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Grassland bird abundance and nesting in short-duration rotationally grazed pastures in southwest Iowa

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Chapter 1. General Introduction

The vast majority of North American grassland birds have shown consistent population declines over the past 40 years. North American breeding bird surveys have shown that only 23 percent of grassland bird species showed positive population trends between 1966 and 1996, the smallest percentage of any breeding bird group (Peterjohn & Sauer, 1999). Grassland obligate species like the Dickcissel (*Spiza Americana*), Grasshopper Sparrow (*Ammodramus savannarum),* Bobolink (*Dolichonyx oryzivorus*), and Eastern Meadowlark (*Sturnella magna*), all have declining population trends in North America ranging from 1.6 to 3.6 percent annual decline (Peterjohn & Sauer, 1999). These population trends have followed the conversion of nesting habitat to agricultural production (McKenzie & Riley, 1995). One study found a direct correlation in Midwestern grassland bird population declines with a regional loss of 6.4 million hectares of pastures and hayfields between 1966 and 1992 (Herkert et al., 1996). Nineteen species show continued declines, but declines are more severe in regions where habitat loss has been the highest (Vickery & Herkert, 1998).

At the time of European settlement, grasslands represented the most dominant vegetative community in North America (Knopf, 1994). The Tallgrass Prairie once stretched from Manitoba, to Texas and from Indiana to eastern North Dakota, Nebraska, and Oklahoma. The Tallgrass Prairie totaled more than 68 million hectares with Iowa containing 12.5 million hectares, the single largest piece within any state or province (Samson & Knopf, 1994). Of Iowa's 12.5 million hectares, only 12,140 hectares remain, representing a 99.9 percent decline (Samson & Knopf, 1994). An Iowa Geological Survey land cover inventory found that in 1992, 60 percent of the state's land area was devoted to row crop production, with 30 percent covered in pasture, hay land, prairie, and wetland vegetation, and 7 percent in woodlands (Giglierano, 1999). The remaining grasslands in Iowa's landscape are dominated by introduced cool-season grass species (Barnes & Nelson, 2003). It is in this context of highly disturbed production grasslands that grassland birds must seek viable nesting habitat.

The three most common agriculture production regimes on Iowa's landscape are row crop production, hay fields, and pastures (Giglierano, 1999). Conservation Reserve Program (CRP) lands are also spread throughout the state, but are concentrated in rolling topography of southern Iowa, along the Loess Hills in western Iowa, and in the northwest corner of Iowa. CRP was a conservation provision of the 1985 Federal Food Security Act and the three other federal "farm bills" passed since then, which provides annual payments and reimbursement of some costs to landowners for removing highly erodible and environmentally sensitive cropland from production to be planted in perennial cover for at least ten years. CRP has provided some relief to many grassland bird species declines, but not all grassland bird species have benefited (Sauer et al., 1999). The future of the CRP land in Iowa is as of yet undetermined with 201,338 hectares in CRP set to expire in 2007; 144,877 hectares set to expire in 2008; and 102,790 hectares set to expire in 2009 (USDA, 2008). Coupled with historic highs in commodity grain and hay prices, a large portion of these lands may return to production. Row crop production--especially the ubiquitous corn and soybean production that covers much of the state--supports less bird use (Best et al., 1990; Best et al., 1995) and lower nest densities than other agricultural habitats (Basore et al., 1986). Nesting success rates on cropland have been observed to be below levels needed to sustain viable populations without inmigration (Basore et al., 1986).

Hayfields and pasturelands have both been observed to be far more attractive to grassland birds by supporting a larger number of species than row crop fields (Best et al., 1995). Timing may be important, as work by Kirsch et al. (1978) found that increasingly early hay harvests were very detrimental to bird nesting success. Since then, many studies have documented the detrimental effects of early hay harvesting (Hamerstrom, 1986; Frawley, 1989; Bollinger et al., 1990; Frawley & Best, 1991; Igl, 1991; Granfors, 1992; Bollinger, 1995). The major issue is that mowing cycles in hay harvesting systems are shorter than nest cycles, which results in frequent nest destruction and the death of young fledglings (Bollinger et al, 1990, Frawley & Best, 1991). Pastures may provide desirable agricultural habitat because grassland birds often favor them as the most attractive agricultural production habitat (Sample, 1989).

Pastures replace mowers with animals as the principal agent of disturbance, but not all methods of grazing manage animal disturbance equally. Animal disturbance will vary in its concentration and duration throughout a grazing management unit. One of the fundamental challenges is simply to define the management and structure of these grazing management units in order to differentiate their potential as grassland bird habitat.

The most straightforward way to define a grazing system is to define it based on grazing duration, forage removal, and rest period between grazing events. Continuous stocking is defined as grazing animals on a given unit of land to which they have unimpeded access to for a set period of time (Voisin, 1959; Barnhart et al., 1998; Allen & Collins, 2003).

Continuously stocked management units often allow cattle to overgraze parts of the pasture repeatedly without rest between grazing periods. Moser and Nelson (2003) describe succinctly the process of degradation that can occur from overgrazing:

> "Close and frequent defoliation reduces both shoot and root development because there is less leaf area to produce the carbohydrates necessary for root production. Shallower roots give less access to nutrients and especially to soil water. This results in less shoot production, further compounding the problem of a smaller root system, and the grass goes into a downward spiral. If defoliation is not relaxed, plants become weak and may eventually die" (p. 35).

Continuous stocking represents the most ubiquitous grazing method in Iowa (Barnhart et al., 1998).

Short-duration rotational stocking (SDRS) or grazing goes by many names including short-duration grazing, strip grazing, management intensive grazing, and management intensive rotational grazing. Short-duration stocking involves subdividing larger pastures into smaller units or paddocks and rotating cattle through those paddocks to allow for controlled grass removal and rest periods (Jensen et al., 1990; Barnhart et al., 1998; Allen & Collins, 2003). The number of paddocks within a SDRS management unit will vary, but a typical cow-calf grazing management unit may have between 8 and 20 paddocks, where as grass-finished cattle or dairy cattle grazing management unit may have as many as 50 or 60 paddocks (Jensen et al., 1990; Barnhart et al., 1998). Strip grazing does not have set paddock numbers but utilizes portable fencing to allow a manager to construct paddocks specific to his or her needs. Despite the lack of permanent fencing, this grazing management unit is still managed in a similar fashion to other SDRS management units.

One of the greatest misconceptions is to label all grazing management units that move cattle between paddocks as rotational stocking management units. Some grazing management units will rotate cattle between paddocks, but may not have enough subdivisions or the management commitment necessary to have a SDRS management unit. Simple rotational grazing management units should be classified as continuously stocked management units because they resemble them more closely in their propensity for overgrazing, lack of ability to limit cattle selectivity, and lack of ability to manage for maximized yield per acre (Voisin, 1959; Barnhart et al., 1998).

Continuously stocked and SDRS management units pose different risks and benefits to the bird species that live in them. Temple et al. (1999) compared bird use and productivity in ungrazed fields and continuously stocked and SDRS management units. They found that ungrazed grasslands and SDRS management units supported more bird species diversity than continuously stocked management units, but that nesting losses from cattle trampling and desertion associated with grazing were highest on SDRS management units. The researchers proposed a design for a “pro bird” grazing management unit that leaves one third of the land out of production during the prime bird nesting months of May and June, saving it for summer forage. Upon modeling this grazing management unit, the researchers found much higher nesting success rates than either continuous grazing or traditional rotational grazing (Temple et al., 1999). The researchers went on to conjecture that this grazing management unit would be most compatible with existing SDRS management units, as pastures would already be subdivided into paddocks for easier May through June set-aside.

Other studies have raised concerns about the possibility of increased cattle trampling losses when stocking density is increased in SDRS management units. Koerth et al. (1983) compared simulated nesting losses between the two types of grazing management units and found nesting losses due to trampling by cattle were higher on the continuously stocked pastures (15%) compared to the SDRS pastures (9%). Higher loss rates were attributed to longer walks between forage and water points within the continuously stocked pastures, however this study was located in western Texas where the stocking density was only 1.2 animal units (AU) per hectare. Koerth et al. (1983) and others (Jensen et al., 1990) have concluded that stocking densities in excess of 2.5 animal units per hectare could become a significant management concern. Paine et al. (1996) conducted research on trampling loss within SDRS management units on dairy farms in Wisconsin with paddocks of only 1 to 2 hectares, stocking densities between 40 to 100 AU per hectare, and grazing periods lasting less than 12 hours to 2 days. They found that about 75 percent of the original nests were destroyed during any given grazing period regardless of duration and that 94 percent of the nests lost were directly related to cattle. The high losses experienced from cattle are not as high as those experienced from hay harvesting (Bollinger et al., 1990; Paine et al., 1996).

To mitigate some of the nesting losses from cattle disturbance, a refuge component like the idled pastures in the pro bird grazing management system proposed by Temple et al. (1999) may be necessary. Pease (2004) conjectured that producers could use warm-season grasses on roughly one-third of their grazing management units to both cover the summer declines in cool-season grass productivity and provide undisturbed nesting habitat in the warm-season paddocks during the months of May and June. Pease (2004) found that cool-season and warm-season grass pastures unused by cattle were attractive to grassland birds and had similar species diversity, but cool-season grass pastures had more general use. Nest searches were conducted, but were inconclusive and only found nests on ungrazed pastures (Pease 2004). Bird use in grazed warm-season grass paddocks has been found to have 60 percent higher avian abundance, 80 percent higher fledging rate, greater bird diversity, and lower cattle disruption rates than grazed cool-season grass paddocks (Giuliano & Daves, 2002).

This research study was initiated in support of farmers, ranchers, and other resource managers who are seeking to find ways to create and promote a profitable grassland agriculture system that has tangible benefits to grassland bird species and to push the discussion forward as to what form optimal grazing management units might take. Unlike other studies that have utilized university research farms, this study sought out a production farm that has warm-season grass paddocks in use. This was to assess grassland bird use and nesting of grazed paddocks and ungrazed CRP fields, measure relationships between vegetation characteristics and avian abundance, and especially to document barriers and challenges that face resource managers. This study hypothesizes that the native warm-season grass paddocks will attract a more diverse community of birds and produce more successful nests than the introduced cool-season grass paddocks. This study also attempted to examine cool-season and warm-season grass CRP fields in order evaluate the proposed SDRS management unit as a potential future production system on CRP fields.

Thesis Organization

This thesis consists of three chapters, one of which is a paper that will be submitted for publication in the Journal of Range Management. Chapter 1 is a general introduction to frame the context in which my research work was originally developed. Chapter 2 is a paper that examines grassland bird nesting in rotationally grazed pastures in southwest Iowa. Chapter 3 contains general conclusions from this research. Ryan D. Marquardt designed the study, recruited primary funding, collected and analyzed the data, and prepared this text. Dr. James L. Pease provided additional funding, assisted with the study design, and provided guidance and editorial comments. Dr. Stephen J. Dinsmore provided assistance with the study design, data analysis and editorial comments.

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Chapter 2. Grassland Birds in Short-duration Rotationally Stocked Pastures that Incorporate Warm-season Grasses in Southwest Iowa

A paper to be submitted to the Journal of Range Management

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Abstract

This study measured abundance, nesting density, bird density and conservation value of grassland birds on four field types in southwestern Iowa (grazed cool-season and warm-season grass paddocks, and ungrazed cool and warm-season grass Conservation Reserve Program [CRP] fields). Paddocks were managed as part of a short-duration rotational stocking management unit, where the cool-season grass paddocks were in rotation from May through June and September through October, and the warm-season grass paddocks from July to August, leaving them undisturbed during much of the grassland bird nesting season. Three species had greatest densities in warm-season grass CRP fields: Sedge Wren (*Cistothorus palustris*) (2.9 ±0.94 birds/ha), Common Yellowthroat (*Geothlypis trichas*) (1.5 ±0.25 birds/ha), and Dickcissel (*Spiza Americana*) (3.8 ±0.29 birds/ha). Dickcissel was the only species with an appreciable density in the warm-season grass paddocks (3.3 ±4.60 birds/ha). Grasshopper Sparrow (*Ammodramus savannarum*) and Eastern Meadowlark (*Sturnella magna*) were primarily found in the grazed paddocks and showed a slight preference for the cool-season grass paddocks. Nest destruction by cattle disturbance was very frequent on cool-season grass paddocks. Conservation value was used as a metric to compare the diversity and conservation priority of the species assemblages of each grazing management unit. Warm-season grass CRP fields had four to five times greater conservation values throughout the season than cool-season grass CRP fields. Grazed fields were typically better than or equivalent to the cool-season grass CRP fields. We suggest that land managers should consider intensifying animal impact within grazed paddocks and increasing rest periods to avoid cattle disturbance losses on cool-season grass paddocks. Land managers should also try to manage grasslands in such a way as to increase forbs and standing dead vegetation to increase bird diversity. Refuge grasslands, undisturbed at least during prime nesting months of May and June, are likely critical for grassland birds. Monoculture cool-season grass CRP fields provide the least conservation value to bird species and mid-contract management practices should be considered to enhance them.

Key Words: nesting, abundance, rotational grazing, conservation value, grassland bird, Dickcissel, Grasshopper Sparrow, Conservation Reserve Program

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Introduction

Grassland obligate species like the Dickcissel (*Spiza Americana*), Grasshopper Sparrow (*Ammodramus savannarum),* Bobolink (Dolichonyx oryzivorus), and Eastern Meadowlark (*Sturnella magna*) all have declining population trends in North America ranging from 1.6 to 3.6 percent annual decline (Peterjohn and Sauer 1999). These population trends have followed the conversion of nesting habitat to agricultural production (McKenzie and Riley 1995), but declines are more severe in regions where habitat loss has been the highest (Herkert et al. 1996; Vickery and Herkert 1998).

In Iowa, the historic Tallgrass Prairie that once covered over 85 percent of the state now covers less than one percent (Samson and Knopf 1994). Over 60 percent of the state's land area is devoted to row crop production, with only 30 percent in grass hay fields, pastures, wetlands, prairie, and land in the Conservation Reserve Program (Giglierano 1999). The Conservation Reserve Program (CRP), was a conservation provision of the 1985 Federal Food Security Act and the three federal "farm bills" passed since, which provides annual payments and reimburses some costs to landowners for removing highly erodible and environmentally sensitive cropland from production and planting it to perennial cover for at least ten years. CRP has provided some relief to many grassland bird species declines, but not all grassland bird species have benefited (Sauer et al. 1999). The future of the CRP land in Iowa is as of yet undetermined with 201,338 hectares in CRP set to expire in 2007, 144,877 hectares set to expire in 2008, and 102,790 hectares set to expire in 2009 (USDA 2008). With historic highs in commodity grain and hay prices, a large portion of these lands may return to production. Row crop production land has been shown to have less bird use (Best et al. 1990; Best et al. 1995) and lower nest densities than both grass hayfields and grazed pastures (Basore et al. 1986).

