26	25	25	25	24
K*	14	28	28	27	26	24	24	24	22
K*	15	30	30	30	30	30	28	28	22
K*	16	28	28	28	27	24	24	24	14

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
N*	10	30	30	30	30	29	29	29	22
N*	11	29	29	29	29	28	28	28	18
N*	12	30	29	29	29	28	28	25	23
N*	13	30	30	30	30	29	28	27	24
N*	14	29	29	29	29	28	28	28	23
N*	15	29	29	29	29	27	27	27	24
N*	16	30	30	30	30	29	29	28	10

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
P*	10	30	30	30	29	23	23	23	0
P*	11	30	30	30	30	30	30	19	2
P*	12	30	28	29	29	28	28	28	24
P*	13	30	30	30	30	30	30	30	4
P*	14	30	30	30	30	29	29	28	1
P*	15	30	28	30	30	29	29	29	0
P*	16	30	30	30	30	30	30	29	22

Capsaicin									
Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
A	20	30	30	30	29	29	20	20	16
A	21	29	29	28	27	24	24	24	18
A	22	30	30	30	30	29	29	29	26
A	23	30	29	29	28	27	27	27	24
A	24	30	30	30	29	27	20	20	20
A	25	30	30	30	30	27	24	24	21
A	26	30	29	30	29	29	29	29	28

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
C	20	30	29	28	28	24	24	15	0
C	21	30	30	30	30	30	30	30	4
C	22	27	11	11	11	10	10	10	2
C	23	29	28	27	27	23	23	11	0
C	24	29	29	29	29	25	25	23	0
C	25	29	29	29	29	26	25	22	0
C	26	29	29	29	28	24	1	0	0

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
E	20	30	30	30	30	29	28	26	26
E	21	30	29	26	26	25	25	25	21
E	22	30	28	24	24	19	19	19	10
E	23	30	30	30	29	22	21	21	17
E	24	30	28	29	29	28	26	25	18
E	25	30	30	29	24	24	22	21	20
E	26	29	29	29	29	20	20	20	14

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
H	20	30	30	30	30	26	26	25	25
H	21	30	30	30	30	29	28	28	13
H	22	29	29	29	29	19	19	19	13
H	23	30	30	30	29	29	29	29	12
H	24	29	29	29	27	19	18	18	13
H	25	30	29	29	29	25	25	25	27
H	26	30	28	28	28	20	18	18	15

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
J	20	30	30	30	30	28	28	28	23
J	21	30	30	29	28	21	16	16	16
J	22	29	29	29	28	27	26	26	24
J	23	30	29	29	27	24	24	22	21
J	24	30	29	26	26	20	20	20	13
J	25	30	29	27	27	26	26	24	18
J	26	26	24	22	20	19	17	16	9

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
L	20	30	30	30	21	18	18	17	14
L	21	28	28	25	25	21	21	21	19
L	22	27	27	19	19	17	12	9	9
L	23	29	29	29	29	26	26	26	24
L	24	30	30	30	30	28	29	29	26
L	25	30	29	29	30	27	25	23	22
L	26	30	30	28	28	28	27	27	25

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
M	20	30	30	30	30	26	26	13	7
M	21	30	30	30	30	28	28	28	4
M	22	30	30	29	29	28	27	27	26
M	23	30	28	27	27	26	26	26	24
M	24	30	30	30	30	30	30	28	2
M	25	30	30	30	30	28	25	25	20
M	26	30	26	26	23	19	19	17	15

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
O	20	27	21	19	19	18	16	15	6
O	21	30	30	29	29	27	27	26	21
O	22	30	20	20	20	19	18	19	11
O	23	30	30	30	30	19	14	13	9
O	24	30	30	28	28	26	25	17	16
O	25	30	26	9	0	0	0	0	0
O	26	30	16	1	0	0	0	0	0

Sacrificial Food and Capsaicin									
Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
B*	20	30	30	28	28	21	21	21	17
B*	21	30	29	29	29	25	25	25	6
B*	22	29	29	29	29	24	24	24	24
B*	23	29	29	29	29	24	24	24	24
B*	24	30	29	30	30	29	29	29	28
B*	25	30	30	29	29	29	29	27	24
B*	26	30	30	30	29	28	28	28	26

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
D*	20	29	29	29	29	25	25	25	20
D*	21	30	30	29	28	29	29	29	25
D*	22	30	30	30	30	23	23	22	18
D*	23	30	30	30	29	29	29	29	27
D*	24	30	30	30	30	28	28	28	25
D*	25	30	30	30	27	23	23	23	21
D*	26	29	29	29	29	28	28	28	19

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
F*	20	30	30	30	30	28	27	23	5
F*	21	30	30	30	30	29	29	29	11
F*	22	30	30	30	30	26	26	26	21
F*	23	28	28	29	29	26	26	26	21
F*	24	30	30	30	30	28	27	26	5
F*	25	30	30	30	30	28	24	12	0
F*	26	30	30	30	30	30	30	28	9

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
G*	20	30	30	30	30	26	26	26	19
G*	21	29	29	29	29	29	29	29	26
G*	22	30	30	30	30	29	29	29	27
G*	23	30	30	30	30	29	29	29	14
G*	24	30	30	30	30	30	30	30	28
G*	25	30	30	30	30	29	29	28	20
G*	26	30	30	30	30	27	27	27	23

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
I*	20	30	30	30	29	28	25	24	22
I*	21	25	20	19	19	18	18	13	8
I*	22	28	27	27	27	22	21	20	15
I*	23	29	29	29	29	25	24	19	1
I*	24	30	30	29	28	25	25	25	19
I*	25	30	30	30	30	30	30	30	28
I*	26	30	30	30	29	28	28	25	22

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
K*	20	30	29	30	30	30	30	30	28
K*	21	30	30	28	28	28	28	28	25
K*	22	29	29	29	29	29	29	29	24
K*	23	29	29	29	29	26	26	26	23
K*	24	29	29	29	29	29	29	29	24
K*	25	30	30	30	30	28	29	28	25
K*	26	30	30	28	28	27	26	25	22

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
N*	20	30	29	29	29	27	27	27	28
N*	21	30	30	30	30	29	29	29	29
N*	22	30	28	28	28	27	27	27	26
N*	23	30	30	29	29	18	18	18	10
N*	24	30	30	30	30	21	21	21	19
N*	25	30	30	30	30	30	30	30	27
N*	26	30	30	29	28	26	26	25	8

