EXPORT OF INSECT ECOSYSTEM SERVICES FROM HAYED NATIVE PRAIRIE

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Natural areas, such as prairie, have the potential to provide the benefits of pest suppression and pollination for agricultural production. In Nebraska, prairie is often used for hay production. The impact of prairie hay production management practices on beneficial arthropods is not well understood. Four prairie hay meadows adjacent to row crop fields were selected in northeast Nebraska. The goal was to assess the impact of haying them on beneficial arthropods and the movement of natural enemies into adjacent crop fields. Three management practices were evaluated for hay harvested from prairie meadows one cut per growing season, two cuts per growing season, and an uncut control. During the course of this study, prairie hay yield and quality were compared between the one and two cutting treatments. The study was conducted from 2012 to 2014. Due to the extreme conditions of drought and heat in 2012, the meadow scheduled to be cut twice received only one cutting, and consequently, 2013 and 2014 data are the only years used in analyzing the results. Natural enemies in the row crop field were sampled using yellow sticky cards (YSC) and pitfall traps. Traps were placed 0, 5, 10, 25, and 50m from the interface of corn or soybean fields with the prairie hay meadow. Two additional sampling methods were used in the prairie hay meadow: sweep netting and blue cross vane traps. Natural enemies and beneficial arthropods were analyzed for abundance/activity density and community composition differences. Prairie hay meadow vegetation was sampled using 10 1m^2 quadrats per plot and the importance value for each plant taxa was

calculated. Crop field YSC natural enemy differences in abundance were at 25 and 50m. Pitfall differences in abundance were at 0, 5, and 10m. The uncut control had a greater abundance or activity density measured by pitfall traps. Community composition differences occurred at 10m or less into the crop field. Little discernable pattern was observed in the abundance/activity density of arthropod natural enemies or pollinators within the prairie hay plots. The same was observed for arthropod natural enemies or pollinators community composition. Vegetation community composition was significantly different between the uncut treatment and the one and two cutting treatments. This may be a result of buildup of plant litter that is typically annually removed. There was a significant difference in annual yield of prairie hay with the two cutting higher than the one cutting in 2014 and both years combined. The difference may be due to management at one site allowing an additional three weeks of growth in 2014. The two cutting treatment had significantly higher crude protein. There was no difference in hay acid detergent fiber or total digestible nutrients. Abundance and activity density results from the crop field suggest that undisturbed natural areas, such as prairie, could be a potential source of insect natural enemies.

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CHAPTER 1

INTRODUCTION

Prairie Biome

Prairie is the French word for grassland. In North America, prairie refers to the grassland biome that once extended from the southern portions of Manitoba, Saskatchewan, and Alberta to Texas, and from the Rocky Mountains to eastern Iowa (Savage 2004). Prairie is often recognized by the dominance of non-woody species. Dominant grasses in the biome include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), buffalo grass (*Bouteloua dactyloides*), sideoats grama (*Bouteloua curtipendula*), indian grass (*Sorghastrum nutans*) and needle-and-thread grass (*Hesperostipa comata*) (Jones & Cushman 2004). There are a number of specialized forb species that are found in prairies, including milkweeds (*Asclepias* spp.), coneflowers (*Ratibita* spp. and *Echinacea* spp.), and compass plant and relatives (*Silphium* spp.) (Jones & Cushman 2004).

The prairie biome is often broken into the three main categories of tallgrass, mixedgrass, and shortgrass (Johnsgard 2007). Tallgrass prairie dominates in the eastern stretches of the prairie biome and runs along an east to west precipitation gradient to mixedgrass and then to shortgrass prairie in the western stretches (Jones & Cushman 2004). Depth to water table can be used to make further divisions (Coupland 1961).

Of the three main categories of prairie, tallgrass prairie is perhaps the most widely recognized (Hamilton 2005). Tallgrass prairie is often characterized by relatively flat topography, rich soil, and consistent rainfall that made it prime agricultural land and led

to its conversion since European settlement (Hamilton 2005). Remnant patches are scattered across its former reaches (Hamilton 2005). In Iowa, <0.1% of the original area remains (Smith 1998). In Nebraska, approximately 1.5 million hectares of tallgrass prairie still remain (Henebry et al. 2005). Northeast Nebraska contains both tall and mixed grass prairies. Tallgrass prairie in Nebraska contains >290 species of vascular plants while mixed grass contains >190 (Johnsgard 2007).

