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Assessing the Potential Habitat Value of Biomass Production Fields for Grassland Birds

Mandy Larson
University of Northern Iowa

ASSESSING THE POTENTIAL HABITAT VALUE
OF BIOMASS PRODUCTION FIELDS FOR GRASSLAND BIRDS

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Mandy Larson

University of Northern Iowa

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Mandy Larson

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Date Jessica Moon, Director, University Honors Program

Table of Contents

Section 1: Introduction

Discovering new resources for renewable energy has been a point of an interest since the oil crisis of the 1970's because of the diminishing availability of oil and its rising prices. In Iowa, using biomass from row crops, such as corn, to produce ethanol has been increasingly widespread. More recently, obtaining energy using biomass from herbaceous vegetation, has been receiving greater attention. Using perennial vegetation as a major source of biomass production could have major implications for creating viable habitats for local wildlife in Iowa.

Ever since the conversion of tallgrass prairies to agriculture in the Midwest, local wildlife, such as grassland birds, have been experiencing major population declines. A primary reason for these population declines is habitat destruction. If potential biomass producers would use perennial grasses as a biomass source, then the role habitat destruction has in grassland bird population decline could perhaps be reversed.

In this paper, I researched the habitat requirements of grassland birds in general, including an in-depth analysis of the specific habitat requirements of four selected species: Bobolink (*Dolichonyx oryzivorus*), Dickcissel (*Spiza Americana*), Grasshopper Sparrow (*Ammodramus savannarum*), and Sedge Wren (*Cistothorus platensis*). In the second part of my research, I evaluated three possible scenarios that could be used for biomass production in Iowa and reviewed the methods producers employ in establishing and managing their fields. I evaluated area, species diversity, timing of harvest, edge habitats, and fertilizers/chemicals used during production. Then I compared these three biomass production scenarios to the habitat requirements of the four aforementioned grassland birds. I concluded by offering recommendations to biomass producers on how to create a more viable habitat for a variety of grassland birds in their biomass production fields.

Section 2: Research Methods

I reviewed the habitat requirements of Bobolink, Dickcissel, Grasshopper Sparrow, and Sedge Wren through literature review. By studying these species, each of which occupies a slightly different niche in an ecosystem, I could discover a generalized set of habitat conditions that would benefit a wide variety of grassland birds (Fitzgerald, et al, 1998). Habitat features considered included vegetation density and structure, forb cover, grass cover, litter cover, and litter depth. I also looked for evidence of species response/sensitivity to mowing, burning, grazing, area, and edge habitats. Through literature review, I found how different authors reconciled the habitat differences among grassland birds. This reconciliation is necessary for my final conclusion, as it will determine how biomass production fields can be most effective in providing not only energy output but also wildlife habitat for grassland birds.

In the second part of this research, I used literature review and interviews to determine the variety of approaches to growing perennial vegetation for biomass and the range of management options utilized. I examined three scenarios that could be possibly used for biomass production: switchgrass monocultures, harvesting existing Conservation Reserve Program land, and diverse prairie plantings. I investigated the species composition of biomass production fields, the shape/size of those fields, frequency/amount of fertilizer and chemicals applied, and the frequency of mowing, burning, and harvest. These findings were then summarized and compared to the habitat requirements of the aforementioned grassland birds.

Section 3: Literature Review

3.1 Biomass Production

In recent years, there has been increasing attention given to using biomass as a source of energy (Florine et al. 2006). Ethanol derived from corn has received a large amount of attention, but some drawbacks from using corn for energy have surfaced, such as increased food prices, low energy yield, and the use of chemicals throughout the production process (Hill et al. 2006). Using biomass energy from other crops, such as switchgrass, hybrid poplar, and willow, has become a focus for research in recent decades (Walsh et al. 2003). The biomass obtained from these plants has lower water content and higher lignin and cellulose content than row crops, which creates a higher heating value when used energetically as well as better support while the plant is growing; these attributes contribute to a higher biomass quality (Lewandowski et al. 2003). If native vegetation were to replace corn as a biomass energy feedstock, the fields used to produce the biomass could provide a myriad of ecosystem services from watershed protection to carbon sequestration to providing a home for wildlife in the area (Tolbert & Schiller, 1995).