Card #		Day 1	Day 2	Day 3	Day 4	Day 7	Day 9	Day 11	Day 18
P*	20	29	26	29	29	27	25	27	7
P*	21	29	29	30	29	25	25	25	0
P*	22	30	30	30	27	27	26	24	25
P*	23	30	30	29	29	28	28	27	5
P*	24	29	29	30	30	28	28	28	5
P*	25	30	30	30	30	28	20	20	0
P*	26	29	29	29	29	22	22	22	2

APPENDIX 2

EFFECTS OF SIMULATED RAIN ON CAPSAICIN TREATED SEEDS DATA

Day 1				
Plot	**TRT**	**Seed # A**	**Seed # B**	**Total**
1	1	5	0	5
1	2	25	16	41
1	3	19	4	23
1	4	19	27	46
2	1	14	0	14
2	2	13	8	21
2	3	9	22	31
2	4	6	8	14
3	1	15	19	34
3	2	4	25	29
3	3	24	27	51
3	4	19	25	44
4	1	1	0	1
4	2	27	0	27
4	3	0	24	24
4	4	23	29	52
5	1	19	8	27
5	2	23	17	40
5	3	26	25	51
5	4	6	20	26
6	1	24	0	24
6	2	24	5	29
6	3	23	18	41
6	4	20	0	20
7	1	0	0	0
7	2	22	16	38
7	3	1	17	18
7	4	0	3	3
Plot	**TRT**	**Seed # A**	**Seed # B**	
8	1	2	21	23
8	2	23	26	49
8	3	29	27	56
8	4	25	0	25
9	1	21	10	31
9	2	12	18	30
9	3	25	25	50
9	4	0	22	22
10	1	0	0	0
10	2	0	23	23
10	3	5	2	7
10	4	23	9	32
11	1	10	11	21
11	2	28	29	57

11	3	23	0	23
11	4	10	0	10
Plot	**TRT**	**Seed # A**	**Seed # B**	0
12	1	17	2	19
12	2	26	17	43
12	3	29	25	54
12	4	20	24	44
13	1	26	11	37
13	2	20	5	25
13	3	26	21	47
13	4	21	16	37
14	1	0	22	22
14	2	24	0	24
14	3	24	19	43
14	4	0	12	12
15	1	11	0	11
15	2	17	9	26
15	3	0	0	0
15	4	0	0	0

Day 2				
Plot	**TRT**	**Seed # A**	**Seed # B**	**Total**
1	1	3	0	3
1	2	0	10	10
1	3	19	0	19
1	4	0	24	24
2	1	0	0	0
2	2	0	0	0
2	3	0	0	0
2	4	0	0	0
3	1	0	0	0
3	2	1	14	15
3	3	1	5	6
3	4	0	13	13
4	1	0	0	0
4	2	18	0	18
4	3	0	0	0
4	4	0	3	3
5	1	5	0	5
5	2	9	4	13
5	3	0	18	18
5	4	3	1	4
6	1	0	0	0
6	2	0	0	0
6	3	0	0	0
6	4	2	0	2
7	1	0	0	0
7	2	1	0	1
7	3	0	0	0
7	4	0	0	0
Plot	**TRT**	**Seed # A**	**Seed # B**	0
8	1	0	0	0
8	2	13	18	31
8	3	0	0	0
8	4	14	0	14
9	1	3	6	9
9	2	1	11	12
9	3	16	0	16
9	4	0	10	10
10	1	0	0	0
10	2	0	12	12
10	3	0	0	0
10	4	0	0	0
11	1	0	0	0
11	2	20	0	20

11	3	1	0	1
11	4	6	0	6
Plot	**TRT**	**Seed # A**	**Seed # B**	0
12	1	0	1	1
12	2	0	0	0
12	3	1	0	1
12	4	0	0	0
13	1	0	0	0
13	2	0	0	0
13	3	0	3	3
13	4	0	0	0
14	1	0	11	11
14	2	0	0	0
14	3	0	3	3
14	4	0	0	0
15	1	0	0	0
15	2	2	0	2
15	3	0	0	0
15	4	0	0	0

Day 3				
Plot	**TRT**	**Seed # A**	**Seed # B**	**Total**
1	1	0	0	0
1	2	0	0	0
1	3	0	0	0
1	4	0	0	0
2	1	0	0	0
2	2	0	0	0
2	3	0	0	0
2	4	0	0	0
3	1	0	0	0
3	2	0	0	0
3	3	0	0	0
3	4	0	0	0
4	1	0	0	0
4	2	0	0	0
4	3	0	0	0
4	4	0	0	0
5	1	0	0	0
5	2	0	0	0
5	3	0	0	0
5	4	0	0	0
6	1	0	0	0
6	2	0	0	0
6	3	0	0	0
6	4	0	0	0
7	1	0	0	0
7	2	0	0	0
7	3	0	0	0
7	4	0	0	0
Plot	**TRT**	**Seed # A**	**Seed # B**	**Total**
8	1	0	0	0
8	2	0	0	0
8	3	0	0	0
8	4	0	0	0
9	1	0	0	0
9	2	0	0	0
9	3	0	0	0
9	4	0	0	0
10	1	0	0	0
10	2	0	0	0
10	3	0	0	0
10	4	0	0	0
11	1	0	0	0
11	2	0	0	0

11	3	0	0	0
11	4	0	0	0
Plot	**TRT**	**Seed # A**	**Seed # B**	**Total**
12	1	0	0	0
12	2	0	0	0
12	3	0	0	0
12	4	0	0	0
13	1	0	0	0
13	2	0	0	0
13	3	0	0	0
13	4	0	0	0
14	1	0	0	0
14	2	0	0	0
14	3	0	0	0
14	4	0	0	0
15	1	0	0	0
15	2	0	0	0
15	3	0	0	0
15	4	0	0	0