The hayfields and pastures of Iowa are dominated by introduced cool-season grass species (Barnes and Nelson 2003). The earlier growth of these species coupled with agricultural selection for species and cultivars with earlier growth has enabled increasingly early hay harvests, which have proven to be catastrophic to nesting success (Kirsch et al. 1978; Hamerstrom 1986; Frawley 1989; Bollinger et al. 1990; Frawley and Best 1991; Igl 1991; Granfors 1992; Bollinger 1995). What has been created are hay production systems in which mowing cycles are usually shorter than nest cycles, resulting in frequent nest destruction and the death of young fledglings (Bollinger et al. 1990; Frawley and Best 1991).

Grazing management units can provide habitat to grassland birds, but certain units have been shown to have more potential than others. Temple et al. (1999) assessed continuously stocked grazing management units, short-duration rotational stocking (SDRS) management units, and ungrazed fields in terms of diversity, density, and nesting success of grassland bird species “to design grassland management systems that accommodate the needs of both livestock and nesting birds” (p. 197). Continuously stocked management units consist of a set area of land that is grazed for an extended period of time where the animals have unimpeded access to forage (Voisin 1959; Jensen et al. 1990; Barnhart et al. 1998; Allen and Collins 2003). In SDRS management units, pastures are subdivided into 8 to 60 smaller units or paddocks and cattle are rotated through those paddocks to allow management of forage removal and rest periods that increase both forage and animal productivity per hectare (Voisin 1959; Jensen et al. 1990; Barnhart et al. 1998; Allen and Collins 2003).

Temple et al. (1999) found that ungrazed fields and SDRS paddocks supported more bird species diversity than continuously stocked pastures, but that nesting losses from cattle disturbance and desertion associated with grazing were highest on SDRS paddocks. Other research in the Upper Midwest has found nest losses of around 75 percent in SDRS management units (Paine et al. 1996). Temple, et al. (1999) proposed a design for a “pro bird” grazing management unit that leaves one third of the land out of production during the prime bird nesting months of May and June. Upon modeling this grazing management unit, the researchers found much higher nesting success rates than either continuously stocked or

SDRS management units. They went on to propose that this grazing management unit would be most compatible with existing SDRS management units, as pastures would already be subdivided into paddocks for easier May through June set-aside.

Pease (2004) proposed that producers could use warm-season grasses on roughly one-third of their grazing management units to both cover the summer declines in cool-season grass productivity and provide undisturbed nesting habitat in the warm-season paddocks during the months of May and June. Compared to cool-season grass pastures, bird use in warm-season grass pastures results in 60 percent greater avian abundance, 80 percent greater fledging rate, greater bird diversity, and lower cattle disruption rates (Giuliano and Daves 2002).

This study was designed to examine a real production pro bird grazing management unit that set aside warm-season grass paddocks to be used as a refuge for grassland nesting birds during the primary breeding season of May to June and grazed in July and August. Grassland bird use and nesting in grazed paddocks and ungrazed CRP fields, relationships between vegetation characteristics and avian abundance, and documentation of barriers and challenges that face resource managers of SDRS management units were assessed by this study. This study hypothesizes that the native warm-season grass paddocks will attract a more diverse community of birds and produce more successful nests than the introduced cool-season grass paddocks. Ungrazed cool-season and warm-season grass CRP fields were examined to evaluate the proposed pro bird grazing management unit as a potential future production system on CRP fields.

Methods

Study Area & Site Management

Research was conducted in Adams County, Iowa located in the southwest corner of the state on the Southern Iowa Drift Plain, a region of steep rolling hills and deep glacial till that was formed by glaciers more than 500,000 years ago (Prior 1991). Adams County is a rural county with a 2006 United States Census estimated human population of 4,192. Once dominated by Tallgrass Prairie, Adams County now contains 63,819 hectares of cropland and an additional 9,950 hectares of grazed lands (USDA 2002). A United States Department of Agriculture Farm Service Agency Conservation Reserve Program report for March 2008 records Adams County as having 11,589 hectares actively enrolled in the program.

The research site consisted of one grazing management unit and five adjacent fields, with all of the fields located within two kilometers of each other (Fig. 1). The grazing management unit consisted of 41.36 hectares divided into twenty-four paddocks or fenced subdivisions ranging in size from 4.05 hectares to 0.57 hectares. The grazing management unit is a working farm that has been managed as a SDRS management unit since 1992. The grazing management unit is composed of 24.77 hectares cool-season grass paddocks, 10.12 hectares of warm-season grass paddocks, and 6.47 hectares of paddocks that are a mix of warm-season and cool-season grass. Five cool-season paddocks totaling 7.77 hectares and five warm-season grass paddocks totaling 6.6 hectares were selected for bird monitoring. Two of the warm-season grass paddocks were new plantings in 2005, and with additional nitrogen inputs in midsummer the majority of the grass in these stands produced seed heads. The rapid establishment of warm-season grass came at the cost of weed problems in 2006 and was addressed in 2007 with a herbicide application on both paddocks. The farm did not contain enough acres in warm-season grass to provide all of the necessary summer forage, so only the five cool-season paddocks chosen for the study were rested in July and August in both 2006 and 2007.

Fall-calving beef cows (*Bos taurus*) were utilized on the grazing management unit in both 2006 and 2007. Fifty-nine fall calving cows started grazing on April 4, 2006 and were gradually reduced in number until fully removed on October 12, 2006. In 2006, stocking density per paddock included in the study ranged from 20.6 to 86.8 animal units per hectare. Fifty fall-calving cows started on the farm on May 10, 2007, and were removed on October 11, 2007. The cattle were introduced to the grazing management unit later in 2007 due to unexpected cold weather that set back pasture grass growth. Drought conditions in 2006 resulted in shorter grass residual going into the winter so the number of grazing animals was reduced in 2007. In 2007, stocking density per paddock ranged from 73.5 to 17.4 head per hectare.

The farm operator was directed to idle the warm-season grass paddocks until after the July 4th holiday. Since none of the warm-season grass paddocks were free of cool-season grass encroachment, the warm-season grass paddocks were subjected to flash grazing within the first two weeks of May. During the brief grazing event, cows grazed the site for a day with grass removal of between one-third and one-half of the available forage. Each warm-season grass paddock was scheduled to be flash grazed once in early May. When given a choice of forages, cattle preferred the cool-season grasses throughout the grazing season, likely because of the greater proportion of nondigestible protein in most warm-season grasses (Moser and Nelson 2003). The intent of the flash grazing was to prevent the cool-season grasses from shading out the warm-season grasses and to prevent the cool-season grasses that had encroached into the field from producing seed. The farm operator kept a detailed grazing log that included information regarding rainfall, paddock movement dates, and stand height measure by meter stick before and after grazing.

Five off-farm sites served as a control and received no grazing treatment. These adjacent off-farm sites were composed of two warm-season grass and three cool-season grass fields enrolled in the CRP program. One of the cool-season CRP control fields was grazed as emergency forage in the fall of 2006, forcing the selection of a new control in 2007. The farm where the research was conducted has a special permit to graze some CRP land for experimental and demonstration purposes. This new control had a similar vegetation community and proximity to water as the cool-season CRP field it replaced, but had not been mowed as recently and contained some eastern red cedar (*Juniperus virginiana*). Field types, treatments, subdivisions, and areas are summarized in Table 1.

Bird Abundance and Species Richness

Bird abundance was measured once per week on each field during the nine-week field season. All observations were recorded in both years by the same observer with two additional non-participatory observers assisting with data recording. Point transect sampling was used instead of line transect sampling because some fields were less than one hectare and because topography on larger fields affected visibility (Buckland et al. 2001). Point transect sampling depends on four assumptions: that objects directly on the point are always detected, that objects are detected at the initial point before any movement, distances are measured accurately, and that there is no avian response to observer prior to detection

(Buckland et al. 2001). The study was designed to meet each of these assumptions by placing distance markers to make measured distances more accurate, and by waiting one minute upon arriving at a site before recording observations to avoid avian response to the observer.

A total of twenty-two point transects were located across the research site (Fig. 1). Six point transects were located in each of the warm-season grass and cool-season grass grazed paddock types. Every paddock had at least one point, with the paddocks over two hectares having two. Five points were located in each of the cool-season and warm-season CRP field types. Every CRP field had at least two points, with the fields over five hectares having three points. Point transects were centered in the middle of each paddock in the case of a single point, in the center of half of the paddock or CRP field in the case of two points, or in the center of three randomly selected quadrants in the largest CRP fields. Point-transects were then visited and adjusted to maximize visibility based on topography.

Visual and auditory observations were recorded in four distance categories of 0-30.5 meters (0-100 feet), 30.6-53.3 meters (101- 175 feet), 53.4-68.6 meters (176 to 225 feet), and greater than 68.6 meters (225 feet). Permanent bamboo stakes were placed at the point transects and served as guides to assist categorizing detections into the four distance categories. Three sets of three bamboo markers were placed radiating outward from the point of observation at 30.5, 53.3, and 68.6 meters.

Point transect sampling occurred from 0600 to 1000 hours from May 25 to July 28 and did not occur during active precipitation or during high winds (>20 km/h) (Ralph et al. 1995). Each point was visited for three minutes and was preceded by one minute of silence and minimal movement.

Nest Searches

Three intensive nest searches were conducted during the breeding season in both 2006 and 2007. A brief 2005 pilot study was conducted on-site, but those results are purely anecdotal and are not included in the results. The first round of nest searches was conducted during the last week of May, the second during the third week of June, and the third round during the second week of July. Nest searches were conducted between 1000 hours and sunset. To find nests, a modified cable-chain drag method was used to initially flush birds so an intensive nest search could subsequently locate the nest. Traditional cable-chain drag methods utilized heavy chains or cables pulled by vehicles to flush waterfowl nesting in relatively uniform and open grasslands (Higgins et al. 1969). The invasiveness of this search method in terms of altering vegetation, damaging nests with the cable and chain, and the noise from the motorized vehicle used to drag it rendered it unusable for this study. The modified drag method used in this study utilized an 11-meter light plastic chain with 1/8-inch nylon line attached every 30 centimeters (Fig. 2). The nylon line was tied to the chain and then the knot was heat fused to prevent it from coming off the chain during use. The nylon line ranged from 45 centimeters in length in the center of the chain to 76 centimeters at the ends where researchers held it. A five-centimeter diameter steel washer was tied to the ends of each section of line, and the knots were once again heat fused. The suspended washers would bounce into and out of the vegetation, flushing birds. A third person walked behind the center of the chain to help flush birds and to help spot them once flushed. After a bird was flushed, the surrounding area around was intensively searched. Records were kept for birds flushed even if no nest was found (Table 5 & Appendix 2).

Nest flags were placed three meters east of the nests to aid in relocation. When nests were found, two eggs were floated to determine age of contents following Westerskov (1950). Nests were visited every three to four days to monitor nest contents, condition, and float eggs to check progress or check developmental stage of nestlings. When a nest was found to be empty, notes about nest condition, contents, and surrounding vegetation were recorded. Nests were considered successful if at least one nestling fledged.

Vegetation Measurements

Vegetation characteristics were measured every two weeks and immediately after each grazing period from May 25 to July 28 of both years. Sampling points were located using a one-hundred-sided die, in lieu of a random number table, to indicate the number of steps north or south and east or west from a fixed starting point in a paddock or fields. The one-hundred-sided die was created using two ten-sided dice with one representing the tens value and the other the ones value. The randomized vegetation sampling amounted to a quasi-grid for each paddock and field. The number of vegetation sampling points for each paddock or CRP field was based on the size of the field and was equivalent to one plus the number of point transects the paddock or CRP field was assigned.

At each sampling point, four vegetative characteristics were measured: vertical density, maximum height of live and dead vegetation, litter depth, and percent ground cover. Vertical density was measured at each point by mean vertical obstruction measured in decimeters from four meters away using a Robel pole at a height of one meter in all four cardinal directions (Robel et al. 1970). Duff depth was measured with a ruler inserted into the litter until it made contact with the soil 0.3 m north of the Robel pole to avoid the area compacted by the insertion of the Robel pole. Maximum stand height for both live and dead vegetation was recorded along a four meter line stretching north from the Robel pole. Percent ground cover of grass, forbs, standing dead vegetation, litter, and bare ground was measured using a 0.5 meter square quadrat with the sum of the ground cover class equaling 100 percent. For each point, ground cover was estimated one meter east of the Robel pole by looking down at the vegetation as an aerial predator would. Independent estimates by three separate observers were pooled and the mean was taken as the final value. In 2007, a single observer estimated species composition at the same time as percent ground cover estimates using a 0.5 meter square quadrat. Percent species composition was recorded on a six point scale with 1=≤6%, 2=6-25%, 3=26-50%, 4=51-75%, 5=76-95%, and 6=≥95%.

Conservation Value Indices

Conservation value indices have been developed and used to compare the diversity of bird assemblages and their conservation values (Nuttle et al. 2003). Partners in Flight (PIF) conservation priority species assessment scores (Carter et al. 2000; Nuttle et al. 2003; Penjabi et al. 2005) (Appendix 5) were used to derive conservation values for each of the nine weeks during the point transect sampling period to assess differences within fields throughout the field season, and to assess what happens to bird communities when fields are grazed (Fig. 4). PIF scores are based on a thirty point scale with up to five points each awarded based on each of the following criteria: population size, breeding distribution, non-breeding distribution, threats to breeding, threats to non-breeding, and population trends (Penjabi et al. 2005). Unlike earlier versions of the index that utilized a “relative abundance” score, the 2005 version of the database uses estimates of actual population size (Penjabi et al. 2005). PIF scores for Bird Conservation Region 22 (Eastern Tallgrass Prairie) were downloaded from the Rocky Mountain Bird Observatory to calculate the indices. Conservation value (CV) was calculated with the formula

$$CV = \sum_{i=1}^{s} a_i w_i$$

where s is the number of species in a paddock or CRP field type, a_i is the density of species i, and w_i is the Partners in Flight conservation priority assessment score of species i (Götmark et al. 1986; Nuttle et al. 2003).

Observations were refined through five steps before incorporation into the index. First, observations beyond 68.6 m of the point transects were removed from the index, because this category was open ended. Observations in this range were more indicative of the surrounding landscape than the field in which the points were originally located. Second, observations for species observed flying overhead and not actively engaged in foraging were removed from the index, because these species may simply have been moving over the site and not interacting directly with it. The attraction behaviors that Tree Swallows (*Tachycineta bicolor*) and Barn Swallows (*Hirundo rustica*) exhibited during point count observations forced them to be removed from the index. Third, observations were sorted based on paddock and field type where the observations occurred. Next, observations were sorted by the week in which they occurred in both the 2006 and 2007 field season so the conservation indices could show fluctuations throughout the field seasons. Lastly, the observations for 2006 and 2007 were combined and a density was created based on twice the total area within all 68.6 meter point transects in each paddock or CRP field type to create a conservation index score that represents an average year. Density is reported as number of birds per hectare.

A conservation value index was chosen over Shannon-Weaver (Shannon 1948a, 1948b) and Simpson's diversity indices (Simpson 1949) because they rely on the assumption that more diverse habitats are better and represent summary statistics, with no information regarding species composition (Nuttle et al. 2003).