More research has been done on switchgrass (*Panicum virgatum*) as an energy provider than other perennial vegetation when the Department of Energy deemed it the model herbaceous crop for biomass production in the early 1990's (Lewandowski et al. 2003; Wright 2007). Switchgrass is a perennial warm season grass that has the ability to withstand many harsh conditions from droughts to floods (McLaughlin & Walsh 1997). After being planted, switchgrass can be maintained on a field for ten years without replanting; the first year of planting requires intensive management, such as the use of herbicides, soil tillage and fertilizer (McLaughlin & Walsh 1997; Walsh et al. 2003, Lewandowski et al. 2003). Since switchgrass only requires soil tillage in the first year, this has positive effects on the soil, such as reduced erosion and an increase in soil carbon content (Lewandowski et al. 2003).

In order to establish a successful stand of switchgrass, it is crucial to have a firm seedbed, correct planting depth, and good weed control (Lewandowski et al. 2003). Perennial grasses such as switchgrass require minimal nutrient input as well as little pesticide use since they have few natural pests (Lewandowski et al. 2003). Also, studies have shown that on relatively fertile sites, fertilizer application has little effect on the productivity of switchgrass (Lewandowski et al. 2003; Mulkey, et al. 2006). Switchgrass can also be easily integrated into established agricultural practices since haying equipment used for planting, management and harvesting can also be used for switchgrass (Lewandowski, et al. 2003). Switchgrass only requires a single harvest annually after the first killing frost, which helps to lower the cost of production (Lewandowski et al. 2003; Sanderson, et al. 1996). If switchgrass is harvested later, it removes fewer nutrients from the soil which results in higher yields in subsequent harvests and better biomass quality because of decreased mineral content (Lewandowski et al. 2003).

Switchgrass has been chosen as the most favorable perennial grass to use as biomass because of its relatively high yield even in infertile, eroded soil and its low input requirements, such as the minimal use of chemicals and fertilizer (Florine et al. 2006). Switchgrass has also been shown to have desirable fuel characteristics when compared to other prairie grasses and corn because of its high net energy, low ash content, and favorable chemistry (Florine et al. 2006). These are important characteristics since the ash content and chemistry of a crop indicate its tendency to slag when being co-fired with coal (Florine et al 2006). When prairie grasses are burned in conjunction with coal in power plants (i.e., co-firing), they tend to slag, which means that the ash is released in a molten state and then adheres to the walls of the furnace, which can create problems with boiler operation (Neville 2009).

Switchgrass has the possibility of being an economically feasible choice of domestic energy (Walsh et al. 2003). The most imposing obstacle that switchgrass proponents must overcome is making it economically competitive with existing agricultural uses of land (Walsh et al. 2003). In a study done by Walsh et al. (2003), the economics of two management scenarios for a switchgrass stand were compared and then compared to the economics of a row crop field. The first management scenario's goal was to achieve high levels of biomass production and the other was to achieve high levels of wildlife diversity (Walsh et al. 2003). In the second scenario, the amount of fertilizers and chemical inputs were limited as well as the frequency of harvest in order to encourage the use of the field by wildlife (Walsh et al. 2003). The first management scenario yielded higher energy output, and thus was economically competitive to that of the row crop fields (Walsh et al. 2003). Even though the second management scenario yielded a lower energy output than the first, it was also still competitive to that of the row crop fields (Walsh et al. 2003).

Establishing switchgrass monocultures specifically for biomass production is not the only potential model for generating energy from perennial vegetation. Iowa has over 1 million acres of land enrolled in the Conservation Reserve Program (CRP), which provides payments to farmers who convert their marginal lands to native vegetation. Harvesting more diverse vegetation on CRP lands could be another approach to biomass production and would also be beneficial to wildlife if CRP acreage were to increase as a result. A diversity of prairie cool season grasses occur in CRP lands, especially in southern Iowa (Florine et al 2006), thus it is important to look at the practical and ecological reasons to increase the diversity of vegetation used in biomass production. Cool season grasses are comparable with switchgrass in regard to biomass yield, ash content, and chemistry (Florine et al 2006). In addition to this, an increase in plant diversity may reduce the risk of epidemic pest and disease outbreak among monoculture stands (Lewandowski et al. 2003). Since cool season grasses are comparable to switchgrass in many ways, it is possible that they can be planted with switchgrass stands (Florine et al 2006). Florine et al. (2006) showed that many cool season grasses, including smooth bromegrass (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*) and birdsfoot trefoil (*Lotus corniculatus*), are capable of producing high yields (Florine et al 2006).