APPENDIX 3

INVERTEBRATES' ROLE IN GRANIVORY DATA

Day 1

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	13
1	Enc	Cont	IndGrass	15	1	Open	Cont	IndGrass	8
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	10		Open	Caps	PPC	14
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	13
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	13	Plot #	Open	Cont	PPC	15
2	Enc	Cont	IndGrass	15	2	Open	Cont	IndGrass	13
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	12		Open	Caps	PPC	14
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	7
	Enc	Caps	Coneflower	11		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	12
3	Enc	Cont	IndGrass	15	3	Open	Cont	IndGrass	9
	Enc	Cont	Coneflower	14		Open	Cont	Coneflower	0
	Enc	Caps	PPC	14		Open	Caps	PPC	11
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	6
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	9	Plot #	Open	Cont	PPC	12
4	Enc	Cont	IndGrass	15	4	Open	Cont	IndGrass	7
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	11		Open	Caps	PPC	2
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	10
	Enc	Caps	Coneflower	5		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	13
5	Enc	Cont	IndGrass	15	5	Open	Cont	IndGrass	15
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	13		Open	Caps	PPC	15
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	13
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	13
6	Enc	Cont	IndGrass	15	6	Open	Cont	IndGrass	11
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	15		Open	Caps	PPC	12
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	11
	Enc	Caps	Coneflower	9		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	12	Plot #	Open	Cont	PPC	15
7	Enc	Cont	IndGrass	15	7	Open	Cont	IndGrass	9
	Enc	Cont	Coneflower	9		Open	Cont	Coneflower	0
	Enc	Caps	PPC	14		Open	Caps	PPC	7
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	13
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	15
8	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	14
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	8
Plot #	Enc	Cont	PPC	15
9	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	15
	Enc	Caps	IndGrass	15
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	15
10	Enc	Cont	IndGrass	12
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	13
	Enc	Caps	Coneflower	13
Plot #	Enc	Cont	PPC	11
11	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	12
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	15
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	13
12	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	15
Plot #	Enc	Cont	PPC	14
13	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	15
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	15
14	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	14
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	15
15	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	12
	Enc	Caps	PPC	14

Plot #	Open	Cont	PPC	14
8	Open	Cont	IndGrass	13
	Open	Cont	Coneflower	0
	Open	Caps	PPC	15
	Open	Caps	IndGrass	13
	Open	Caps	Coneflower	1
Plot #	Open	Cont	PPC	14
9	Open	Cont	IndGrass	13
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	12
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	12
10	Open	Cont	IndGrass	14
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	13
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	15
11	Open	Cont	IndGrass	8
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	5
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	13
12	Open	Cont	IndGrass	12
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	12
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	9
13	Open	Cont	IndGrass	11
	Open	Cont	Coneflower	0
	Open	Caps	PPC	12
	Open	Caps	IndGrass	15
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	15
14	Open	Cont	IndGrass	15
	Open	Cont	Coneflower	15
	Open	Caps	PPC	15
	Open	Caps	IndGrass	15
	Open	Caps	Coneflower	15
Plot #	Open	Cont	PPC	15
15	Open	Cont	IndGrass	5
	Open	Cont	Coneflower	0
	Open	Caps	PPC	13

	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	9
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0

Day 2

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	14	Plot #	Open	Cont	PPC	12
1	Enc	Cont	IndGrass	14	1	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	9		Open	Caps	PPC	13
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	6
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	11	Plot #	Open	Cont	PPC	12
2	Enc	Cont	IndGrass	14	2	Open	Cont	IndGrass	9
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	12		Open	Caps	PPC	13
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	2
	Enc	Caps	Coneflower	11		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	14	Plot #	Open	Cont	PPC	12
3	Enc	Cont	IndGrass	15	3	Open	Cont	IndGrass	7
	Enc	Cont	Coneflower	13		Open	Cont	Coneflower	0
	Enc	Caps	PPC	13		Open	Caps	PPC	10
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	2
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	9	Plot #	Open	Cont	PPC	10
4	Enc	Cont	IndGrass	13	4	Open	Cont	IndGrass	2
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	11		Open	Caps	PPC	2
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	5		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	11
5	Enc	Cont	IndGrass	14	5	Open	Cont	IndGrass	3
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	13		Open	Caps	PPC	15
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	7
	Enc	Caps	Coneflower	14		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	12
6	Enc	Cont	IndGrass	15	6	Open	Cont	IndGrass	11
	Enc	Cont	Coneflower	14		Open	Cont	Coneflower	0
	Enc	Caps	PPC	12		Open	Caps	PPC	12
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	11
	Enc	Caps	Coneflower	9		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	10
7	Enc	Cont	IndGrass	13
	Enc	Cont	Coneflower	8
	Enc	Caps	PPC	13
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	15
8	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	13
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	7
Plot #	Enc	Cont	PPC	15
9	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	14
	Enc	Caps	IndGrass	13
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15
10	Enc	Cont	IndGrass	12
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	13
	Enc	Caps	Coneflower	13
Plot #	Enc	Cont	PPC	11
11	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	13
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	12
12	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	15
Plot #	Enc	Cont	PPC	14
13	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	15
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	14
14	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	12

Plot #	Open	Cont	PPC	14
7	Open	Cont	IndGrass	4
	Open	Cont	Coneflower	0
	Open	Caps	PPC	7
	Open	Caps	IndGrass	6
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	13
8	Open	Cont	IndGrass	4
	Open	Cont	Coneflower	0
	Open	Caps	PPC	13
	Open	Caps	IndGrass	10
	Open	Caps	Coneflower	1
Plot #	Open	Cont	PPC	13
9	Open	Cont	IndGrass	13
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	15
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	5
10	Open	Cont	IndGrass	9
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	11
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	11
11	Open	Cont	IndGrass	1
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	5
12	Open	Cont	IndGrass	8
	Open	Cont	Coneflower	0
	Open	Caps	PPC	3
	Open	Caps	IndGrass	8
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	9
13	Open	Cont	IndGrass	9
	Open	Cont	Coneflower	0
	Open	Caps	PPC	11
	Open	Caps	IndGrass	13
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	15
14	Open	Cont	IndGrass	15
	Open	Cont	Coneflower	15
	Open	Caps	PPC	15

	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	14
	Enc	Caps	Coneflower	14		Open	Caps	Coneflower	15
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	15
15	Enc	Cont	IndGrass	14	15	Open	Cont	IndGrass	5
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	15		Open	Caps	PPC	12
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	9
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0

Day 5

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	14	Plot #	Open	Cont	PPC	10
1	Enc	Cont	IndGrass	14	1	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	9		Open	Caps	PPC	10
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	6
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	9	Plot #	Open	Cont	PPC	9
2	Enc	Cont	IndGrass	14	2	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	13		Open	Cont	Coneflower	0
	Enc	Caps	PPC	9		Open	Caps	PPC	12
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	2
	Enc	Caps	Coneflower	11		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	13	Plot #	Open	Cont	PPC	9
3	Enc	Cont	IndGrass	15	3	Open	Cont	IndGrass	3
	Enc	Cont	Coneflower	11		Open	Cont	Coneflower	0
	Enc	Caps	PPC	13		Open	Caps	PPC	10
	Enc	Caps	IndGrass	12		Open	Caps	IndGrass	2
	Enc	Caps	Coneflower	13		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	7	Plot #	Open	Cont	PPC	4
4	Enc	Cont	IndGrass	13	4	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	12		Open	Cont	Coneflower	0
	Enc	Caps	PPC	7		Open	Caps	PPC	0
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	11
5	Enc	Cont	IndGrass	14	5	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	12		Open	Caps	PPC	14
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	1		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	15
6	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	8
Plot #	Enc	Cont	PPC	9
7	Enc	Cont	IndGrass	13
	Enc	Cont	Coneflower	8
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	10
8	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	15
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	7
Plot #	Enc	Cont	PPC	15
9	Enc	Cont	IndGrass	13
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	7
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	13
10	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	11
Plot #	Enc	Cont	PPC	11
11	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	13
	Enc	Caps	PPC	8
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	10
12	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	10
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	6
Plot #	Enc	Cont	PPC	14
13	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	14
	Enc	Caps	PPC	12