Density Estimation

Program Distance (Thomas et al. 2006) was used to model species-specific detection functions for the six most abundant grassland bird species: Sedge Wren (*Cistothorus palustris*), Common Yellowthroat (*Geothlypis trichas*), Grasshopper Sparrow (*Ammodramus savannarum*), Dickcissel (*Spiza Americana*), Red-winged Blackbird (*Agelaius phoeniceus*), and Eastern Meadowlark (*Sturnella magna*). Since avian detection probabilities differ based on plant community structure (Bibby and Buckland 1987; Buckland et al. 2001), vertical density and maximum stand height for each vegetation sample point was plotted (Fig. 3) to determine if there were structural differences within the field types that would influence detectability. Based on the plot, detection functions were calculated for two field type groupings. All of the grazed paddocks and the cool-season CRP fields showed varying degrees of overlap in vegetation characteristics, so observations for these field types were pooled when developing a detection function. The warm-season grass CRP fields showed little overlap with the other fields and so a separate detection function was calculated for this field type.

Only observations within 68.6 m of point transects were used to calculate detection functions. Since the initial observational data were collected in distance intervals, the model had to be truncated into three categories. The center point of each of the three distance intervals was used to represent the distance for each observation that occurred within that distance interval (Thomas et al. 2006). Since all of the observations in both years occurred during the breeding season after migration had subsided, all of the species-specific observations were pooled to estimate the detection functions.

In program Distance, the uniform base function with either the cosine or simple polynomial adjustment terms, the half-normal base function with the hermite polynomial adjustment term, and the hazard-rate base function with the cosine polynomial adjustment term were selected as likely base-function and adjustment term combinations to best fit the data (Buckland et al. 2001). Program Distance chooses the model that best fits the data by evaluating combinations of base functions and adjustment terms and selecting a best model using Akaike's Information Criterion (AIC) (Akaike 1973). Density $(\hat{D})$ was calculated using the formula

$$\hat{D} = \frac{n}{k\pi w^2 \hat{P}_a}$$

where *n* equals the number of species observations, *k* equals the number of points in the field type, *w* equals strip width (68.6 m), and $\hat{P}_a$ equals the detection probability derived based on short-grass or tall-grass vegetation (Buckland et al. 2001). The variation for density $(\mathrm{var}\,\hat{D})$ was calculated using the formula

$$\mathrm{var}(\hat{D}) = \frac{\hat{D}^2\,\mathrm{var}(\hat{P}_a)}{\hat{P}_a^2}$$

with var $\hat{P}_a$ derived from percent confidence value part of the standard program Distance output (Buckland et al. 2001).

Bird Nesting

Earliest and mean nest initiation dates were back calculated for both 2006 and 2007 for all nesting species (Appendix 1) from known stages in the nest cycle and nestling development (Baicich and Harrison, 2005). A Mayfield maximum likelihood estimator was used to estimate daily survival rates for six species (Mayfield 1961, 1975; Bart and Robinson 1982). The Mayfield estimator was chosen over more recently developed approaches (Dinsmore et al. 2002; Shaffer 2004) because of small sample sizes spread out over the breeding season. The Mayfield estimator assumes that nests are homogeneous in their likelihood of fledging young, that nest survival is independent of the stage of the nesting cycle, that survival is constant throughout the breeding season, and that nest outcome is correctly determined. The Mayfield estimator can be biased high because the estimator assumes that if a nest is destroyed between visits that are several days apart, exposure days are equivalent to 50 percent of that interval, but in actuality exposure days are closer to 40 percent of the interval (Johnson 1974). Common Yellowthroats, Grasshopper Sparrows, Dickcissels, Red-winged Blackbirds, and Eastern Meadowlark nests were chosen for analysis because they had the largest sample sizes in both years. Daily nest survival rates (*DSR*) were calculated by using the equation

DSR= 1- (number of nests lost while under observation/ total exposure)

Exposure was reported in nest days, where one 24-hour period of exposure equals one nest day.

Vegetation Analysis

No satisfactory method was found to determine fine scale relationships between avian abundance and vegetation variables because small avian sample sizes and the use of aggregate vegetation variables diluted relationships. Efforts to assess avian and vegetation relationships were also limited by the fact that bird species detectability varied based on habitat type and invalidated the use of unmodified transect observations. Transect observations could not be adjusted based on detection probability for all species, because detection functions for Grasshopper Sparrows, Eastern Meadowlarks, and Red-winged Blackbirds could not be fit to the data. Vegetation analysis was conducted on a broad level by field type and pooled for both years using principal component analysis to assess the primary strength of two dominant factors in the vegetation data in SAS using the varimax rotation method (SAS 2003).

Results

Bird Observations

Forty-six species were observed at point transects in 2006 and 2007 (Appendix 4). Summaries of point-transect observations from 0-69.6 meters for seven species (Table 2) showed differentiation of preferential habitats by species. Sedge Wrens, Common Yellowthroats, and Dickcissels were all far more prevalent in the ungrazed warm-season grass CRP fields than any other fields. Grasshopper Sparrows and Eastern Meadowlarks were abundant in both cool-season and warm-season grass paddocks, but showed a preference for the cool-season grass paddocks. Red-winged Blackbirds were observed in all field types, but showed the strongest preferences for the warm-season CRP fields and the grazed cool-season grass paddocks. No species showed a preference for the cool-season grass CRP fields, which had the fewest observations across all species. Appendix 3 displays more detailed observation breakdowns by distance intervals for all six species.

Bird Densities

Detection functions for Grasshopper Sparrows, Eastern Meadowlarks, and Red-winged Blackbirds could not be fit to the data due to avoidance behavior and small sample sizes. Detection functions for Sedge Wrens, Common Yellowthroats, and Dickcissels (Table 3) were all fit using a uniform base function with a cosine polynomial adjustment term.

With the detection functions calculated for tall-grass and short-grass habitat types, densities for the three species were tabulated (Table 4). Dickcissels had the highest density with over 3.8 birds per hectare (±0.29) in the warm-season CRP fields. Dickcissels also had high density in the warm-season grass paddocks with 3.3 birds per hectare (±4.60), more than 4.5 times greater density than in the cool-season grass paddocks. Sedge Wrens and Common Yellowthroats had densities of 2.9 (±0.94) and 1.9 (±0.25) birds per hectare in the warm-season CRP fields with limited presence in other fields.

Conservation Value Indices

The conservation value indices (Fig. 4) provided a measure for the relative value of each field type for bird species communities. The warm-season grass CRP fields had the highest conservation values of any field type, which were typically twice as great as the cool-season grass grazed paddocks, three times as great as the warm-season grass grazed paddocks, and four times as great as the cool-season CRP fields. General trends across the nine week sample period were flat to falling gradually across the nesting season. The conservation value of cool-season grass paddocks did not appear to be adversely affected by grazing, but the warm-season grass paddocks experienced a sharp decline after being grazed. The sharp decline in the warm-season grass paddocks may also simply be an artifact of timing. All of the paddocks show varying degrees of declines during week 6, which represent the last week in June. The indices suggest that much of the nesting has subsided by week six, and dispersion has commenced. Despite the low conservation values of the warm-season grass paddocks, the indices do affirm that the majority of nesting has concluded by early July, when the warm-season grass paddocks enter into the grazing rotation.

Flushed birds

Records for birds flushed by the chain-drag method or seen within ten meters of the chain (Table 5) showed that the warm-season grass CRP fields had far more birds flushed per hectare throughout the season than in all other field types. The grazed paddocks typically had more flushes per hectare than the cool-season CRP fields. In the grazed paddocks, the cool-season grass paddocks consistently flushed more birds per hectare than the warm-season grass paddocks. Species-specific flush records are presented in Appendix 2.

Grassland Bird Nesting

Seven species were found nesting on the research site (Table 6), with initial and mean initiation dates for 2006 and 2007 available in Appendix 1. Of the seven species, only Grasshopper Sparrows and Eastern Meadowlarks were encountered nesting in the grazing management unit. Although the number of nests was low, cool-season grass paddocks had more than four times the nests of the warm-season grass paddocks. Efforts to create paddocks that can support a greater variety of grassland birds may have instead created a situation in which none of the prevalent bird species found the paddocks desirable. During the short 2005 pilot study, both Dickcissel and Red-winged Blackbird nests were located in the grazed warm-season grass paddocks, but none were found in 2006 or 2007. Northern Harrier was the only nesting species was found on the cool-season grass CRP field in both 2006 and

2007. The high nesting success rate for this field type is likely an artifact of the type of bird found on site where one parent is often on or near the nest when the young are most vulnerable and the complete absence of other species that can initiate multiple nests within a breeding season. The warm-season grass CRP fields had the largest number of species nesting and the greatest number of total nests.

Apparent nest success on the ungrazed warm-season grass CRP fields was twice that of the cool-season grass paddocks. The warm-season grass paddocks had no known successful nests in 2006 or 2007. The low apparent nesting success on the grazed areas is a concern because apparent nesting success is biased high. Cattle disturbance caused 67 percent of the unsuccessful Eastern Meadowlark nests and 50 percent of the unsuccessful Grasshopper Sparrow nests.

Mayfield daily survival rates were calculated for five species (Table 7). Grasshopper Sparrows and Eastern Meadowlarks had some of the lowest daily survival rates with 0.8586 ± 0.0609, and 0.9240 ±0.0281 respectively. The daily survival rate for Eastern Meadowlark may be greater than Grasshopper Sparrows, but they have the longest incubation period--14 days--and the longest nestling period--12 days--of all five species in Table 7, resulting in more exposure days in which the nest can fail. Bird species observed nesting outside the grazing management unit had higher nesting success rates, except for Common Yellowthroats which had the smallest number of nests of any species reported in Table 7.

Vegetation Results

Two primary principal components were described as a vertical structure factor and a grass and forb composition factor. The vertical structure factor was composed of maximum live vegetation, maximum standing dead vegetation, litter depth, and visual obstruction at greater than a 0.5 loading. The vertical structure factor was not composed of any vegetation variables that were less than 0.5. The grass and forb composition factor was composed of only percent grass ground cover at a greater than 0.5 loading and percent forb ground cover at the less than 0.5 loading. Plotting these two principal components (Fig. 6) shows that the cool and warm-season grass CRP fields showed distinct separation from one another, as well as the grazed fields. The grazed cool-season and warm-season grass paddocks were almost entirely overlapping, indicating that there was structurally no difference between these field types.

Mean vegetation measurements (Table 8) showed that litter depth was deepest, standing live and dead vegetation was tallest, and visual obstruction was greatest in the warm-season CRP fields. The grazed paddocks were relatively similar for all variables. Mean percent ground cover composition (Fig. 5) showed the grazed paddocks had the highest grass and bare ground composition. The warm-season grass CRP fields had the least percent grass ground cover, but the most forb and standing dead vegetation ground cover. Herbicide application is likely the reason for a slight decline the percent forb ground cover observed in 2007 in two of the warm-season grass paddocks. The cool-season grass CRP fields had a moderate percentage of grass ground cover compared to other fields, by far the largest percentage of litter, and the least percentage of forb ground cover.

Herbaceous plant species abundance shows a variety of different species found between the four sites (Table. 9). In the cool-season paddocks tall fescue (*Festuca arundainacea*), Kentucky bluegrass (*Poa pratensis*), and smooth bromegrass (*Bromus* *inermis*) were the most abundant species, and red clover (*Trifolium pratense*) and birdsfoot trefoil (*Lotus corniculatus*) were the most abundant forbs. In the warm-season grass paddocks, big bluestem (*Andropgon gerardii*), Indiangrass (*Sorghastrum nutans*), and Kentucky bluegrass were the most abundant grasses, and birdsfoot trefoil was the only forb of appreciable abundance. The cool-season grass CRP fields were composed almost entirely of smooth bromegrass (*Bromus inermis*) monoculture plantings. The bromegrass monoculture had more than 1.5 times the single species abundance of the most dominant species in the other field types. The CRP fields recorded as "warm-season grass" were actually composed of smooth bromegrass with appreciable amounts of goldenrod (*Solidago spp.,*), switchgrass (*Panicum virgatum*), wild carrot (*Daucus carota*), and Canada thistle (*Cirsium arvens*e).

Grazing Log

Grazing records for only the ten paddocks studied were included in this summary. Cows within the SDRS management unit grazed paddocks on average 1.63 (±0.03) days in 2006 and 1.64 (±0.03) days in 2007. Mean forage removal was 14.15 (±1.57) centimeters per grazing rotation in 2006 and 12.40 (±1.12) centimeters per grazing rotation in 2007. This forage removal amounted to 47.8 (±0.1) percent of available forage in 2006 and 40.4 (±0.1) percent in 2007. Excluding flash grazing, the mean rest period for paddocks for both 2006 and 2007 was 26.4 (±3.1) days. During both years, rainfall on the site was 46 to 80 percent above average in May, but was 76 to 82 percent below average in June and 23 to 61 percent below average in July.

Discussion

Avian Community and Grazing Compatibility

The specific habitat needs and preferences of grassland bird species sort them into three categories of compatibility with SDRS management units: compatible, moderately compatible, and not compatible. Compatible species are those that were ground nesters, which appear to prefer shorter, more open vegetation and were rarely observed outside of the grazing management unit. Moderately compatible species are species that nest primarily within vertical vegetation, are abundant both within and outside of the grazing management unit, but require special management considerations in order fulfill their nesting needs. Noncompatible species are those whose nesting habitat requirements are challenging to accommodate in a grazing management unit, have life cycle attributes that limit their compatibility, and were not abundant in pastures.

Compatible species include Eastern Meadowlarks and Grasshopper Sparrows. These species nest on the ground or within short grass clumps (Baicich and Harrison 1997). Eastern Meadowlark and Grasshopper Sparrow nests were only located within the SDRS management unit and had far higher abundances within the unit. Both species potentially showed slight preference for the cool-season grass paddocks as seen in avian abundance and the number of nests by field type. Grasshopper Sparrows and Eastern Meadowlarks have historically responded positively to grazing (Skinner 1974; Risser et al. 1981; Kantrud and Kologiski 1982; Skinner 1984 Bock et al. 1993), but both species have avoided heavily grazed areas (Smith 1940; Weins 1970). Grasshopper Sparrows are an area sensitive species with abundance positively correlated to patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski 1999). Results are mixed regarding area sensitivity of Eastern

Meadowlarks with some finding no sensitivity to patch area (Bollinger 1995; Winter and Faaborg 1999), and others finding moderate to strong sensitivity (Herkert 1991; Herkert et al. 1993).