In a study done by Tilman et al. (2006), it was shown that a diverse community of grass and forb species resulted in greater ecosystem stability and greater biomass production. The authors concluded: "Our results indicate that the reliable, efficient and sustainable supply of some foods (for example, livestock fodder), biofuels and ecosystem services can be enhanced by the use of biodiversity" (Tilman et al. 2006). Since this study was a decade long, it allowed for a long-term view on the effects of plant diversity on biomass yields.

In a previous study, Tilman et al. (1996) showed that soil fertility and soil nutrients depend on biodiversity. In addition, the more plant diversity that exists, the greater the productivity of the ecosystem is and the lower the loss of nutrients in the soil (Tilman et al. 1996). In another study, Tilman et al. (2001) found that plots with higher plant diversity attained 2.7-2.9 times greater biomass than monocultures. Similarly, Hector et al. (1999) found that when plant species richness increased, so did above ground biomass. Conversely, when species richness was limited, the field was less productive on average (Hector et al 1999).

Such research results suggest an alternative to growing switchgrass monocultures for energy production: establishing diverse prairie plantings that have multiple benefits, including not only biomass production, but also enriching soil nutrients, sequestering carbon and increasing ecosystem stability (Tilman et al. 2006; Murray et al. 2003; Hector et al. 1999; Sanderson et al. 1996). Since diverse prairie plantings require little to no chemicals, fertilizer, or soil tillage in the first year of establishment, the amount of sediment and chemical runoff that enters into streams or infiltrates groundwater is limited (Murray et al. 2003; McLaughlin & Walsh 1997). These are all very important qualities since years of row crop farming has depleted the topsoil of nutrients, reduced soil carbon levels by 60%, and caused approximately 2.7 billion tons of soil to be eroded away in the United States each year (McLaughlin & Walsh 1997; Sanderson et al. 1996).

3.2 Grassland Birds

North America's tallgrass prairies have been systematically replaced by agriculture since the 1800's (Fitzgerald 1999). Now, only 1% of the once extensive ecosystem remains (Johnson 2001). As the destruction of Iowa's native prairie progressed, there were rapid declines of many grassland birds, many of which continue today (Fitzgerald et al. 1998). According to Murray et al. (2003), "Grassland birds are declining faster than any other group of birds in North America." Even though there have been conservation efforts to slow this process in the form of habitat rehabilitation and habitat management, many bird populations are losing their nesting and breeding habitats (Ehresman 2007). According to Partners in Flight's Bird Conservation Plan of 1998, "grassland bird communities persist mostly in habitats such as hayfields, pastures, small grain fields and land enrolled in Federal incentive programs such as Conservation Reserve Program" (Fitzgerald et al. 1998). Because they are forced to live in these marginal habitats, grassland birds experience major disturbances in their lifecycles, such as mowing, burning, and pesticide spraying (Ehresman 2007). Also, due to the fragmented nature of these habitats, many grassland birds are susceptible to an increased frequency of predation, brood parasitism, and competition (Fitzgerald et al. 1998; Winter et al 2000).

The development of an agricultural system based upon the harvest of prairie vegetation for biomass could create significant habitat for grassland birds. One study has shown that "converting row crop and CRP [conservation reserve program] land to switchgrass biomass production would create additional habitat for some bird species of management concern" (Murray et al. 2003). However, in order to be utilized effectively for its maximal energy output, these prairie fields would have to be harvested annually (Cooper, Braster & Woolsey 1998). Unfortunately, harvesting may disrupt grassland birds' breeding and nesting seasons depending on when and how often the harvesting is done (Walk & Warner 2000).