Plot #	Open	Cont	PPC	12
6	Open	Cont	IndGrass	11
	Open	Cont	Coneflower	0
	Open	Caps	PPC	8
	Open	Caps	IndGrass	10
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	13
7	Open	Cont	IndGrass	4
	Open	Cont	Coneflower	0
	Open	Caps	PPC	6
	Open	Caps	IndGrass	5
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	13
8	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	9
	Open	Caps	IndGrass	1
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	11
9	Open	Cont	IndGrass	13
	Open	Cont	Coneflower	0
	Open	Caps	PPC	3
	Open	Caps	IndGrass	13
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	4
10	Open	Cont	IndGrass	9
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	5
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	11
11	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	1
12	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	1
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	7
13	Open	Cont	IndGrass	9
	Open	Cont	Coneflower	0
	Open	Caps	PPC	10

	Enc	Caps	IndGrass	10		Open	Caps	IndGrass	11
	Enc	Caps	Coneflower	10		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	14	Plot #	Open	Cont	PPC	13
14	Enc	Cont	IndGrass	14	14	Open	Cont	IndGrass	10
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	2
	Enc	Caps	PPC	11		Open	Caps	PPC	12
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	14
	Enc	Caps	Coneflower	14		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	11
15	Enc	Cont	IndGrass	12	15	Open	Cont	IndGrass	4
	Enc	Cont	Coneflower	13		Open	Cont	Coneflower	0
	Enc	Caps	PPC	9		Open	Caps	PPC	6
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	9
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0

Day 12

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	14	Plot #	Open	Cont	PPC	4
1	Enc	Cont	IndGrass	14	1	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	15		Open	Cont	Coneflower	0
	Enc	Caps	PPC	8		Open	Caps	PPC	8
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	15		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	7	Plot #	Open	Cont	PPC	0
2	Enc	Cont	IndGrass	12	2	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	4		Open	Cont	Coneflower	0
	Enc	Caps	PPC	5		Open	Caps	PPC	0
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	8	Plot #	Open	Cont	PPC	9
3	Enc	Cont	IndGrass	14	3	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	8		Open	Cont	Coneflower	0
	Enc	Caps	PPC	7		Open	Caps	PPC	9
	Enc	Caps	IndGrass	15		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	7		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	7	Plot #	Open	Cont	PPC	4
4	Enc	Cont	IndGrass	13	4	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	12		Open	Cont	Coneflower	0
	Enc	Caps	PPC	7		Open	Caps	PPC	0
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	8
5	Enc	Cont	IndGrass	11
	Enc	Cont	Coneflower	10
	Enc	Caps	PPC	8
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	3
6	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	1
	Enc	Caps	IndGrass	13
	Enc	Caps	Coneflower	8
Plot #	Enc	Cont	PPC	9
7	Enc	Cont	IndGrass	15
	Enc	Cont	Coneflower	8
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	14
	Enc	Caps	Coneflower	14
Plot #	Enc	Cont	PPC	9
8	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	13
	Enc	Caps	PPC	12
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	12
Plot #	Enc	Cont	PPC	15
9	Enc	Cont	IndGrass	12
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	9
	Enc	Caps	IndGrass	7
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	10
10	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	8
	Enc	Caps	IndGrass	12
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	11
11	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	13
	Enc	Caps	PPC	5
	Enc	Caps	IndGrass	11
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	3
12	Enc	Cont	IndGrass	14
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	5

Plot #	Open	Cont	PPC	11
5	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	11
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	12
6	Open	Cont	IndGrass	7
	Open	Cont	Coneflower	0
	Open	Caps	PPC	5
	Open	Caps	IndGrass	9
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	10
7	Open	Cont	IndGrass	4
	Open	Cont	Coneflower	0
	Open	Caps	PPC	2
	Open	Caps	IndGrass	4
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	11
8	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	8
	Open	Caps	IndGrass	1
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	11
9	Open	Cont	IndGrass	11
	Open	Cont	Coneflower	0
	Open	Caps	PPC	2
	Open	Caps	IndGrass	5
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	3
10	Open	Cont	IndGrass	8
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	4
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	6
11	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
12	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	1

	Enc	Caps	IndGrass	12		Open	Caps	IndGrass	1
	Enc	Caps	Coneflower	6		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	1	Plot #	Open	Cont	PPC	6
13	Enc	Cont	IndGrass	9	13	Open	Cont	IndGrass	6
	Enc	Cont	Coneflower	4		Open	Cont	Coneflower	0
	Enc	Caps	PPC	6		Open	Caps	PPC	8
	Enc	Caps	IndGrass	9		Open	Caps	IndGrass	8
	Enc	Caps	Coneflower	7		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	10	Plot #	Open	Cont	PPC	10
14	Enc	Cont	IndGrass	13	14	Open	Cont	IndGrass	7
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	9		Open	Caps	PPC	6
	Enc	Caps	IndGrass	12		Open	Caps	IndGrass	14
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	15	Plot #	Open	Cont	PPC	4
15	Enc	Cont	IndGrass	10	15	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	11		Open	Cont	Coneflower	0
	Enc	Caps	PPC	6		Open	Caps	PPC	1
	Enc	Caps	IndGrass	13		Open	Caps	IndGrass	3
	Enc	Caps	Coneflower	14		Open	Caps	Coneflower	0