The biggest concern for the species compatible with SDRS is that high nest losses due to cattle disturbance could result in the site becoming a population sink. Nest losses of 75 percent were typical in a number of Wisconsin SDRS management units with cattle stocking rates of between 40 to 100 animal units per hectare (Paine et al. 1996). With average rest periods of just over 26 days, the only way most grassland birds could establish a territory, attract a mate, build a nest, lay and incubate eggs, and successfully fledge young would be to nest in idled warm-season grass paddocks or initiate a nest immediately as the cattle are rotated out of the field. For Eastern Meadowlarks, 26 days represents the amount of time it takes to incubate eggs and fledge young, and does not include the establishment or reestablishment of territories after grazing and the construction of a new nest. In order for more young to be fledged on paddocks in the grazing management unit, rest periods between grazing events have to be increased. Rest periods of up to 90 days have been attained on SDRS management units by increasing the number of subdivisions and intensifying animal impact still further (T. German, personal communication, March 2008) using a grazing method called mob grazing. Further concentration of animal impact and acceleration of rotations through more numerous paddocks would not add considerably to avian losses, because so few nests survive present grazing densities of between 17.4 to 86.8 animal units per hectare. With rest periods increased to beyond 45 days, the window in which species could attempt to fledge young undisturbed by cattle grazing becomes palpable. One North

Dakota study found that Grasshopper Sparrow densities were much higher on SDRS paddocks that intensified animal impact because it decreased the litter layer in pastures (Messmer 1990). Increasing animal impact may reduce vegetation to low enough levels that species like Killdeer (*Charadrius vociferus*) and Horned Larks (*Eremophila alpestris*), which typically prefer very disturbed open habitats may utilize them (Wiens 1970; Skinner 1974; Messmer 1990). Whether Grasshopper Sparrows and Eastern Meadowlarks would respond favorably to higher levels of forage removal caused by intensified grazing events is uncertain.

Species of moderate compatibility to SDRS include Dickcissels and Red-winged Blackbirds. Both of these species nest in vertical vegetation and require additional management inputs to create nesting habitat in the SDRS grazing management unit. The warm-season grass paddocks provide the greatest opportunity to nest within the management unit, but no Dickcissel or Red-winged Blackbird nests were located in these paddocks in 2006 and 2007. During a brief pilot study in 2005, both species were observed nesting in the grazed warm-season grass paddocks but there was minimal standing dead vegetation for nest construction in 2006 and 2007. All of the nests for these two species were limited to the warm-season grass CRP fields, which had roughly four times the standing dead vegetation of the warm-season grass paddocks. Neither Dickcissels nor Red-winged Blackbirds have been found to be area sensitive (Herkert 1991; Herket et al. 1993; Helzer and Jelinski 1999) but both species prefer areas with less edge habitat (Helzer and Jelinski 1999).

The warm-season grass CRP fields also had nearly three times the forb content of the all other fields. Forbs serve as a valuable food source for many grassland birds, not only from the seeds they produce, but also from the insects they help attract (Tscharntke and Greiler 1995; DiGiulio et al. 2001). Patterson and Best (1996) have observed that Dickcissel population fluctuations have been strongly correlated to forb cover fluctuations in CRP fields in Iowa. Density estimates show that Dickcissels were the most abundant in the ungrazed warm-season grass, but density only declines by thirteen percent in the grazed paddocks. Density estimates for Red-winged Blackbirds could not be calculated, but abundance data shows a greater presence in the cool-season grass paddocks than the warm-season grass paddocks. This difference in Red-winged Blackbird abundance between the two paddock types is likely influenced by the cool-season grass paddocks' closer proximity to several ponds because Red-winged Blackbirds were historically a wetland species that has adapted to a variety of habitat types (Kent and Dinsmore 1996).

In order to enhance the acceptability of the proposed SDRS management unit to these moderately compatible species, several adjustments to the unit and its management should be considered. Flash grazing that occurs on the warm-season grass paddocks in early May needs to very carefully managed. Flash grazing must both remove enough biomass to suppress cool-season grass growth as well as avoid destroying the entirety of the vertical standing dead vegetation needed for nesting. The management decision here is one of the most important the land manager has to make. Grazing the previous August must be similarly well managed to allow the warm-season grass to produce standing vegetation. To maximize the attractiveness of the warm-season grass paddocks and the rest of the grazing management unit to a variety of grassland bird species, forb content within pastures should be increased

(Hull et al. 1996; Klute et al. 1997). The use of leguminous forbs would also benefit producers by providing additional nitrogen to stimulate grass growth (Barnhart et al. 1998).

Species that are not compatible with SDRS include Northern Harriers, Sedge Wrens and Common Yellowthroats. Northern Harriers were not found nesting within grazed areas and have not been found in heavily grazed habitat (Bock et al. 1993). Northern Harriers have large territories--often over 250 hectares (Breckingridge 1935, Toland 1985)--and frequently locate their nests near disturbed areas, like grazing lands, to take advantage of higher small mammal prey populations (Leman and Clausen 1984; Kaufman et al. 1990).

Sedge Wrens and Common Yellowthroats both nest in dense vertical vegetation. Sedge Wrens avoid areas of vegetation below ten centimeters in height and areas where vegetation density has been reduced from moderate to heavy grazing (Skinner 1974; Kantrude 1981; Messmer 1985; Lingle and Bedell 1989). Sedge Wrens' compatibility with the studied SDRS management unit is also limited, because their nesting season in the upper Midwest may extend into late summer (Lingle and Bedell 1989; Kent and Dinsmore 1996). Common Yellowthroats are more of a generalist species, being able to utilize a variety of dense woody and non-woody herbaceous vegetation for nesting (Baicich and Harrison 1997). Common Yellowthroats may be able to nest in the warm-season grass paddocks, but their estimated density in all grazed paddocks was low. Common Yellowthroats prefer areas where vegetation is dense and periods between disturbances are long (Harr 2005).

The use of warm-season grass paddocks within a SDRS management unit serve as undisturbed habitat during most of the breeding season and appeared to bolster Dickcissel density within the grazing management unit, but Grasshopper Sparrow abundance in 2007 and Eastern Meadowlark abundance in both years was lower in the warm-season grass paddocks. Densities for these two species could not be calculated, but their density in the cool-season grass paddocks would be similar to or greater than the warm-season grass paddocks because of the greater number of observations and use of the same short-grass detection function. This suggests that the warm-season grass paddocks did indeed help attract a more diverse bird community, but at the price of some level of reduced abundance of species closely associated with the grazing management unit. Nesting differences could not be adequately assessed because of small sample sizes, but the cool-season grass paddock had more nests in them than the warm-season grass paddocks. Heavier than desired spring flash grazing coupled with drought conditions largely destroyed vertical standing dead vegetation residue in the warm-season grass paddocks, severely limiting the possibility for Dickcissels and Red-winged Blackbirds to nest in those paddocks. Under more favorable weather conditions, like those observed in the 2005 pilot study, these species have been observed nesting in the warm-season grass paddocks.

CRP Stand Differences

The differences between the cool-season and warm-season grass CRP fields were substantial. Both fields were mainly comprised of smooth bromegrass, but the warm-season grass CRP fields had far more forbs including multiple species of legumes and composites. The switchgrass in the warm-season grass CRP fields provided the standing dead structure that supported many of the nests found in the field type. Densities for Sedge Wrens, Common Yellowthroats and Dickcissels were all high in the warm-season grass CRP fields and either zero or very low in the cool-season grass CRP fields. The conservation value of the warm-season grass CRP fields was consistently between four and five times greater than the cool-season grass CRP fields. The conservation value of the grazed paddocks was typically equivalent to or greater than the cool-season grass CRP fields.

The monotypic cool-season grass CRP fields provided neither the structural environment for aboveground nesters, nor the open clumped habitat of grazed grasslands. The cool-season grass CRP fields in this study highlight the importance of mid-contract management on older monoculture grass stands. Allowing some form of grazing on those CRP fields would help incorporate the dense litter layers and would allow forb seeds to make contact with the soil, stimulate grass growth, and cycle nutrients. However, the intensity of grazing examined in this study would be detrimental to the bird species found in abundance in the CRP warm-season grass fields because it would reduce the heterogeneity of the stand, damage standing dead grass residue, and reduce vertical density.

Many proposed lignocellulosic ethanol production systems would have similar detrimental effects on grassland bird habitat. These ethanol production systems favor monoculture stands of Switchgrass or other introduced grass species (Anex et al. 2007). Given the low quality of monoculture Smooth Bromegrass CRP fields for birds, it is unlikely that Switchgrass monocultures will perform any better. Fall harvesting is proposed on these productions systems as well (Anex et al. 2007). This will mean that there will be only minimal wildlife cover available throughout the winter and no standing dead vegetation available during the spring nesting season. This new type of production regime has the advantage of not luring in grassland birds and serving as a population sink, but it is questionable how diverse and abundant a group of grassland bird species this new habitat type will accommodate.

There will always be a need for CRP lands or some other form of idled lands, because every grazing management unit, no matter its design, will have species that cannot tolerate disturbance or have vegetation requirements for nesting that cannot be met. Refuge lands may serve as a nesting habitat safety net for many bird species from fluctuations in land use, but their availability will always be limited because of competing land uses (Patterson and Best 1996).

Grazing Management

Land managers should always strive to create heterogeneity, because it is the precursor to biological diversity and should be one of the goals in land management (Christenson 1997). Principal component analysis of grassland vegetation characteristics showed that warm-season grass paddocks did not create a more heterogeneous habitat within the grazing management unit compared to cool-season grass paddocks alone. Flash grazing likely contributed to the lack of heterogeneity within the grazed paddocks, but flash grazing did provide a tool that helped suppress early spring cool-season grass growth in warm-season grass paddocks. Balancing the desire to set-back cool-season grasses within warm-season grass stands with the interest of leaving vertical dead vegetation is one of the largest challenges the managers of this grazing management unit must address. Fire would be a potential tool to suppress cool-season grass growth, but it would also destroy vertical dead vegetation. Greater forb composition and diversity within paddocks would provide a variety of structure and serve as a direct and indirect food source in terms of seeds and arthropods for grassland birds (Hull et al. 1996; Klute et al. 1997). For land managers, leguminous forbs can fix nitrogen, which grasses use to stimulate growth, and reduce the need for expensive nitrogen inputs. Avoiding the use of broad-leaf herbicides should always be a goal of land managers interested in grassland birds. Managing for grassland birds includes recognition of both nesting habitat needs in terms of managing for appropriate residual vegetation, and providing abundant food sources in the form of pasture legumes and other forbs. Land managers interested in the conservation of grassland birds in grazing systems will have to consider the following:

- No rotational grazing system can be all things to all grassland bird species. Grassland birds differ in their specific needs for vegetation height, area needed, amount of bare ground or standing live or dead vegetation desired, and other requirements. Some grazing systems are compatible with some bird species, but not with others. Nearby ungrazed grassland refugia will always be needed to maintain grassland bird populations. However, well thought-out grazed grasslands can contribute to populations of some grassland bird species.
- This research suggests that a minimum rest period of at least 45 days between grazing periods is necessary for grassland birds to successfully nest and fledge young from paddocks. Rest periods of 45 days can be obtained by shifting to mob grazing, which would increase the number of paddocks and animal densities and create longer rest periods without compromising the carrying capacity of the grazing management unit. Mob grazing will require a greater

level of management commitment from the producer and would likely eliminate the potential for bird species that require standing dead vegetation to nest in the cool-season grass paddocks.

- When removing paddocks from the grazing rotation, it is best for birds to remove adjacent paddocks to create a larger habitat block so area sensitive species like Grasshopper Sparrows and Eastern Meadowlarks are more likely to be attracted to the area.
- External and internal fencing that creates a softer edge, like high tensile electric fence or barbed wire, has the advantage of not only being less expensive to install than traditional woven wire fence, but benefits grassland birds by reducing edge habitat that is attractive to predators.
- Flash grazing in early spring can help control cool-season grass encroachment into warm-season grass paddocks, but it comes at the cost of reduced standing dead grass residue in which Dickcissels and Red-winged Blackbirds may nest.
- Increasing forb content within pastures benefits grassland birds as a direct food source of seeds and an indirect food source in the form of insects attracted to forbs. Producers also benefit from leguminous forbs because, depending on their abundance, they can provide some or all of the nitrogen needs of a pasture.
- Limited grazing after mid July should be considered as a possible form of mid contract management on monoculture cool-season Conservation Reserve

Program land. Grazing has the potential to improve the plant species diversity and make these lands more attractive to grassland birds.

Implications

The use of warm-season grass paddocks within a SDRS management unit as undisturbed habitat during most of the early breeding season of grassland birds appeared to bolster density of some grassland bird species and suppress abundance in others. Dickcissel densities within the warm-season grass paddocks were not as high as is undisturbed warm-season grass CRP fields, but they were still much higher than the grazed cool-season grass paddocks. Fewer nests were found within the warm-season grass paddocks than the cool-season grass paddocks and the warm-season grass CRP fields, but nesting sample sizes were so small that no definitive conclusions could be reached. The warm-season grass paddocks helped to bolster diversity by bringing in a few species seldom encountered in grazed cool-season paddocks, but not without some declines in species strongly associated with grazed areas.

Adjacent warm-season grass CRP fields composed of a mixes of forbs and grass types had the highest conservation value of any site as well as the greatest bird densities and high abundances for all species except those strongly associated with grazed areas. The relative dearth of avian activity within the monotypic cool-season CRP fields would suggest a need for some form of disturbance to incorporate or remove the dense litter layer associated with such fields to allow forb seeds to make contact with the soil. Managed short-duration grazing management units that incorporate the use of warm-season grasses can meet some of the needs of some grassland bird species, but they cannot be all things to all species, suggesting a continued need for diverse CRP/refuge fields on the landscape.

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TABLE 1. Field treatment variables in Adams County, IA, 2006-2007.

Field Treatments	Hectares	Acres	Field Subdivisions	Point Transects
Cool-season grass paddock (grazed May-June & Sept-Oct)	7.5	18.58	5	6
Warm-season grass paddock (grazed July-August)	6.5	16.07	5	6
Cool-season CRP field (ungrazed)	7.3-6.8	18.00-16.71	3	5
Warm-season CRP field (ungrazed)	7.7	18.89	2	5

* One of the cool-season grass CRP fields used in 2006 was grazed for emergency forage reserves for a week in August of 2006 and so it was replaced in 2007. The first number in hectares represented field are in 2006 and the second is for 2007.

TABLE 2. Point transects observations of six bird species by field treatment from 0-68.6 m in Adams County, IA, 2006-2007.

Field Treatment	SWN	CYT	DKL	GHS	BLK	EML	RWB
2006							
Cool-season grass paddocks (grazed May-June & Sept-Oct)	0	5	3	32	2	61	11
Warm-season grass paddocks (grazed July-Aug)	0	8	6	33	0	56	23
Cool-season grass CRP fields (ungrazed)	0	5	2	17	0	1	13
Warm-season grass CRP fields (ungrazed)	83	74	291	6	0	22	81
2007							
Cool-season grass paddocks (grazed April-June & Sept-Oct)	0	8	5	110	6	43	80
Warm-season grass paddocks (grazed July-Aug)	0	0	16	65	2	33	8
Cool-season grass CRP fields (ungrazed)	0	0	1	18	0	0	7
Warm-season grass CRP fields (ungrazed)	62	113	191	1	1	4	58

SWN=Sedge Wren
CYT=Common Yellowthroat
DKL=Dickcissel
GHS=Grasshopper Sparrow
BLK=Bobolink
EML=Eastern Meadowlark
RWB=Red-winged Blackbird

TABLE 3. Model selection of detection functions of grassland nesting birds Adams County, IA, 2006-2007.