However, in the past, prairies experienced natural disturbances such as fires and regular grazing by bison that fostered plant diversity and was essential to grassland birds (Fitzgerald et al. 1998). Numerous studies demonstrated that grassland bird communities are more diverse and abundant in grassland habitats with greater plant diversity and structural complexity (Tilman et al. 2006; Walk & Warner 1999). So, it is possible that fields used to produce biomass could be harvested in a way that would mimic natural disturbance events on a timetable that would not disrupt grassland bird's breeding and nesting seasons. Murray et al. (2003) found that the best way to harvest biomass fields in order to accommodate a diversity of grassland birds was to have a mixture of total harvest and nonharvest fields in a region. By doing this, some fields would remain unharvested for a time while others would continue through annual harvesting during the fall season (Murray et al. 2003). This would be most effective since a variety of grassland birds prefer fields in different stages of growth for breeding and nesting (Dyke et al. 2006; Horn & Koford 2000).

A major issue that presents itself with mowing is the possibility of fields being disturbed during breeding seasons (Horn & Koford 2000). According to Horn and Koford (2000), "mowing in the breeding season destroys or causes abandonment of a large proportion of the nests that were active just prior to mowing and repeated mowing may not allow birds to complete their nesting cycles." In their study, Horn and Koford (2000) recommended that partial mowing of management units in addition to other management regimes such as burning and grazing would be most beneficial to create a mosaic habitat for a variety of birds. It was also recommended in this study that mowing should generally not be done during breeding season, but rather before or after the grassland birds had completed reproduction (Horn & Koford 2000). If the mowing must be done during the breeding season, Horn and Koford (2000) recommended doing it no earlier than July 15-20.

One way to increase the diversity of plants in a management unit is to allow for moderate to light grazing. Walk and Warner (2000) showed that a variety of grassland birds responded well to moderate to light grazing. Grazing creates heterogeneous vegetation structure within a field or pasture, so it would support a variety of grassland birds that require different habitats (Walk & Warner 2000). Also, according to Dyke et al. (2007), prescribed burning can alter vegetation density, structure, and habitat heterogeneity. Using prescribed burnings in management units may prove beneficial to a number of grassland birds that require a variety of vegetation structure and density (Dyke et al. 2007).

Vegetation structure is another important characteristic to grassland birds that inhabit biomass production fields (Murray et al. 2003). Having heterogeneous vegetation structure within a field will attract a community of grassland birds since some species prefer short, sparse vegetation while others prefer tall, dense vegetation (Murray et al. 2003). McCoy et al. (2001) found that, "single-species plantings or warm- or cool-season grasses should be avoided to increase the potential wildlife benefits of CRP and other grassland habitats." This study showed that plant diversity is more beneficial to grassland birds than switchgrass monocultures (McCoy et al. 2001).

Besides the issues of vegetation structure and management regimes, another major issue is the relationship between repeated biomass harvest and habitat fragmentation. Many grassland birds are area-sensitive, which means that some grassland birds do not nest successfully in habitats with a small area for various reasons. Reasons for this sensitivity include habitat selection/recognition, competition with generalists, brood parasitism, and increased rates of predation (Johnson & Igl 2001). Herkert (1994), found that 8 of the 15 bird species in his study were area-sensitive, and five of those eight were identified as showing the greatest population decline in the Midwest. One of the reasons the author gave for this area-sensitivity is fragmentation, which also increases the chance of edge effects occurring (Herkert 1994).

Edge habitat is the area that occurs at the junction between two dissimilar habitat types. Some common edge habitats bordering biomass production fields include forests, shrubby hedgerows, agricultural row crops, and roadside vegetation (Winter et al. 2000). Edge effects are the negative effects on habitat conditions and/or species populations that result from the junction of the dissimilar habitat types. Edge effects may occur as a result of changes in microhabitat or increased rates of interaction with other species, including predators,brood parasites, and competitors (Winter et al. 2000). Winter et al. (2000), found that edge effects have an even more important effect on grassland birds than area effects. It was found in this study that frequency of predation and brood parasitism increased within a closer distance to forest and shrubby edge habitats (Winter et al. 2000). Winter et al. (2000) suggested that woody edges—such as forest and shrubby edge habitats—seem to serve as travel routes for nest predators. Winter et al. (2000) recommended that woody edges should be removed from prairie fragments and the prairie fragments should be joined to create a larger, connected open area. This, then, could have the possibility of attracting a more diverse array of grassland birds that had previously avoided small areas because of their close proximity to woody edges (Winter et al. 2000).