Day 22

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	0
1	Enc	Cont	IndGrass	6	1	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	1		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	0
	Enc	Caps	IndGrass	14		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	3		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	4	Plot #	Open	Cont	PPC	0
2	Enc	Cont	IndGrass	10	2	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	3		Open	Caps	PPC	0
	Enc	Caps	IndGrass	8		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	6
3	Enc	Cont	IndGrass	6	3	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	5
	Enc	Caps	IndGrass	7		Open	Caps	IndGrass	1
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	5
4	Enc	Cont	IndGrass	10
	Enc	Cont	Coneflower	10
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	5
	Enc	Caps	Coneflower	6
Plot #	Enc	Cont	PPC	0
5	Enc	Cont	IndGrass	7
	Enc	Cont	Coneflower	2
	Enc	Caps	PPC	2
	Enc	Caps	IndGrass	8
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	0
6	Enc	Cont	IndGrass	13
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	9
	Enc	Caps	Coneflower	8
Plot #	Enc	Cont	PPC	0
7	Enc	Cont	IndGrass	7
	Enc	Cont	Coneflower	5
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	1
	Enc	Caps	Coneflower	5
Plot #	Enc	Cont	PPC	0
8	Enc	Cont	IndGrass	6
	Enc	Cont	Coneflower	10
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	9
	Enc	Caps	Coneflower	3
Plot #	Enc	Cont	PPC	9
9	Enc	Cont	IndGrass	8
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	4
	Enc	Caps	IndGrass	9
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	3
10	Enc	Cont	IndGrass	13
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	10
	Enc	Caps	Coneflower	3
Plot #	Enc	Cont	PPC	3
11	Enc	Cont	IndGrass	5
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	5

Plot #	Open	Cont	PPC	0
4	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
5	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
6	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	5
7	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	1
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	9
8	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	2
9	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	3
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
10	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
11	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0

	Enc	Caps	IndGrass	0		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	1		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	0
12	Enc	Cont	IndGrass	13	12	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	0
	Enc	Caps	IndGrass	10		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	6		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	0
13	Enc	Cont	IndGrass	8	13	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	3		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	0
	Enc	Caps	IndGrass	4		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	7	Plot #	Open	Cont	PPC	2
14	Enc	Cont	IndGrass	11	14	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	4		Open	Caps	PPC	4
	Enc	Caps	IndGrass	10		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	1
15	Enc	Cont	IndGrass	7	15	Open	Cont	IndGrass	4
	Enc	Cont	Coneflower	2		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	0
	Enc	Caps	IndGrass	7		Open	Caps	IndGrass	7
	Enc	Caps	Coneflower	3		Open	Caps	Coneflower	0

Day 29

Enclosed					Open				
		Trt	Species	Seed #			Trt	Species	Seed #
Plot #	Enc	Cont	PPC	0	Plot #	Open	Cont	PPC	0
1	Enc	Cont	IndGrass	0	1	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	0		Open	Caps	PPC	0
	Enc	Caps	IndGrass	0		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	4	Plot #	Open	Cont	PPC	0
2	Enc	Cont	IndGrass	0	2	Open	Cont	IndGrass	0
	Enc	Cont	Coneflower	0		Open	Cont	Coneflower	0
	Enc	Caps	PPC	3		Open	Caps	PPC	0
	Enc	Caps	IndGrass	0		Open	Caps	IndGrass	0
	Enc	Caps	Coneflower	0		Open	Caps	Coneflower	0

Plot #	Enc	Cont	PPC	0
3	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	3
4	Enc	Cont	IndGrass	9
	Enc	Cont	Coneflower	9
	Enc	Caps	PPC	3
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
5	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	2
	Enc	Caps	Coneflower	1
Plot #	Enc	Cont	PPC	0
6	Enc	Cont	IndGrass	6
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	2
	Enc	Caps	Coneflower	8
Plot #	Enc	Cont	PPC	0
7	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	1
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
8	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	7
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	4
9	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
10	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0

Plot #	Open	Cont	PPC	0
3	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	4
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
4	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
5	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
6	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
7	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
8	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
9	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
10	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0

	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
11	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
12	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	6
Plot #	Enc	Cont	PPC	0
13	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	2
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
14	Enc	Cont	IndGrass	1
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	3
	Enc	Caps	Coneflower	0
Plot #	Enc	Cont	PPC	0
15	Enc	Cont	IndGrass	0
	Enc	Cont	Coneflower	0
	Enc	Caps	PPC	0
	Enc	Caps	IndGrass	0
	Enc	Caps	Coneflower	0

	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
11	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
12	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	1
13	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
14	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	1
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0
Plot #	Open	Cont	PPC	0
15	Open	Cont	IndGrass	0
	Open	Cont	Coneflower	0
	Open	Caps	PPC	0
	Open	Caps	IndGrass	0
	Open	Caps	Coneflower	0

APPENDIX 4

FALL 2006 SEED PREDATION TRIAL DATA

Control

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
A	Siin	1	28	28	25	26	26	26
A	Siin	2	27	23	25	24	18	18
A	Siin	3	27	27	25	24	23	23
A	Siin	4	29	27	27	23	20	20
A	Siin	5	28	28	25	25	29	27

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
A	Phpi	1	40	0	0	0	0	0
A	Phpi	2	38	2	2	0	0	0
A	Phpi	3	40	1	2	0	0	0
A	Phpi	4	38	4	2	0	0	0
A	Phpi	5	39	1	1	1	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
A	Dome	1	36	0	0	0	0	0
A	Dome	2	33	7	0	0	0	0
A	Dome	3	36	0	0	5	0	0
A	Dome	4	38	6	5	5	4	4
A	Dome	5	35	8	4	4	2	1

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
C	Siin	1	28	28	28	21	21	19
C	Siin	2	28	11	8	7	8	7
C	Siin	3	26	20	9	8	10	8
C	Siin	4	30	9	9	3	3	2
C	Siin	5	27	26	25	3	3	2

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
C	Phpi	1	40	6	4	0	0	0
C	Phpi	2	37	2	2	0	0	0
C	Phpi	3	38	4	4	0	0	0
C	Phpi	4	39	1	0	0	0	0
C	Phpi	5	39	8	8	2	2	1

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
C	Dome	1	36	0	0	5	0	0
C	Dome	2	38	6	5	5	4	4
C	Dome	3	37	15	15	14	13	13
C	Dome	4	31	5	5	5	4	4
C	Dome	5	34	6	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
I	Siin	1	29	25	7	6	6	6

I	Siin	2	30	29	28	27	27	27
I	Siin	3	28	28	28	23	4	2
I	Siin	4	30	29	28	23	17	15
I	Siin	5	28	25	25	15	14	12

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
I	Phpi	1	35	2	2	0	0	0
I	Phpi	2	33	0	0	0	0	0
I	Phpi	3	38	2	2	0	0	0
I	Phpi	4	38	0	0	0	0	0
I	Phpi	5	39	0	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
I	Dome	1	38	7	7	6	7	7
I	Dome	2	40	9	9	9	9	7
I	Dome	3	37	15	15	4	3	3
I	Dome	4	31	5	5	5	4	4
I	Dome	5	32	7	7	7	2	1