Species	Model Selection	*AICc*	Δ*AICc*	*n*	$f_{(0)}$	$\hat{D}$
Sedge Wren	Uniform-cosine	156.61	0.00	70	0.3831	12.9
	Uniform-simple		1.11			
	Hazard rate-cosine		1.81			
	Half-normal-hermite		2.82			
Common Yellowthroat	Uniform-cosine	206.99	0.00	90	0.4397	0.6
	Uniform-simple		1.84			
	Hazard rate-cosine		2.12			
	Half-normal-hermite		3.73			
Dickcissel	Uniform-cosine	435.04	0.00	199	0.3657	1.2
	Uniform-simple		1.04			
	Hazard rate-cosine		1.98			
	Half-normal-hermite		2.6			

Detection functions for three species (Grasshopper Sparrow, Red-winged Blackbird, and Eastern Meadowlark) could not be fit because of avoidance behavior and small sample sizes.

AICc = Akaike's Information Criterion score with a second order correction for small sample sizes

n = number of observations

$f_{(o)}$ = final parameter values

m = number of parameters in a detection function

TABLE 4. Detection probabilities and estimated densities (birds/ha) of 3 bird species in Adams County, IA, 2006-2007.

Species	Field Treatment	$\hat{P}_a$	$var\,\hat{P}_a$	n	k	$\hat{D}$	$var\,\hat{D}$
Sedge Wren	Cool-season grass paddock (grazed April-June & Sept-Oct)			0	54		
	Warm-season grass paddock (grazed July-August)			0	54		
	Cool-season CRP field (ungrazed)			0	45		
	Warm-season CRP field (ungrazed)	0.3580	0.0140	70	45	2.9	0.9424
Common Yellowthroat	Cool-season grass paddock (grazed April-June & Sept-Oct)	0.2250	0.0215	1	54	0.1	0.0013
	Warm-season grass paddock (grazed July-August)			0	54		
	Cool-season CRP field (ungrazed)	0.2250	0.0215	2	45	0.1	0.0076
	Warm-season CRP field (ungrazed)	0.8640	0.0829	87	45	1.5	0.2855
Dickcissel	Cool-season grass paddock (grazed April-June & Sept-Oct)	0.0340	0.0005	2	54	0.7	0.2273
	Warm-season grass paddock (grazed July-August)	0.0340	0.0005	9	54	3.3	4.6035
	Cool-season CRP field (ungrazed)			0	45		
	Warm-season CRP field (ungrazed)	0.7320	0.0105	186	45	3.8	0.2855

TABLE 5. All birds flushed by modified chain drag method or observed within 10 m of chain in Adams County, IA, 2006-2007.

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (grazed May-June & Sept-Oct)	7.5			14	1.9	5	0.7
Warm-season grass paddocks (grazed July-Aug)	6.5			9	1.4	3	0.5
Cool-season grass CRP fields (ungrazed)	7.3			1	0.1	8	1.1
Warm-season grass CRP fields (ungrazed)	7.7			75	9.8	37	4.8
2007							
Cool-season grass paddocks (grazed April-June & Sept-Oct)	7.5	22	2.9	14	1.9	12	1.6
Warm-season grass paddocks (grazed July-Aug)	6.5	7	1.1	5	0.8	2	0.3
Cool-season grass CRP fields (ungrazed)	6.8	1	0.2	3	0.4	4	0.6
Warm-season grass CRP fields (ungrazed)	7.7	40	5.2	30	3.9	57	7.5

Fsh=flushes
Round 1 flushes for 2006 were not recorded
Species-specific tables in APPENDIX 2

TABLE 6. Bird nests and apparent nesting success by species and field type in Adams County, IA, 2006-2007.

Field Treatment	NHR	SWN	CYT	DKL	GHS	EML	RWB	Total Nests Per Field Treatment	% Nests Successful
Cool-season grass paddocks (grazed May-June & Sept-Oct)	0	0	0	0	5	8	0	13	15.4
Warm-season grass paddocks (grazed July-Aug)	0	0	0	0	1	2	0	3	0.0
Cool-season grass CRP fields (ungrazed)	2	0	0	0	0	0	0	2	100.0
Warm-season grass CRP fields (ungrazed)	0	1	3	11	0	0	6	21	33.3
Total Nests	2	1	3	11	6	10	6	39	28.2
% Successful	100.0	0.0	33.3	36.4	16.7	10.0	33.3	28.2	

NHR=Northern Harrier
SWN=Sedge Wren
CYT=Common Yellowthroat
DKL=Dickcissel
GHS=Grasshopper Sparrow
EML=Eastern Meadowlark
RWB=Red-winged Blackbird

TABLE 7. Mayfield estimated daily survival rates in Adams County, IA, 2006-2007.

(Mayfield 1961; Mayfield 1975; Bart & Robinson 1982).

Species	n	Survival Rate	SE
Common Yellowthroat	3	0.9211	0.1295
Dickcissel	11	0.9343	0.0242
Grasshopper Sparrow	6	0.8586	0.0609
Eastern Meadowlark	10	0.9240	0.0281
Red-winged Blackbird	6	0.9439	0.0240

TABLE 8. Mean vegetation measures from May to July for 4 field types in Adams County, IA, 2006-2007.

Field Treatment	Litter Depth (cm)	Max Standing Live (cm)	Max Standing Dead (cm)	Visual Obstruction (dm)
2006				
Cool-season grass paddocks (grazed May-June & Sept-Oct)	1.06	64.84	32.88	1.17
Warm-season grass paddocks (grazed July-Aug)	0.83	74.14	44.27	2.56
Cool-season grass CRP fields (ungrazed)	4.06	95.00	36.66	3.86
Warm-season grass CRP fields (ungrazed)	4.45	116.94	123.31	7.04
2007				
Cool-season grass paddocks (grazed May-June & Sept-Oct)	0.25	73.78	22.98	2.46
Warm-season grass paddocks (grazed July-Aug)	0.88	67.16	24.98	2.68
Cool-season grass CRP fields (ungrazed)	3.55	78.07	53.09	4.16
Warm-season grass CRP fields (ungrazed)	2.85	110.82	101.04	6.78

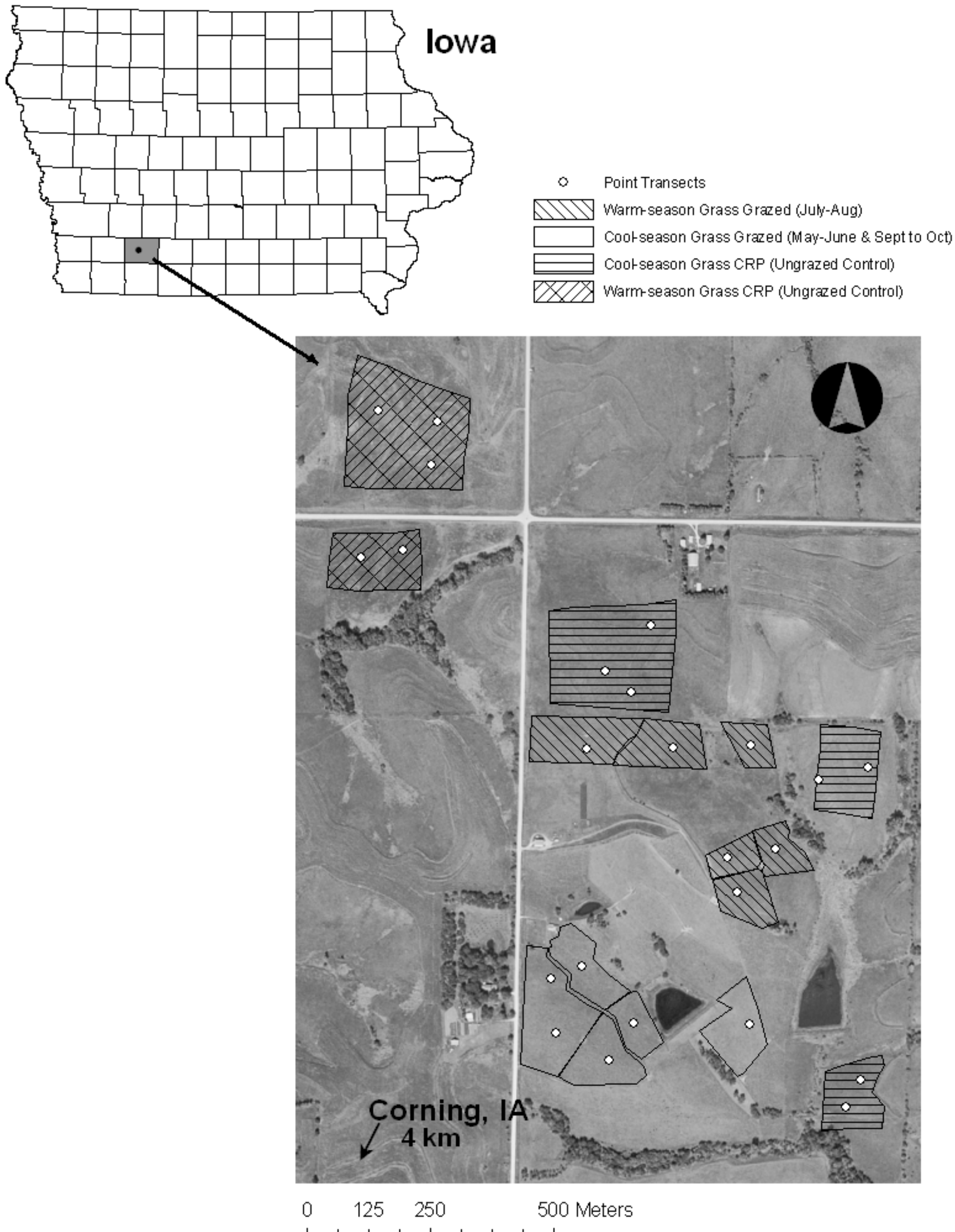
TABLE 9. Herbaceous plant species overall abundance and weighted abundance based on number of sampling points of fields from May to July in Adams County, IA, 2006-2007.

Common Name	Scientific Name	Total Abundance	Weighted Abundance
Cool-season grass paddocks (grazed May-June & Sept-Oct)			
Tall Fescue	*Festuca arundinacea*	135	2.41
Kentucky Bluegrass	*Poa pratensis*	80	1.43
Smooth Bromegrass	*Bromus inermis*	79	1.41
Red Clover	*Trifolium pratense*	24	0.43
Birdsfoot Trefoil	*Lotus corniculatus*	23	0.41
Dandelion	*Taraxacum sp.*	7	0.13
Warm-season grass paddocks (grazed July-August)			
Big Bluestem	*Andropogon gerardii*	128	2.61
Indiangrass	*Sorghastrum nutans*	74	1.51
Kentucky Bluegrass	*Poa pratensis*	46	0.94
Smooth Bromegrass	*Bromus inermis*	39	0.80
Little Bluestem	*Schizachyrium scoparium*	21	0.43
Birdsfoot Trefoil	*Lotus corniculatus*	20	0.41
Tall Fescue	*Festuca arundinacea*	20	0.41
Cool-season CRP field (ungrazed)			
Smooth Bromegrass	*Bromus inermis*	149	5.32
Kentucky Bluegrass	*Poa pratensis*	7	0.25
Warm-season CRP field (ungrazed)			
Smooth Bromegrass	*Bromus inermis*	90	3.21
Goldenrod sp.	*Solidago sp.*	31	1.11
Switchgrass	*Panicum virgatum*	17	0.61
Wild Carrot	*Daucus carota*	16	0.57
Canada Thistle	*Cirsium arvense*	11	0.39
Tall Fescue	*Festuca arundinacea*	8	0.29

Birdfoot Trefoil	*Lotus corniculatus*	7	0.25
Sweet Clover	*Melitotus sp.*	4	0.14
Red Clover	*Trifolium pratense*	3	0.11
Wild Parsnip	*Pastinaca sativa*	3	0.11

1=<6%   2=6%-25%   3=26%-50%   4=51%-75%   5=76%-95%   6=>95%

FIGURE 1. Study Area in Adams County, IA, 2006-2007.



2006 aerial photograph

FIGURE 2. Modified cable-chain construction for use in systematic nest searches in Adams County, IA, 2006-2007.

A. Modified 11 m long chain in use.

B. Close up of modified chain construction.

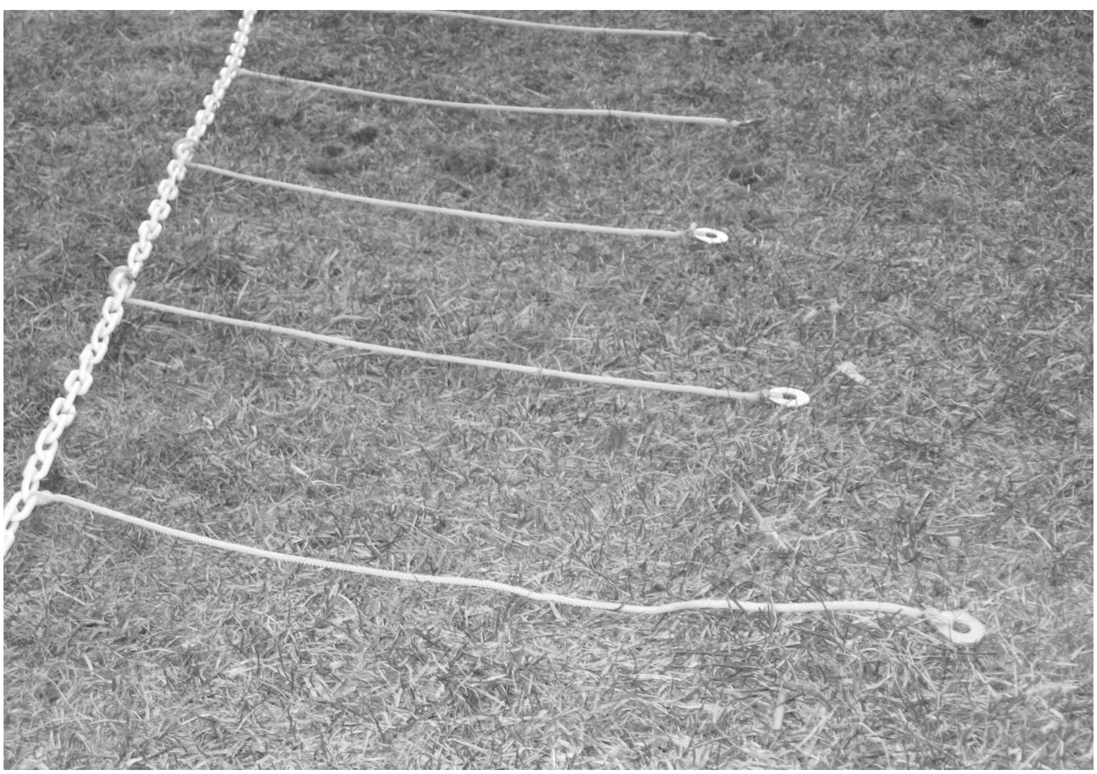


FIGURE 3. Influences of vertical density and maximum stand height on avian detectability for vegetation sample points in Adams County, IA, 2006-2007.