In order to combat the effects of area sensitivity and edge effects, Partners in Flight suggested a model for grasslands that,

> ...recommends a minimum of 800 ha (2,000 acre) block as a core area within a 1.6 km (one mile) wide matrix (approximately 4000 ha or 10,000 acre) surrounding the core. The matrix should provide another 1,000 ha (2,500 acres) of grassland habitat of some sort with a suggested minimum field sizes of 40 ha (100 acres) (Fitzgerald et al. 1998).

As this is a massive plot of land, it was also suggested by Partners in Flight in 2000 that area sensitivity could be mitigated with an increase of grass cover in the area surrounding a site (Fitzgerald 2000). What the first model suggests is that management units need to be much larger than they currently are in order to be most effective in attracting a variety of grassland birds. The second model suggests that grassland birds perhaps only need the security of a greater amount of grass cover between them and the woody edges.

Section 4: Results

4.1 Potential Scenarios for Biomass Production in Iowa

Through interviews and literature review, I identified three scenarios that could possibly be implemented for biomass production using perennial vegetation in Iowa: switchgrass monocultures, diverse prairie plantings, and harvesting existing Conservation Reserve Program land.

In my correspondence with John Sellers, Jr., a Grassland Systems Program Coordinator from Corydon, Iowa, I discovered that stand density in addition to fertility levels were the primary contributors to higher yields in switchgrass monocultures. Sellers uses much of his privately owned land to grow switchgrass in order to improve wildlife habitat and reduce soil erosion (Leopold Center for Sustainable Agriculture 2009). Sellers is active in renewable energy and conservation issues as well as being a past field coordinator for the Chariton Valley Biomass Project (Center for Sust. Ag. 2009). The information that I learned from Sellers in our correspondence is outlined in Table 1.

While producing biomass, Sellers harvested the majority of his fields once a year while leaving parts of some of his plots not harvested due to their wildlife value, small/odd shape, or difficulty to harvest. While Sellers was harvesting for biomass, he used herbicides to control weeds and fertilizer to support growth.

In my correspondence with Dave Williams, Prairie Institute Program Manager at the Tallgrass Prairie Center (TPC) at the University of Northern Iowa, I was given information about the biomass research fields he manages for the TPC. At the TPC, there are eight fields with a total of 48 plots that have different management regimes. While the TPC research will examine four levels of plant diversity, for the purpose of this paper, I will focus solely on the most diverse treatment. The description of this treatment is in Table 1.

In our interview, Williams informed that the TPC uses no till drill as their planting technique as this does very little to disturb the soil. Disturbing the soil, as described above, causes more soil erosion and a decrease in soil carbon content (Lewandowski et al. 2003). The drawback of using no till drill is it can only be used on old agricultural fields. If any other kind of land, such as old Conservation Reserve Program fields, were to be used for biomass production, no till drill could not be used because the existing grasses must be removed in order to be able to plant the grasses required for biomass production.

The TPC does not graze or burn their fields, but they do use establishment mowing. This means that they will mow their plots in the first, and perhaps in the second, year of establishment. Establishment mowing maximizes germination and assists in the establishment of natives seeds. Mowing also helps to eliminate annual weeds, which helps to reduce weed competition. This is important as weed competition is a major contributor to the failing of young prairie seedlings. By mowing when the seedlings are still short, the amount of sunlight that reaches the seedlings is maximized. The annual weeds that are removed would otherwise cause nearly 100% canopy cover if they were not mowed down. This amount of canopy cover would create cooler, damp conditions that in turn can cause pathogenic problems such as fungal growth.