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
J	Siin	1	30	29	29	27	21	21
J	Siin	2	28	26	27	16	11	12
J	Siin	3	31	30	30	3	3	0
J	Siin	4	28	24	24	24	19	19
J	Siin	5	29	27	25	20	17	13

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
J	Phpi	1	34	0	0	0	0	0
J	Phpi	2	35	0	0	0	0	0
J	Phpi	3	35	1	1	0	0	0
J	Phpi	4	37	1	1	0	0	0
J	Phpi	5	36	1	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
J	Dome	1	39	24	21	17	17	17
J	Dome	2	34	0	0	0	0	0
J	Dome	3	36	14	0	0	0	0
J	Dome	4	32	12	12	8	0	0
J	Dome	5	37	14	14	14	7	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
L	Siin	1	29	29	29	29	27	7
L	Siin	2	30	29	29	28	26	26
L	Siin	3	30	29	29	28	23	22
L	Siin	4	30	30	30	28	29	25

L	Siin	5	30	30	30	29	29	29

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
L	Phpi	1	39	0	0	0	0	0
L	Phpi	2	38	1	0	0	0	0
L	Phpi	3	36	2	0	0	0	0
L	Phpi	4	38	1	1	0	0	0
L	Phpi	5	35	0	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
L	Dome	1	37	15	15	14	13	13
L	Dome	2	31	5	5	5	4	4
L	Dome	3	33	5	5	5	0	0
L	Dome	4	34	15	6	6	6	0
L	Dome	5	38	22	2	2	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
O	Siin	1	27	27	25	21	18	11
O	Siin	2	29	27	13	12	12	12
O	Siin	3	30	22	22	17	17	16
O	Siin	4	29	28	25	24	25	5
O	Siin	5	29	27	21	14	19	15

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
O	Phpi	1	32	1	2	0	0	0
O	Phpi	2	39	1	1	1	1	0
O	Phpi	3	39	0	1	0	0	0
O	Phpi	4	39	3	3	0	0	0
O	Phpi	5	33	4	4	1	1	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
O	Dome	1	40	20	20	16	15	15
O	Dome	2	35	0	0	1	1	1
O	Dome	3	38	18	0	0	0	0
O	Dome	4	37	12	2	0	0	0
O	Dome	5	33	15	15	15	7	7

Sacrifice Food

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
B	Siin	1	29	21	14	11	11	7
B	Siin	2	30	6	4	4	3	2
B	Siin	3	26	7	3	3	5	4
B	Siin	4	29	18	18	9	7	5
B	Siin	5	30	14	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
B	Phpi	1	39	5	3	1	1	1
B	Phpi	2	36	1	1	0	0	0
B	Phpi	3	38	8	4	0	0	0
B	Phpi	4	38	11	7	0	0	0
B	Phpi	5	40	8	5	1	1	1

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
B	Dome	1	32	7	8	0	3	3
B	Dome	2	15	0	0	0	1	1
B	Dome	3	24	12	4	4	4	0
B	Dome	4	27	12	0	0	0	0
B	Dome	5	22	13	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
F	Siin	1	30	28	12	11	10	10
F	Siin	2	29	27	27	26	3	1
F	Siin	3	29	26	22	19	20	20
F	Siin	4	27	25	16	16	17	16
F	Siin	5	30	27	24	21	21	20

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
F	Phpi	1	40	8	9	2	2	2
F	Phpi	2	40	6	6	2	1	1
F	Phpi	3	38	3	5	1	0	0
F	Phpi	4	40	2	0	0	0	0
F	Phpi	5	36	0	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
F	Dome	1	20	0	0	0	0	0
F	Dome	2	26	6	5	4	4	4
F	Dome	3	25	5	0	0	0	0
F	Dome	4	28	8	4	0	0	0
F	Dome	5	31	10	8	6	4	4

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
G	Siin	1	30	30	30	27	2	0

G	Siin	2	24	22	19	19	17	16
G	Siin	3	31	29	29	23	25	22
G	Siin	4	26	24	16	14	9	6
G	Siin	5	29	26	7	6	1	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
G	Phpi	1	37	6	5	1	0	0
G	Phpi	2	39	3	2	0	0	0
G	Phpi	3	40	5	5	1	0	0
G	Phpi	4	39	4	4	0	0	0
G	Phpi	5	27	8	7	1	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
G	Dome	1	39	5	5	2	0	0
G	Dome	2	15	0	0	0	0	0
G	Dome	3	26	10	1	1	1	1
G	Dome	4	32	8	8	8	8	4
G	Dome	5	22	8	3	3	3	3

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
K	Siin	1	29	29	26	26	21	15
K	Siin	2	30	30	30	30	30	21
K	Siin	3	30	30	30	30	30	30
K	Siin	4	29	28	29	27	24	23
K	Siin	5	26	24	23	19	12	5

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
K	Phpi	1	33	0	0	0	0	0
K	Phpi	2	39	4	3	0	0	0
K	Phpi	3	38	6	4	2	0	0
K	Phpi	4	35	0	0	0	0	0
K	Phpi	5	34	1	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
K	Dome	1	20	0	0	0	0	0
K	Dome	2	30	2	2	2	2	2
K	Dome	3	25	4	4	4	0	0
K	Dome	4	22	6	0	0	0	0
K	Dome	5	28	8	8	3	3	3

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
M	Siin	1	30	30	28	13	13	10
M	Siin	2	30	30	28	7	5	5
M	Siin	3	16	14	14	5	4	4
M	Siin	4	30	25	17	4	2	2

M	Siin	5	26	24	19	3	3	3

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
M	Phpi	1	36	0	0	0	0	0
M	Phpi	2	37	1	1	0	0	0
M	Phpi	3	37	2	4	0	0	0
M	Phpi	4	36	13	4	0	0	0
M	Phpi	5	40	2	2	1	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
M	Dome	1	23	0	0	0	0	0
M	Dome	2	32	1	1	0	0	0
M	Dome	3	28	5	5	5	1	1
M	Dome	4	25	1	1	1	0	0
M	Dome	5	29	8	3	3	3	1

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
Q	Siin	1	29	25	25	20	20	20
Q	Siin	2	27	27	13	12	8	8
Q	Siin	3	24	26	16	5	5	4
Q	Siin	4	21	21	21	20	17	17
Q	Siin	5	28	27	24	24	4	3