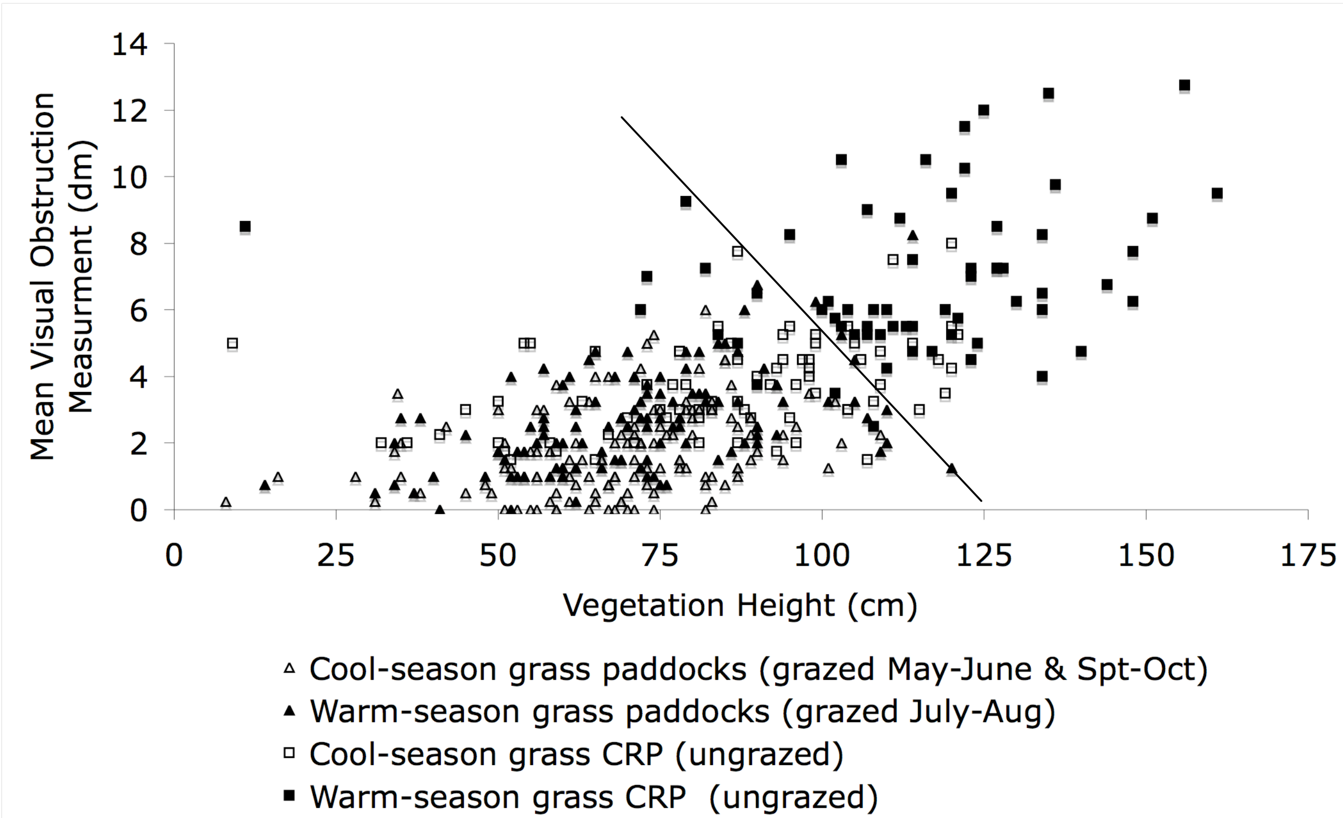
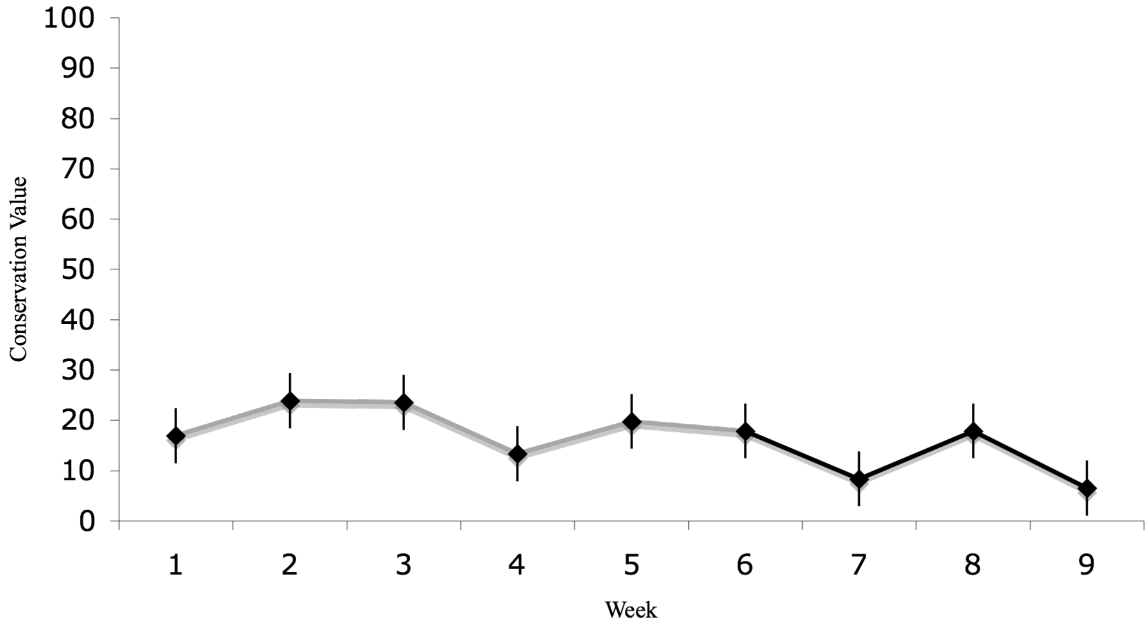
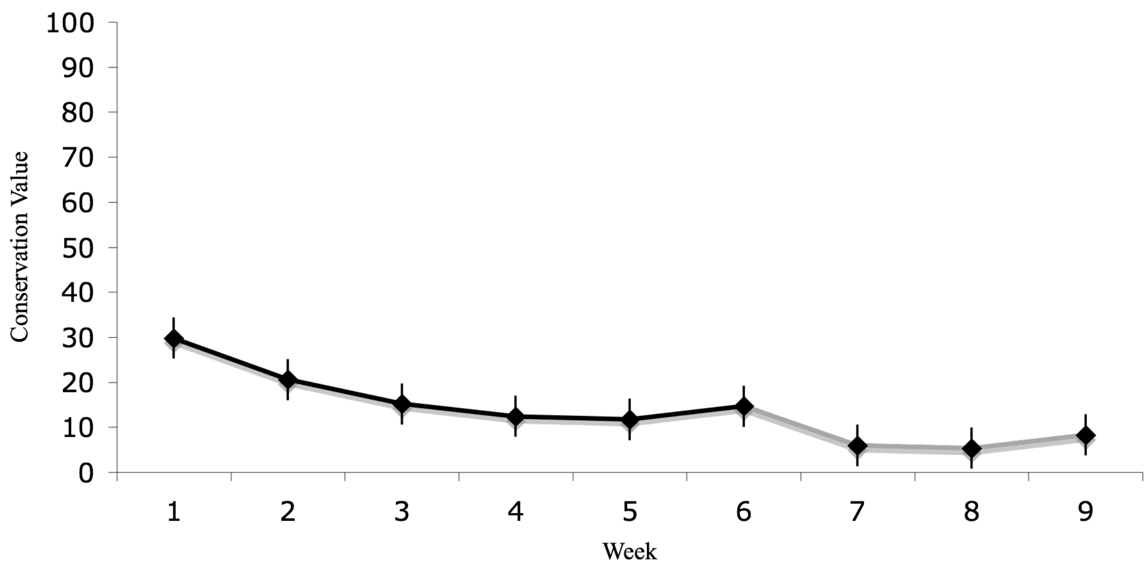


FIGURE 4. Conservation value index (±SE) of grazed paddocks and CRP fields by weekly point transect observations within 68.6 m from May 25 to July 28 in Adams County, IA, 2006-2007.

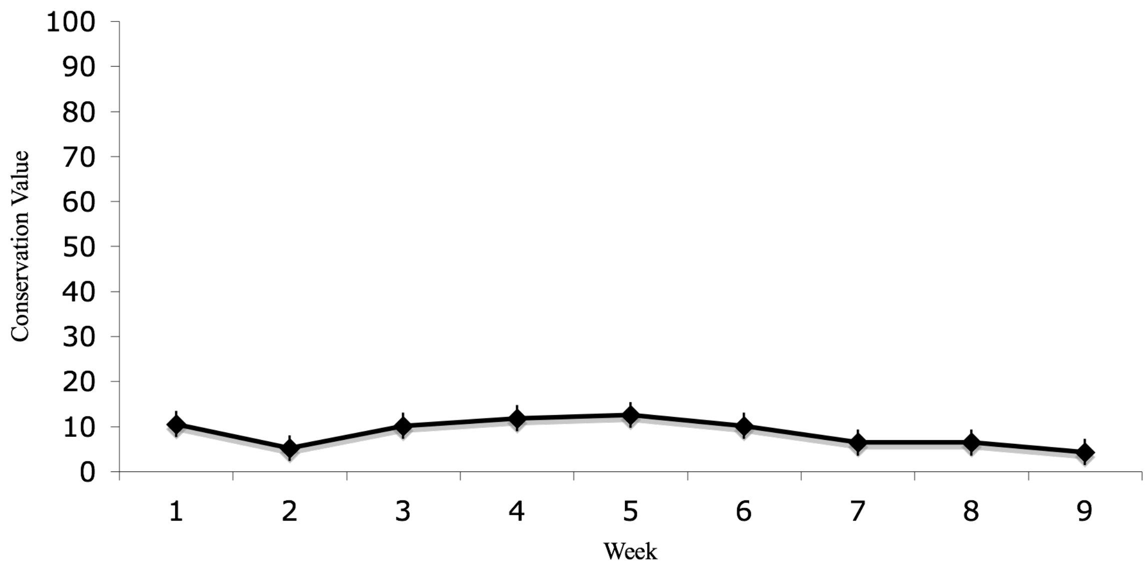
A. Cool-season grass paddock (grazed May-June & Sept-Oct)



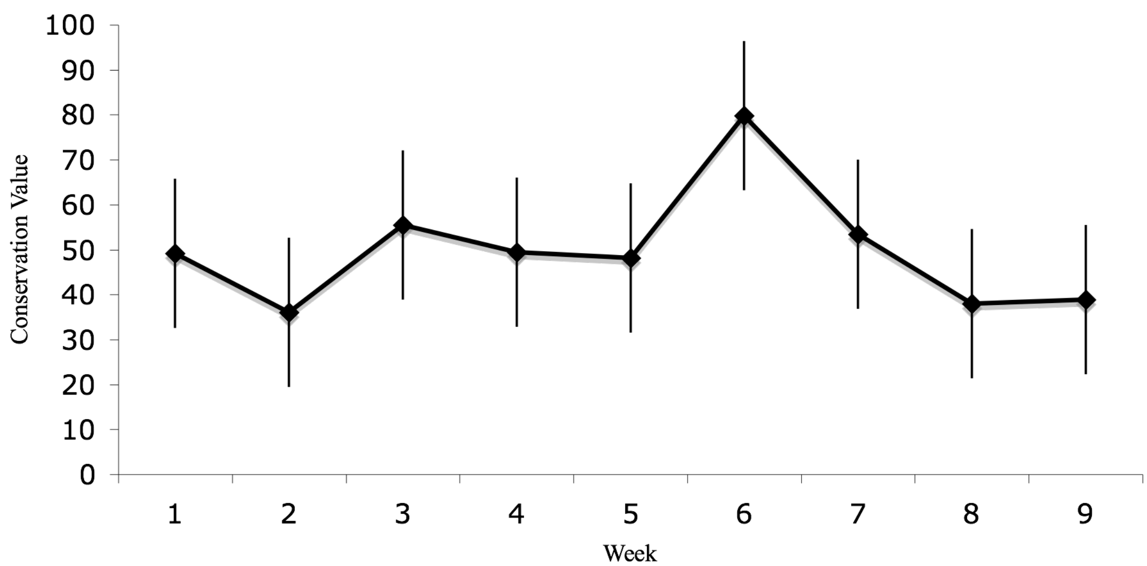
B. Warm-season grass paddock (grazed July-Aug)



C. Cool-season grass CRP Fields (ungrazed)



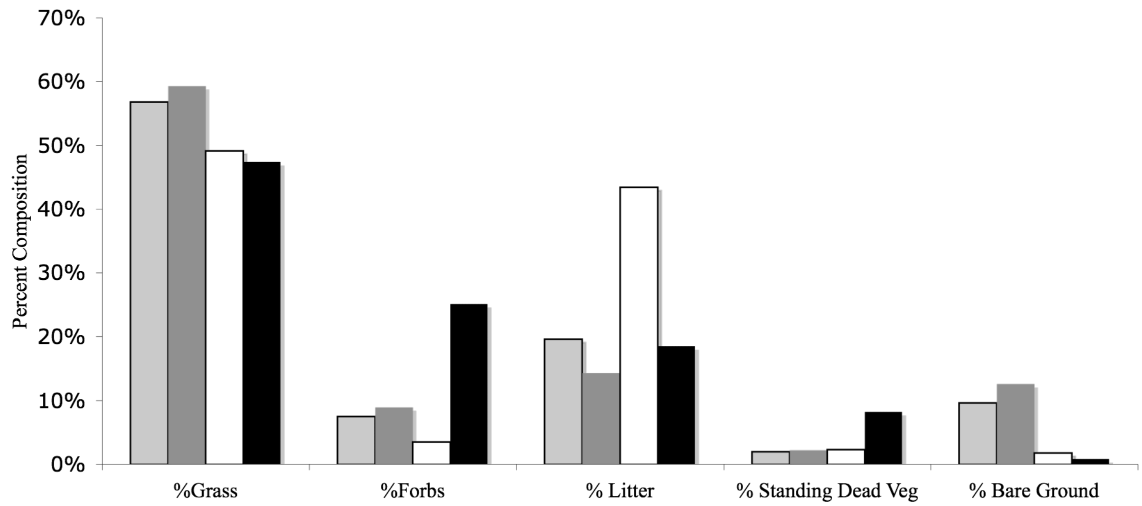
D. Warm-season grass CRP Fields (ungrazed)



Week 1 represents the last full week in May and week 9 represents the last full week in July. Gray lines represent periods of time when the areas were in the grazing rotation, while black diamonds and lines represent periods of time when the areas were not in the grazing rotation.

FIGURE 5. Mean percent ground cover composition from May to July for four field types in Adams County, IA, 2006-2007.