Prairie Hay

Prairie can be managed as a resource for agriculture. This resource is often used for hay production in Nebraska (Baker et al. 1951) and elsewhere (Briggs et al. 1948, Embry et al. 1956, Moxon et al. 1951). Typically prairie hay is cut within 5 cm of the soil surface to maximize yield (Cooper 1956), a common practice. Past research in Nebraska has shown that prairie hay cut earlier in the growing season has a higher crude protein content than when cut later (Baker et al. 1951). Additional prairie hay studies in other states have shown similar results (Briggs et al. 1948, Cooper 1956, Embry et al. 1956, Moxon et al. 1951, Streeter et al. 1966). The decrease in protein content is correlated with the increase plant maturity as the growing season progresses (Baker et al. 1951, Briggs et al. 1948, Cooper 1956, Embry et al. 1956).

Natural Areas as a Source of Beneficial Insect Predators

Ecosystem services are benefits that people receive from ecosystems (Chapin et al. 2009). These services include provisioning, regulating, and cultural services (Chapin et al. 2009). Insects contribute to these ecosystem services through various means and are involved in pollination, pest control, decomposition, and maintenance of wildlife species (Losey & Vaughan 2006). Losey and Vaughan (2006) estimate that the value of pest

control from native ecosystems for crop plants in the United States to be $13.6 billion annually. They further estimate that of that amount $4.6 billion is attributed to insects.

Hajek (2004) defines conservation biological control as modifying the environment or management practices to enhance natural enemies. Natural enemies are defined as "organisms normally killing arthropods that people consider to be pests, without human intervention" (Capinera 2004). One aspect of conservation biological control that has proven effective in reducing the impact of agricultural pests is habitat management (Landis et al. 2000). One specific example involves cereal crops bordered with *Phacelia tanacetifolia* (Hydrophyllaceae). These borders were linked to higher rates of aphid predation by syrphid fly (Syrphidae) larvae due to adult utilization of the floral resource (Sengonça & Frings 1988, Hickman & Wratten 1996). DeBach & Rosen (1991) and Menalled et al. (1999) documented that providing non-crop areas for habitat management can enhance natural enemies of crop pests by providing alternate hosts shelter (Gurr et al. 1998), and non-host food (Baggen et al. 1999, Wilkinson & Landis 2005).

Natural areas are important sources of floral resources, nesting material, and nesting substrate. These resources can vary among habitat types and across time (Westrich 1996). Isolation of habitat for pollinators has an effect on seed and fruit set (Kremen et al. 2002, Steffan-Dewenter & Tscharntke 1999). The value of pollination services for directly dependent crops in the United States is estimated at $55.99 billion in 2009 (Calderone 2012). Indirectly dependent crops have an additional estimated value of $16.02 billion in 2009 (Calderone 2012).

In recent years there has been an increasing interest in the benefits provided by maintaining naturally occurring plant communities in agricultural landscapes (Landis et al. 2000). Pollination services (Kremen et al. 2002, 2004) and the abundance of natural enemies (Cox et al. 2014, Gill et al. 2014, Ohnesorg 2008, Schmidt et al. 2011, Walton & Isaacs 2011) have been examined in recent studies. Native prairie plants have received much attention in the north central region of the United States (Cox et al. 2014, Gill et al. 2014, Schmidt et al. 2011, Walton & Isaacs 2011), since they thrive in areas of intensive agricultural production. Cox et al. (2014) and Gill et al. (2014) both found that vegetative borders around crop fields could be enhanced for natural enemies with flowering plants. Of particular interest to them in their studies were native prairie plants. However, neither was able to demonstrate increased predator abundance or predation in that adjacent row crop fields.

Some native prairie plants have been assessed for their attractiveness to natural enemies (Fiedler & Landis 2007a). They identified 24 native plant species that were considered to have high attraction to natural enemies. Many were more attractive than some commonly recommended Eurasian species. The specific plant characteristics that attract them have also been investigated (Fiedler & Landis 2007b). Floral area, period of peak bloom, maximum flower height, and decreasing corolla width were important characteristics. However, for a given time of the season, a selection based on floral area, preferably larger, alone had the potential to increase natural enemy abundance. Given these findings, it is possible to enhance habitat for natural enemies by including these native plants.

Growing and managing prairie hay meadows has the potential to beneficially impact both natural enemies and pollinators. A better understanding of how to manage natural areas for agricultural production and beneficial insect conservation is the subject of the studies reported in this dissertation.

Hypotheses & Objectives

Chapter 2

Hypothesis – Prairie hay fields are a source of natural enemies for adjacent row crop fields.

Objectives

- Determine if natural enemies move into adjacent crop fields when prairie hay fields are harvested.
- Determine how far natural enemies move into adjacent crop fields from prairie hay fields.

Chapter 3

Hypothesis – There is an impact of haying native prairie on beneficial arthropods.

Objectives

- Determine the impact of haying regime on arthropod natural enemies.
- Determine the impact of haying regime on pollinators.

Chapter 4

Hypothesis – There is a difference in quantity and quality of prairie hay between one and two cuttings per growing season.

Objectives

- Determine differences in hay quality measured in nutritive value.
- Determine differences in quantity of hay produced.

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