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
Q	Phpi	1	34	1	1	0	0	0
Q	Phpi	2	30	0	0	0	0	0
Q	Phpi	3	22	0	2	0	0	0
Q	Phpi	4	26	0	0	0	0	0
Q	Phpi	5	27	0	0	0	0	0

Card #			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
Q	Dome	1	32	0	0	0	1	0
Q	Dome	2	38	13	13	10	9	9
Q	Dome	3	36	9	4	4	4	4
Q	Dome	4	32	12	12	0	0	0
Q	Dome	5	37	7	7	0	0	0

Capsaicin

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
D	Siin	1	30	27	27	24	13	10
D	Siin	2	27	21	5	5	5	5
D	Siin	3	26	22	3	0	0	0
D	Siin	4	30	29	30	3	3	2
D	Siin	5	30	27	17	17	16	16

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
D	Phpi	1	15	0	0	0	0	0
D	Phpi	2	40	1	0	0	0	0
D	Phpi	3	34	0	0	0	0	0
D	Phpi	4	32	0	0	0	0	0
D	Phpi	5	30	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
D	Dome	1	38	21	21	19	18	18
D	Dome	2	38	18	18	14	14	14
D	Dome	3	33	20	16	16	13	13
D	Dome	4	35	16	14	14	14	14
D	Dome	5	38	20	20	18	18	18

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
E	Siin	1	30	28	2	2	1	1
E	Siin	2	30	5	2	2	2	2
E	Siin	3	30	16	4	4	2	1
E	Siin	4	27	0	0	0	0	0
E	Siin	5	30	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
E	Phpi	1	33	1	0	0	0	0
E	Phpi	2	39	1	0	0	0	0
E	Phpi	3	39	0	0	0	0	0
E	Phpi	4	39	3	3	0	0	0
E	Phpi	5	37	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
E	Dome	1	20	0	8	0	0	0
E	Dome	2	36	8	8	4	4	3
E	Dome	3	30	10	8	8	8	8
E	Dome	4	37	10	6	6	2	2
E	Dome	5	27	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
H	Siin	1	39	30	29	7	8	5

H	Siin	2	30	29	29	25	18	16
H	Siin	3	21	21	23	16	10	8
H	Siin	4	28	27	26	4	4	4
H	Siin	5	28	29	25	2	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
H	Phpi	1	34	0	0	0	0	0
H	Phpi	2	36	0	0	0	0	0
H	Phpi	3	40	0	0	0	0	0
H	Phpi	4	35	0	0	0	0	0
H	Phpi	5	34	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
H	Dome	1	40	12	15	8	7	6
H	Dome	2	40	0	0	0	0	0
H	Dome	3	40	12	8	8	2	2
H	Dome	4	38	10	8	8	8	8
H	Dome	5	37	5	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
N	Siin	1	29	28	28	15	14	14
N	Siin	2	28	13	4	0	0	0
N	Siin	3	24	12	10	6	2	2
N	Siin	4	28	28	28	23	21	12
N	Siin	5	30	29	29	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
N	Phpi	1	35	1	0	0	0	0
N	Phpi	2	26	0	0	0	0	0
N	Phpi	3	34	0	0	0	0	0
N	Phpi	4	36	0	0	0	0	0
N	Phpi	5	32	1	1	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
N	Dome	1	33	6	5	3	3	3
N	Dome	2	34	0	0	0	0	0
N	Dome	3	36	8	4	4	0	0
N	Dome	4	32	8	0	0	0	0
N	Dome	5	35	10	5	5	5	5

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
P	Siin	1	30	29	29	19	9	8
P	Siin	2	28	28	28	26	20	18
P	Siin	3	28	27	19	12	11	4
P	Siin	4	24	24	16	11	7	7

P	Siin	5	30	29	29	25	21	21

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
P	Phpi	1	26	0	0	0	0	0
P	Phpi	2	28	0	0	0	0	0
P	Phpi	3	34	0	0	0	0	0
P	Phpi	4	29	0	0	0	0	0
P	Phpi	5	34	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
P	Dome	1	36	5	5	4	4	4
P	Dome	2	38	2	0	0	0	0
P	Dome	3	38	5	3	3	3	0
P	Dome	4	35	0	0	0	0	0
P	Dome	5	36	8	6	6	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
R	Siin	1	26	26	24	24	22	22
R	Siin	2	29	26	25	23	11	2
R	Siin	3	28	25	4	4	4	3
R	Siin	4	30	30	18	12	12	4
R	Siin	5	26	24	24	9	10	5

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
R	Phpi	1	32	0	0	0	0	0
R	Phpi	2	24	0	0	0	0	0
R	Phpi	3	34	0	1	0	0	0
R	Phpi	4	34	0	0	0	0	0
R	Phpi	5	27	0	0	0	0	0

Plot			Day 5	Day 14	Day 19	Day 26	Day 41	Day 57
R	Dome	1	39	10	10	1	1	1
R	Dome	2	36	4	3	1	0	0
R	Dome	3	36	8	8	8	0	0
R	Dome	4	39	12	7	7	1	1
R	Dome	5	35	7	7	0	0	0

APPENDIX 5

2007 SEEDLING DATA

Block	Plot	Trt	Species	Seedlings/m^2	Sdling/1000PLS	Seedlings
1	B	Alt	Dome	1.111	0.667	5
1	F	Alt	Dome	9.111	5.467	41
1	G	Alt	Dome	11.556	6.933	52
1	B	Alt	PhPi	2.222	1.600	10
1	F	Alt	PhPi	1.778	1.280	8
1	G	Alt	PhPi	0.889	0.640	4
1	B	Alt	Siin	0.889	1.600	4
1	F	Alt	Siin	0.667	1.200	3
1	G	Alt	Siin	0.889	1.600	4
1	D	Caps	Dome	2.667	1.600	12
1	E	Caps	Dome	2.000	1.200	9
1	H	Caps	Dome	5.111	3.067	23
1	D	Caps	PhPi	1.778	1.280	8
1	E	Caps	PhPi	0.667	0.480	3
1	H	Caps	PhPi	0.444	0.320	2
1	D	Caps	Siin	0.222	0.400	1
1	E	Caps	Siin	0.667	1.200	3
1	H	Caps	Siin	1.778	3.200	8
1	A	Cont	Dome	9.778	5.867	44
1	C	Cont	Dome	1.778	1.067	8
1	I	Cont	Dome	2.889	1.733	13
1	A	Cont	PhPi	3.111	2.240	14
1	C	Cont	PhPi	0.667	0.480	3
1	I	Cont	PhPi	0.444	0.320	2
1	A	Cont	Siin	1.778	3.200	8
1	C	Cont	Siin	1.778	3.200	8
1	I	Cont	Siin	1.556	2.800	7
2	B	Alt	Dome	0.222	0.133	1
2	D	Alt	Dome	2.000	1.200	9
2	H	Alt	Dome	0.667	0.400	3
2	B	Alt	PhPi	0.222	0.160	1
2	D	Alt	PhPi	0.889	0.640	4
2	H	Alt	PhPi	0.000	0.000	0
2	B	Alt	Siin	0.222	0.400	1
2	D	Alt	Siin	2.222	4.000	10
2	H	Alt	Siin	3.111	5.600	14
2	E	Caps	Dome	2.000	1.200	9
2	G	Caps	Dome	1.111	0.667	5
2	I	Caps	Dome	2.667	1.600	12
2	E	Caps	PhPi	0.222	0.160	1
2	G	Caps	PhPi	0.000	0.000	0
2	I	Caps	PhPi	0.000	0.000	0
2	E	Caps	Siin	0.222	0.400	1
2	G	Caps	Siin	1.111	2.000	5
2	I	Caps	Siin	2.444	4.400	11