A. 2006 Average Vegetation Composition



B. 2007 Average Vegetation Composition

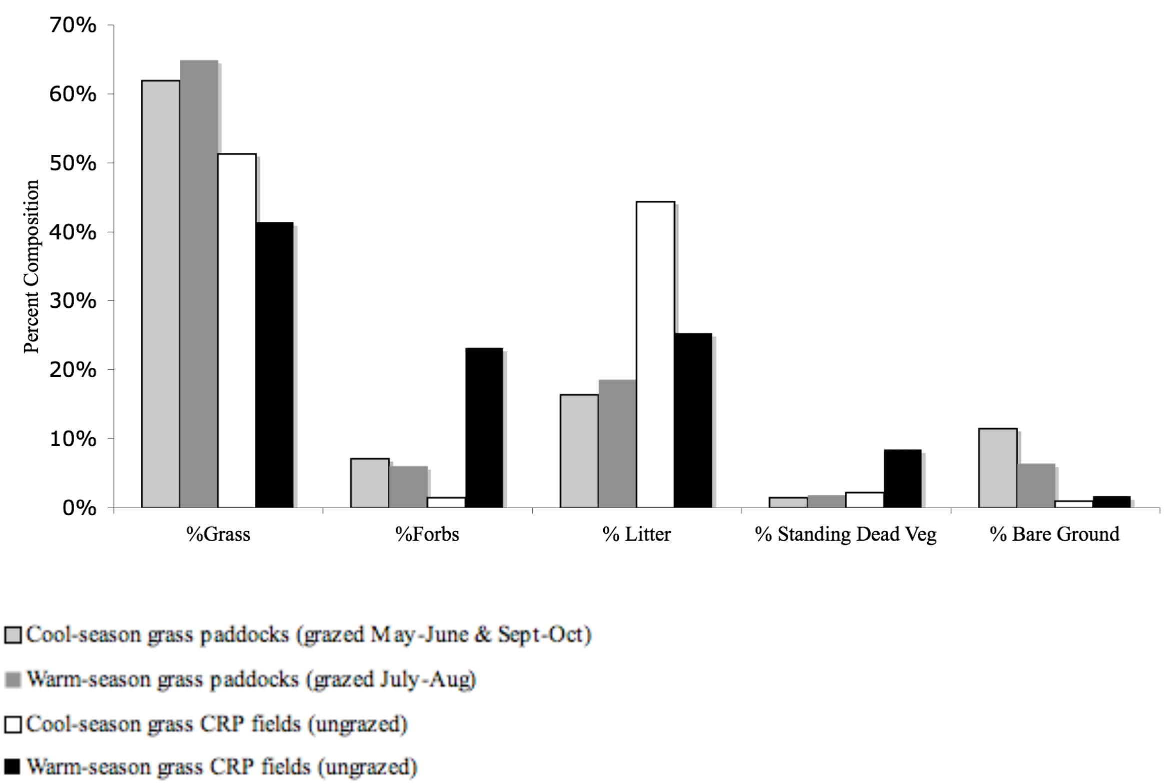
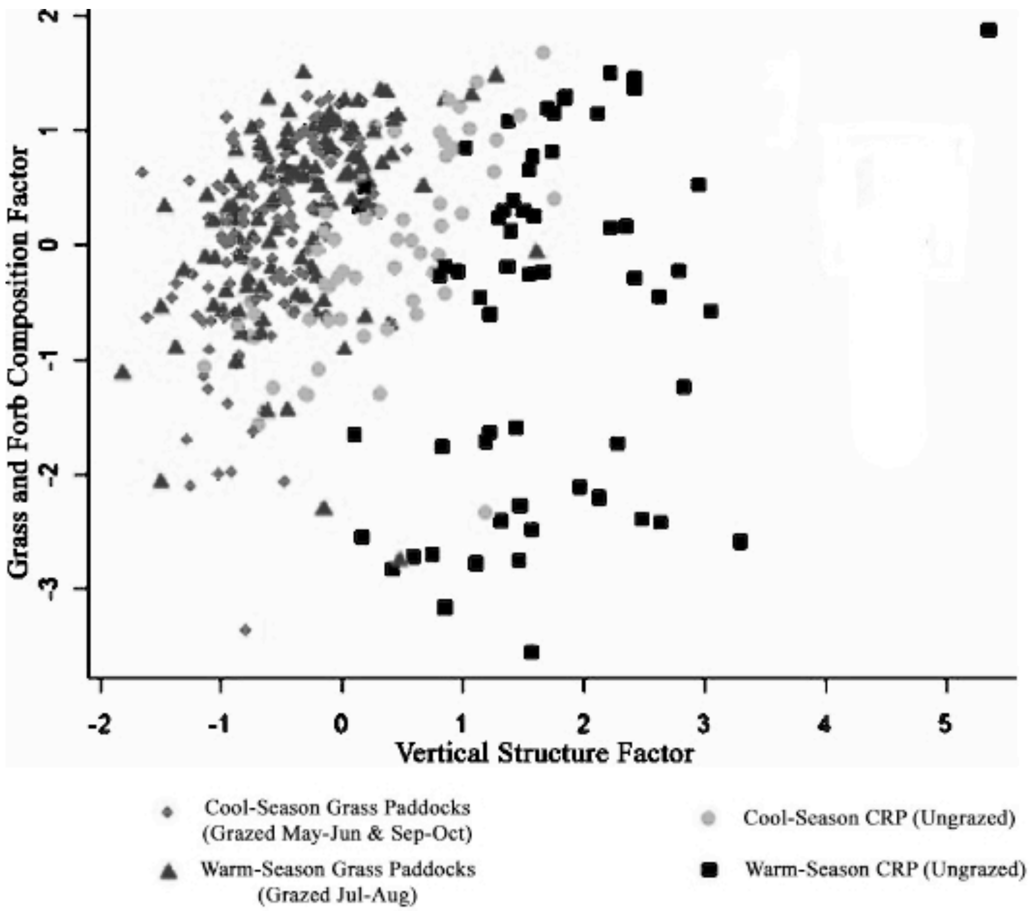


FIGURE 6. Separation of four field types through principal vegetation components in Adams County, IA, 2006-2007.



Vertical Structure Factor

- Positively influencing over ≥0.5
  - Maximum height live vegetation (cm)
  - Maximum height standing dead vegetation(cm)
  - Litter depth (cm)
  - Visual obstruction (dm)
- Negatively influencing ≤-0.5
  - N/A

Grass and Forb Composition Factor

- Positively influencing over ≥0.5
  - Percent grass cover
- Negatively influencing ≤-0.5
  - Percent forb cover

Chapter 3. General Conclusions

The Tallgrass Prairie that once dominated Iowa's landscape is all but gone (Samson & Knopf, 1994), plowed for commodity crop production and replaced by tame grasslands (Giglierano, 1999) that are dominated by introduced cool-season grass species (Barns & Nelson, 2003). Within this environment, the majority of grassland bird species have had trouble adapting, posting consistent declines since modern long-term monitoring was initiated in 1966 (Peterjohn & Sauer, 1999). Within this production landscape, few habitat options exist that are attractive to nesting species and are not population sinks (Frawley, 1989; Basore et al., 1986; Bollinger et al., 1990; Best et al., 1990; Frawley & Best, 1991; Igl, 1991; Granfors, 1992; Best et al., 1995; Bollinger, 1995). Grazing systems are often more attractive to grassland birds than hayfields and row cropland (Sample, 1989).

There is considerable variability in the management and control producers have over grazing systems and in the potential for grassland birds to successfully nest. Continuous stocking represents a grazing method in which cattle have prolonged access to a fixed pasture area and in which cattle are allowed to selectively graze repeatedly (Voisin, 1959; Barnhart et al., 1998; Allen & Collins, 2003). Overgrazing is common and there is a potential cycle of degradation resulting in a weakened grass and even the death of much of the stand is possible when continuous stocking is misused (Voisin, 1959; Barnhart et al., 1998; Moser & Nelson, 2003). Short-duration rotational stocking (SDRS) management units represent an alternative where cattle or other grazing livestock are rotated through numerous subdivisions (8-60), or paddocks, within a grazing management unit and the producer controls grass removal and rest periods between rotations (Voisin, 1959; Jensen et al., 1990; Barnhart et al., 1998; Moser & Nelson, 2003). Perhaps the greatest single misconception is to think of all rotational stocking management units as SDRS management units. This is certainly not the case, and in many ways, simple rotational management units are far more similar to continuous stocking in terms of limited control of grass removal and rest than they are to SDRS units (Voisin, 1959; Barnhart et al., 1998).

The potential of these grazing management units for grassland bird nesting will largely depend upon the grazing method and forage removal that is applied to them. Nest losses from cattle disturbance on both continuous stocking and SDRS management units have been reported as high (Koerth et al., 1983; Jensen et al., 1990; Paine et al., 1996). High cattle trampling losses in continuous stocking have been associated with greater walking distances to water, and more walking observed during foraging (Koeth et al., 1983). In SDRS management units, high stocking density concentrates animal impact in a confined area, typically resulting in around 75 percent nest loss from cattle disturbance (Paine et al., 1996).

The advantage that SDRS has over continuous stocking is that it has been found to be more attractive to a diversity of bird species (Temple et al., 1999). SDRS management units have been recognized for their potential to create a “pro bird” grazing management unit by taking roughly one-third of the paddocks out of production from May to June, creating an area in which grassland birds can nest relatively undisturbed and producers can stockpile standing grass reserves for lean summer dry conditions (Temple et al., 1999). This pro bird grazing management unit has the potential to be enhanced by the use of warm-season grasses as spring refugia for grassland birds and as summer forage (Pease, 2004).

This study hypothesized that native warm-season grass paddocks would attract a more diverse community of birds and produce more successful nests than the introduced cool-season grass paddocks. This study also compared grazed paddocks to adjacent fields enrolled in the Conservation Reserve Program (CRP) that had a warm-season grass component and those without. This study was conducted in southwest Iowa, in Adams County in 2006 and 2007. A subset of ten paddocks within a SDRS management unit were selected for evaluation: five in cool-season grasses that were grazed in May to June, and September to October, and five in warm-season grasses that were flash grazed in May and then grazed as part of the rotation in July and August. Five adjacent CRP fields were sampled: three in cool-season grass, and two in a mix of cool-season and warm-season grasses, referred to as warm-season grass CRP.

Grassland Bird Abundance, Density, & Nesting

Grassland bird species can largely be separated by their tolerance to SDRS. Grasshopper Sparrow (*Ammodramus savannarum*) and Eastern Meadowlark (*Sturnella magna*) were far more abundant in grazed paddocks than in ungrazed CRP fields, with both species showing a slight preference for the cool-season grass paddocks over the warm-season grass paddocks. Sedge Wrens (*Cistothorus platensis*), Common Yellowthroats (*Geothlypis trichas*), Dickcissels (*Spiza americana*), and Red-winged Blackbirds (*Agelaius phoeniceus*) were most abundant in ungrazed CRP fields. Avian abundance within the monotypic cool-season CRP fields was much lower than the warm-season grass CRP fields and was often lower than the grazed paddocks.

Detection probabilities could not be computed for Grasshopper Sparrows, Eastern Meadowlarks, and Red-winged Blackbirds because of a combination of avoidance behavior and small sample sizes. Densities were estimated for the remaining species and all except

Dickcissels showed high densities in warm-season CRP fields in relation to all other fields. Dickcissels were nearly as abundant in the warm-season grass paddocks as in the warm-season grass CRP fields. This suggests that the warm-season grass paddocks can indeed help bolster species diversity within grazing management units, but that might come at some level of decreased abundance for species that prefer grazed areas.

Seven species were found nesting on the study site. Only Grasshopper Sparrow and Eastern Meadowlark nests were found within grazed paddocks. Mayfield daily survival rates (Mayfield, 1961, 1975; Bart & Robinson, 1982) for these two these species were found to be consistently lower than species found nesting in ungrazed CRP fields. Losses from cattle disturbance amounted to 50 percent of the losses within the grazed paddocks. Warm-season grass paddocks did not attract Dickcissel or Red-winged Blackbird nests in 2006 or 2007, likely because of the minimal amount of standing dead vegetation to provide nesting structure within the paddocks. During the 2005 pilot study both species were observed nesting in the warm-season grass paddocks, but not during the subsequent two breeding seasons.

Northern Harrier (*Circus cyaneus*) was the only species to nest in the cool-season grass CRP fields. Four species were observed nesting in warm-season grass CRP fields: Sedge Wrens, Common Yellowthroats, Dickcissels, and Red-winged Blackbirds. Aside from the Northern Harrier nesting, the warm-season grass CRP fields had the highest success rates across fields with 33.3 percent of the nests successful. Nesting sample sizes were too small to draw definitive conclusions about the potential of the warm-season grass paddocks to bolster grassland bird nesting. What is clear is that that species like Dickcissels and Red-winged

Blackbirds will not nest in these paddocks in the absence of enough standing dead vegetation for nest construction. Warm-season grass CRP fields had a greater number of nests and had species nesting within them not observed nesting in the warm-season grass paddocks. These results suggest a need for these diverse CRP fields on the landscape, serving as habitat for species requiring very dense vegetation, and to provide a back up when conditions with the grazing management unit are not conducive to species like Dickcissels and Red-winged Blackbirds.

Management Recommendations

Based on the observations within this study, management recommendations exist. The single greatest cause of nest loss was cattle disturbance. Rest periods with paddocks in the grazing rotation was typically only 26.4 (±3.1) days, resulting in time periods large enough to attract birds to nest, but not large enough to fledge young without cattle disturbance. If animal impact on the paddocks could be intensified and rest periods extended, then these rest periods might be increased to around 45 days, creating a period of time to nest and fledge young in a relatively undisturbed fashion. This assumes that the remaining vegetative structure post-grazing is sufficient to attract nesting birds.

The practice of flash grazing the warm-season grass paddocks in early May is intended to set-back cool-season grass encroaching into the paddocks by grazing them intensely for a short period of time (usually a few hours to one day). If animals remain in the pasture for longer periods of time, then standing dead vegetation is more likely to be knocked-over and destroyed. Warm-season grass paddocks will not support a diverse set of species nesting within the paddocks without this standing dead vegetation. Managers must be cognizant of this when grazing these paddocks and they must recognize that managing for standing dead vegetation is a two year process requiring one year to grow it and another year for it to provide nesting structure.

The dearth of avian activity in monotypic cool-season CRP fields and a lack of abundance of forbs have been observed by others (Patterson and Best, 1996). The absence of forbs would suggest a need for some form of disturbance on these fields to beak-up the thick layer of litter that accumulates and prevents forb seeds from making contact with the soil or getting any light as seedlings. Two of the warm-season grass paddocks were seeded in the spring of 2005, and with the timely application of nitrogen the stand went from seed in ground to seed head within one year. The main drawback for grassland birds was the fact that these fields also had a large number of thistles in them and managers felt that the site had to be sprayed to control them. Spraying these fields in spring of 2007 reduced forb ground cover in these paddocks and likely reduced avian abundance within these paddocks.

Grassland managers have many variables to consider when operating a SDRS management unit: cattle performance, stand health, available forage, and weather, to name a few. Managers need to consider how their actions both help and hurt grassland bird species. Balancing these many moving targets is as much an art as it is a science. The following management recommendations come from this body of research:

- No rotational grazing system can be all things to all grassland bird species. Grassland birds differ in their specific needs for vegetation height, area needed, amount of bare ground or standing live or dead vegetation desired, and other requirements. Some grazing systems are compatible with some bird species, but not with others. Nearby ungrazed grassland refugia will always be needed to maintain grassland bird populations. However, well thought-out grazed grasslands can contribute to populations of some grassland bird species.

- This research suggests that a minimum rest period of at least 45 days between grazing periods is necessary for grassland birds to successfully nest and fledge young from paddocks. Rest periods of 45 days can be obtained by shifting to mob grazing, which would increase the number of paddocks and animal densities and create longer rest periods without compromising the carrying capacity of the grazing management unit. Mob grazing will require a greater level of management commitment from the producer and would likely eliminate the potential for bird species that require standing dead vegetation to nest in the cool-season grass paddocks.
- When removing paddocks from the grazing rotation, it is best for birds to remove adjacent paddocks to create a larger habitat block so area sensitive species like Grasshopper Sparrows and Eastern Meadowlarks are more likely to be attracted to the area.
- External and internal fencing that creates a softer edge, like high tensile electric fence or barbed wire, has the advantage of not only being less expensive to install than traditional woven wire fence, but benefits grassland birds by reducing edge habitat that is attractive to predators.

- Flash grazing in early spring can help control cool-season grass encroachment into warm-season grass paddocks, but it comes at the cost of reduced standing dead grass residue in which Dickcissels and Red-winged Blackbirds may nest.
- Increasing forb content within pastures benefits grassland birds as a direct food source of seeds and an indirect food source in the form of insects attracted to forbs. Producers also benefit from leguminous forbs because, depending on their abundance, they can provide some or all of the nitrogen needs of a pasture.
- Limited grazing after mid July should be considered as a possible form of mid contract management on monoculture cool-season Conservation Reserve Program land. Grazing has the potential to improve the plant species diversity and make these lands more attractive to grassland birds.

Recommendations for Future Research

In the future, ecologists should clarify the management of grazing lands when discussing their sites and recognize the diversity of forms that grazing and grazing management can take. Future research efforts should focus on SDRS management units that utilize longer rest periods to create windows between grazing events large enough to successfully fledge young. Rest periods of 45 days or longer may create a habitat that is not a population sink. Information regarding the suitability and attractiveness of specific legume and other forb species and warm-season grass mixes might help maximize the attractiveness and nest structure within warm-season grass paddocks for grassland birds. Information regarding multispecies grazing and its effect on grassland birds is not presently available.

The effect on area sensitive grassland bird species of a larger pro bird grazing management unit would also provide useful information. The rapid development of corn ethanol in Iowa will in all likelihood be followed by the rapid development and expansion of lignocellulosic ethanol production. The use of perennial crops in lignocellulosic ethanol production would allow it to expand into highly erodible and environmentally sensitive areas that corn production cannot, resulting in this form of agricultural production being conducted on CRP fields and other idled lands that many grassland birds depend upon for nesting habitat. Research must be conducted on different lignocellulosic ethanol production crops and crop systems and their effects on grassland birds now, before these systems explode across the landscape and concerns of ecologists are moot.

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APPENDIX 1. Mean nest initiation dates (±SE) for seven bird species in Adams County, IA, 2006-2007.

	2006			2007		
Species	n	Early	Mean (SE)	n	Early	Mean (SE)
Northern Harrier	1	21 Apr	21 Apr	1	7 May	7 May
Sedge Wren	0	-	-	1	2 Jun	2 Jun
Common Yellowthroat	0	-	-	3	4 Jun	7 Jun (2.5)
Dickcissel	8	24 May	22 Jun (7.9)	3	9 Jun	16 Jun (5.2)
Grasshopper Sparrow	2	17 May	21 May (3.5)	5	16 May	1 Jun (7.3)
Red-winged Blackbird	1	30 May	30 May	5	6 Jun	23 Jun (7.2)
Eastern Meadowlark	8	29 May	18 Jun (4.2)	1	5 Jul	5 Jul

APPENDIX 2. Species-specific tables of birds flushed by modified chain drag method or observed within 10 m of chain in Adams County, IA, 2006-2007.

Ring-necked Pheasant (*Phasianus colchicus*) and Northern Bobwhite (*Colinus virginianus*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			2	0.3	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			2	0.3	1	0.2
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	2	0.3
Warm-season grass CRP fields (Ungrazed)	7.7			0	0.0	0	0.0
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	0	0.0	0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	1	0.2	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	0	0.0	3	0.4	3	0.4

Sedge Wren (*Cistothorus platensis*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7			20	2.6	7	0.9
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	0	0.0	0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	2	0.3	1	0.1	6	0.8

Common Yellowthroat (*Geothlypis trichas*)

Field Treatment	ha	Round 1		Round 2		Round 3	
		Fsh	Fsh/ha	Fsh	Fsh/ha	Fsh	Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7			32	4.2	15	2.0
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	0	0.0	0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	10	1.3	13	1.7	12	1.6

Dickcissel (*Spiza americana*)

Field Treatment	ha	Round 1		Round 2		Round 3	
		Fsh	Fsh/ha	Fsh	Fsh/ha	Fsh	Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7			22	2.9	15	2.0
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	0	0.0	0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	20	2.6	18	2.4	22	2.9

Grasshopper Sparrow (*Ammodramus savannarum*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			3	0.4	5	0.7
Warm-season grass paddocks (Grazed July-Aug)	6.5			5	0.8	2	0.3
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7			0	0.0	0	0.0
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	13	1.7	10	1.3	6	0.8
Warm-season grass paddocks (Grazed July-Aug)	6.5	4	0.6	2	0.3	1	0.2
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	3	0.4	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	0	0.0	0	0.0	0	0.0

Bobolink (*Dolichonyx oryzivorus*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	0	0.0	3	0.4	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	8	1.1	2	0.3	1	0.1

Bobolinks were not observed as a flushed species in 2006

Eastern Meadowlark (*Sturnella magna*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			9	1.2	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			2	0.3	0	0.0
Cool-season grass CRP fields (Ungrazed)	7.3			0	0.0	7	1.0
Warm-season grass CRP fields (Ungrazed)	7.7			0	0.0	0	0.0
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	2	0.3	2	0.3	1	0.1
Warm-season grass paddocks (Grazed July-Aug)	6.5	1	0.2	1	0.2	5	0.8
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	0	0.0	0	0.0	0	0.0

Red-winged Blackbird (*Agelaius phoeniceus*)

Field Treatment	ha	Round 1 Fsh	Round 1 Fsh/ha	Round 2 Fsh	Round 2 Fsh/ha	Round 3 Fsh	Round 3 Fsh/ha
2006							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5			0	0.0	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5			0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	7.3			3	0.4	5	0.7
Warm-season grass CRP fields (Ungrazed)	7.7			4	0.5	2	0.3
2007							
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	7.5	3	0.4	1	0.1	0	0.0
Warm-season grass paddocks (Grazed July-Aug)	6.5	0	0.0	0	0.0	0	0.0
Cool-season grass CRP fields (Ungrazed)	6.8	0	0.0	0	0.0	0	0.0
Warm-season grass CRP fields (Ungrazed)	7.7	0	0.0	0	0.0	4	0.5

Fsh=flushes, round 1 flushes for 2006 were not recorded

APPENDIX 3. Summary of detection by distance category (m) for six bird species in Adams County, IA, 2006-2007.

Sedge Wren (*Cistothorus platensis*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	0	0	0	2
Warm-season grass paddocks (grazed July-Aug)	6	0	0	0	0	2
Cool-season grass CRP fields (Ungrazed)	5	0	0	0	0	4
Warm-season grass CRP fields (Ungrazed)	5	34	28	21	83	49
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	0	0	0	0
Warm-season grass paddocks (Grazed July-Aug)	6	0	0	0	0	0
Cool-season grass CRP fields (Ungrazed)	5	0	0	0	0	0
Warm-season grass CRP fields (Ungrazed)	5	22	18	22	62	30

Common Yellowthroat (*Geothlypis trichas*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	1	4	5	84
Warm-season grass paddocks (Grazed July-Aug)	6	0	2	6	8	161
Cool-season grass CRP fields (Ungrazed)	5	0	0	5	5	108
Warm-season grass CRP fields (Ungrazed)	5	26	20	28	74	174
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	1	4	3	8	97
Warm-season grass paddocks (Grazed July-Aug)	6	0	0	0	0	77
Cool-season grass CRP fields (Ungrazed)	5	0	0	0	0	81
Warm-season grass CRP fields (Ungrazed)	5	48	27	38	113	154

Dickcissel (*Spiza americana*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	1	2	3	60
Warm-season grass paddocks (Grazed July-Aug)	6	0	2	4	6	74
Cool-season grass CRP fields (Ungrazed)	5	0	2	0	2	77
Warm-season grass CRP fields (Ungrazed)	5	86	128	77	291	294
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	1	4	5	92
Warm-season grass paddocks (Grazed July-Aug)	6	0	6	10	16	95
Cool-season grass CRP fields (Ungrazed)	5	0	0	1	1	128
Warm-season grass CRP fields (Ungrazed)	5	79	55	57	191	141

Grasshopper Sparrow (*Ammodramus savannarum*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	4	19	9	32	65
Warm-season grass paddocks (Grazed July-Aug)	6	7	17	9	33	45
Cool-season grass CRP fields (Ungrazed)	5	1	10	6	17	34
Warm-season grass CRP fields (Ungrazed)	5	0	1	5	6	9
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	41	25	44	110	84
Warm-season grass paddocks (Grazed July-Aug)	6	8	24	33	65	51
Cool-season grass CRP fields (Ungrazed)	5	3	6	9	18	45
Warm-season grass CRP fields (Ungrazed)	5	0	0	1	1	1

Eastern Meadowlark (*Sturnella magna*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	9	27	25	61	377
Warm-season grass paddocks (grazed July-Aug)	6	3	28	25	56	253
Cool-season grass CRP fields (Ungrazed)	5	0	0	1	1	202
Warm-season grass CRP fields (Ungrazed)	5	1	8	13	22	89
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	3	10	28	41	246
Warm-season grass paddocks (Grazed July-Aug)	6	1	8	24	33	148
Cool-season grass CRP fields (Ungrazed)	5	0	0	0	0	227
Warm-season grass CRP fields (Ungrazed)	5	0	0	4	4	95

Red-winged Blackbird (*Agelaius phoeniceus*)

Field Treatment	Point Transects	0-30.5	30.6-53.3	53.4-68.6	0-68.6	>68.6
2006						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	0	1	10	11	357
Warm-season grass paddocks (Grazed July-Aug)	6	2	12	9	23	129
Cool-season grass CRP fields (Ungrazed)	5	1	2	10	13	126
Warm-season grass CRP fields (Ungrazed)	5	25	22	34	81	218
2007						
Cool-season grass paddocks (Grazed May-June & Sept-Oct)	6	15	20	45	80	421
Warm-season grass paddocks (Grazed July-Aug)	6	0	3	5	8	68
Cool-season grass CRP fields (Ungrazed)	5	2	3	2	7	128
Warm-season grass CRP fields (Ungrazed)	5	11	11	0	22	204

APPENDIX 4. Summary of all bird detections in Adams County, IA, 2006-2007.

		Observations	
Common Name	***Genus species***	**2006**	**2007**
Ring-necked Pheasant	*Phasianus colchicus*	87	59
Northern Bobwhite	*Colinus virginianus*	166	38
Double-crested Cormorant	*Phalacrocorax auritus*	0	1
Great Blue Heron	*Ardea herodias*	4	2
Canada Goose	*Branta canadensis*	7	5
Turkey Vulture	*Cathartes aura*	129	69
Northern Harrier	*Circus cyaneus*	20	51
Red-tailed Hawk	*Buteo jamaicensis*	4	2
American Kestrel	*Falco sparverius*	16	24
Killdeer	*Charadrius vociferus*	16	24
Mourning Dove	*Zenaida macroura*	74	83
Red-headed Woodpecker	*Melanerpes erythrocephalus*	3	47
Red-bellied Woodpecker	*Melanerpes carolinus*	18	19
Northern Flicker	*Colaptes auratus*	16	15
Eastern Kingbird	*Tyrannus tyrannus*	41	30
Loggerhead Shrike	*Lanius ludovicianus*	1	2
Blue Jay	*Cyanocitta cristata*	89	93
American Crow	*Corvus brachyrhynchos*	48	16
Barn Swallow	*Hirundo rustica*	98	83
Tree Swallow	*Tachycineta bicolor*	34	85
Black-capped Chickadee	*Parus atricapillus*	0	6
House Wren	*Troglodytes aedon*	12	12
Sedge Wren	*Cistothorus platensis*	53	47
Eastern Bluebird	*Sialia sialis*	0	14
Wood Thrush	*Hylocichla mustelina*	15	0
American Robin	*Turdus migratorius*	70	94
Gray Catbird	*Dumetella carolinensis*	13	9
Brown Thrasher	*Toxostoma rufum*	12	9
European Starling	*Strunus vulgarius*	13	0
Common Yellowthroat	*Geothlypis trichas*	227	230
Dickcissel	*Spiza americana*	53	283
Northern Cardinal	*Cardinalis cardinalis*	96	34
Chipping Sparrow	*Spizella passerina*	1	0

Field Sparrow	*Spizella pusilla*	222	73
Vesper Sparrow	*Pooecetes gramineus*	1	0
Grasshopper Sparrow	*Ammodramus savannarum*	85	205
Song Sparrow	*Melospiza melodia*	2	25
Bobolink	*Dolichonyx oryzivorus*	2	23
Red-winged Blackbird	*Agelaius phoeniceus*	366	342
Eastern Meadowlark	*Sturnella magna*	360	311
Western Meadowlark	*Sturnella neglecta*	0	18
Common Grackle	*Quiscalus quiscula*	8	24
Brown-headed Cowbird	*Molothrus ater*	43	53
Baltimore Oriole	*Icterus galbula*	1	10
Orchard Oriole	*Icterus spurius*	3	0
American Goldfinch	*Carduelis tristis*	12	26

APPENDIX 5. Partners in Flight conservation priority species assessment scores for Bird Conservation Region 22 (Eastern Tallgrass Prairie).

Common Name	Scientific Name	PIF Score
Ring-necked Pheasant	*Phasianus colchicus*	13
Northern Bobwhite	*Colinus virginianus*	18
Northern Harrier	*Circus cyaneus*	13
Killdeer	*Charadrius vociferus*	12
Mourning Dove	*Zenaida macroura*	10
Red-headed Woodpecker	*Melanerpes erythrocephalus*	19
Northern Flicker	*Colaptes auratus*	16
Eastern Kingbird	*Tyrannus tyrannus*	15
Blue Jay	*Cyanocitta cristata*	12
Sedge Wren	*Cistothorus platensis*	14
American Robin	*Turdus migratorius*	9
Brown Thrasher	*Toxostoma rufum*	16
Common Yellowthroat	*Geothlypis trichas*	13
Dickcissel	*Spiza americana*	18
Northern Cardinal	*Cardinalis cardinalis*	9
Field Sparrow	*Spizella pusilla*	17
Grasshopper Sparrow	*Ammodramus savannarum*	16
Bobolink	*Dolichonyx oryzivorus*	15
Red-winged Blackbird	*Agelaius phoeniceus*	13
Eastern Meadowlark	*Sturnella magna*	16
Western Meadowlark	*Sturnella neglecta*	13
Common Grackle	*Quiscalus quiscula*	11
Brown-headed Cowbird	*Molothrus ater*	10

Used to derive conservation values (Fig. 3) in Adams County, IA, 2006-2007. (Penjabi et al. 2005: Rocky Mountain Bird Observatory to calculate the index (2008).

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