2	A	Cont	Dome	8.444	5.067	38
2	C	Cont	Dome	3.111	1.867	14
2	F	Cont	Dome	2.222	1.333	10
2	A	Cont	PhPi	0.444	0.320	2
2	C	Cont	PhPi	0.444	0.320	2
2	F	Cont	PhPi	0.444	0.320	2
2	A	Cont	Siin	0.444	0.800	2
2	C	Cont	Siin	4.000	7.200	18
2	F	Cont	Siin	4.222	7.600	19

APPENDIX 6

GRANIVORY ON CONSERVATIVE SPECIES DATA

Species	Year	Block	Time	Trt	Total	Ttl/m^2
Dome	2007	1	Fall	Caps	315	1400.00
Dome	2007	4	Fall	Caps	109	484.44
Dome	2007	6	Fall	Caps	187	831.11
Dome	2007	8	Fall	Caps	108	480.00
Dome	2007	10	Fall	Caps	139	617.78
Dome	2007	1	Spring	Caps	284	1262.22
Dome	2007	4	Spring	Caps	322	1431.11
Dome	2007	6	Spring	Caps	168	746.67
Dome	2007	8	Spring	Caps	138	613.33
Dome	2007	10	Spring	Caps	106	471.11
Dome	2007	1	Fall	Non	61	271.11
Dome	2007	4	Fall	Non	2	8.89
Dome	2007	6	Fall	Non	256	1137.78
Dome	2007	8	Fall	Non	36	160.00
Dome	2007	10	Fall	Non	29	128.89
Dome	2007	1	Spring	Non	18	80.00
Dome	2007	4	Spring	Non	29	128.89
Dome	2007	6	Spring	Non	72	320.00
Dome	2007	8	Spring	Non	82	364.44
Dome	2007	10	Spring	Non	33	146.67
Phlox	2007	1	Fall	Caps	9	8.00
Phlox	2007	2	Fall	Caps	2	1.78
Phlox	2007	3	Fall	Caps	10	8.89
Phlox	2007	5	Fall	Caps	2	1.78
Phlox	2007	9	Fall	Caps	5	4.44
Phlox	2007	1	Spring	Caps	132	117.33
Phlox	2007	2	Spring	Caps	131	116.44
Phlox	2007	3	Spring	Caps	123	109.33
Phlox	2007	5	Spring	Caps	134	119.11
Phlox	2007	9	Spring	Caps	219	194.67
Phlox	2007	1	Fall	Non	4	3.56
Phlox	2007	2	Fall	Non	1	0.89
Phlox	2007	3	Fall	Non	2	1.78
Phlox	2007	5	Fall	Non	4	3.56
Phlox	2007	9	Fall	Non	7	6.22
Phlox	2007	1	Spring	Non	48	42.67
Phlox	2007	2	Spring	Non	63	56.00
Phlox	2007	3	Spring	Non	157	139.56
Phlox	2007	5	Spring	Non	132	117.33
Phlox	2007	9	Spring	Non	139	123.56

Species	Year	Block	Time	Trt	Total	Ttl/m^2
Dome	2006	1	Fall	NoCaps		0.00
Dome	2006	4	Fall	NoCaps		0.00
Dome	2006	6	Fall	NoCaps		0.00
Dome	2006	8	Fall	NoCaps		0.00
Dome	2006	10	Fall	NoCaps		0.00
Dome	2006	1	Fall	Caps		0.00
Dome	2006	4	Fall	Caps		0.00
Dome	2006	6	Fall	Caps		0.00
Dome	2006	8	Fall	Caps		0.00
Dome	2006	10	Fall	Caps		
Dome	2006	1	Spring	NoCaps	36	160.00
Dome	2006	4	Spring	NoCaps	48	213.33
Dome	2006	6	Spring	NoCaps	24	106.67
Dome	2006	8	Spring	NoCaps	48	213.33
Dome	2006	10	Spring	NoCaps	43	191.11
Dome	2006	1	Spring	Caps	68	302.22
Dome	2006	4	Spring	Caps	96	426.67
Dome	2006	6	Spring	Caps	75	333.33
Dome	2006	8	Spring	Caps	78	346.67
Dome	2006	10	Spring	Caps	107	475.56
Phpi	2006	1	Fall	NoCaps		0.00
Phpi	2006	2	Fall	NoCaps		0.00
Phpi	2006	3	Fall	NoCaps		0.00
Phpi	2006	5	Fall	NoCaps		0.00
Phpi	2006	9	Fall	NoCaps		0.00
Phpi	2006	1	Fall	Caps		0.00
Phpi	2006	2	Fall	Caps		0.00
Phpi	2006	3	Fall	Caps		0.00
Phpi	2006	5	Fall	Caps		0.00
Phpi	2006	9	Fall	Caps		0.00
Phpi	2006	1	Spring	NoCaps	12	10.67
Phpi	2006	2	Spring	NoCaps	58	51.56
Phpi	2006	3	Spring	NoCaps	38	33.78
Phpi	2006	5	Spring	NoCaps	16	14.22
Phpi	2006	9	Spring	NoCaps	20	17.78
Phpi	2006	1	Spring	Caps	14	12.44
Phpi	2006	2	Spring	Caps	53	47.11
Phpi	2006	3	Spring	Caps	59	52.44
Phpi	2006	5	Spring	Caps	9	8.00
Phpi	2006	9	Spring	Caps	25	22.22