In order to maximize production of biomass, the TPC will have to completely harvest of all of their plots for the first harvest. Since the TPC are using their plots to test the energy efficiency of the grasses at the Cedar Falls Utilities power plant, they need at least 100 tons of biomass for a test burn. Seeing as they have approximately 44 acres in production that yield 5-8 tons/acre, it is necessary that they completely harvest the entire field for the first harvest. The TPC is planning on harvesting their plots after the first killing frost or in late winter/early spring.

Williams informed me that the TPC will not be using herbicides, pesticides or fertilizers as their goal is not only geared to maximize biomass production, but also to minimize their carbon footprint. Williams said that mowing will be able to replace the benefits of chemicals and fertilizers. The only time that the TPC will use chemicals on their plots is if there is excessive growth of noxious weeds in the plots. If this occurs, then spot treatments will be used to remove the weed. Williams acknowledged that fertilizer may increase the productivity of their plots, but it is not needed as most of the grasses can grow successfully in highly infertile soil.

The final scenario I looked at was harvesting existing Conservation Reserve Program land for biomass. John Sellers, Jr. once used his fields for biomass production, but now he has enrolled his land in the Conservation Reserve Program in order to benefit wildlife and the environment more. When Sellers enrolled his land in CRP, he stopped harvesting and suspended the use of herbicides and fertilizer. Now, Sellers does prescribed burnings on his land every three years in April. He may also rotary mow, but he leaves the plant material he mows in the field as it supports the early growth of switchgrass seedlings.

It was evident through both my interviews and literature review that there has been some debate over whether monoculture-switchgrass stands are better for biomass production than more diverse polyculture stands (Tilman et al. 2006). The Department of Energy chose switchgrass to be the model herbaceous grass to be researched and used for biomass production (Lewandowski et al. 2003). However, since then, there have been studies done that show that an increase in biodiversity increases the amount of biomass that is harvested every year (Hector et al. 1999). More recent research supports previous studies and also includes more incentives for biodiversity such as carbon sequestering, replenishing soil nutrients, and greater ecosystem stability (Tilman et al. 2006; Murray et al. 2003; Hector et al. 1999; Sanderson et al. 1996). These findings tend to point to a biomass production field that is full of biodiversity rather than monoculture stands.

Perennial grasses tend to have long production cycles that only require intensive management within the first year (McLaughlin & Walsh 1997; Walsh et al. 2003;

Lewandowski et al. 2003). In order to be successful, prairie grasses must be carefully managed in the year of establishment because in this year, the grasses are susceptible to weed competition (Lewandowski et al. 2003). Intensive management techniques include the use of herbicides and soil tillage to reduce weed competition and fertilizers to encourage good seed growth (Lewandowski et al. 2003; McLaughlin & Walsh 1997). However, after the first year, the field is then established and studies have shown little evidence of any positive effect of chemicals, fertilizers or soil tillage after this stage (Lewandowski et al. 2003). Studies have actually found that using minimal management regimes increases soil nutrients and water quality, decreases soil erosion, and promotes larger below ground biomass growth, which then encourages greater above ground biomass production (McLaughlin & Walsh 1997; Tilman et al. 2006; Sanderson et al. 1996).

In order to obtain the maximum biomass from harvesting, studies have shown that mowing biomass production fields once a year in late summer tends to yield the most biomass (Lewandowski et al. 2003; Sanderson et al. 1996). Although in some studies, a two cut harvest has yielded slightly higher biomass, it was concluded that the costs of another harvest was not worth the slight increase in yield (Lewandowski et al. 2003). In order to boost wildlife diversity in a biomass production field, it would be necessary to reduce the acreage of field harvested each year of the frequency of harvest to decrease disturbance to the wildlife. This may seem as though it would decrease the field's productivity, but one study found that this scenario produced enough biomass to be competitive to a row crop field (Walsh et al. 2003). Both Sellers and the TPC participate in annual harvesting of their fields and do so in late winter/early spring or after the first killing frost.

4.2 Grassland Bird Habitat Requirements

I have included in Table 2 the specific requirements of the four grassland birds that I chose to study. These four grassland birds are meant to be representatives of grassland bird groups with similar habitat requirements. The habitat requirements of each group and other species in the group are shortly detailed at the bottom of Table 2. By grouping the birds in such a way, I could more easily compare their habitat requirements to conditions resulting from the various management scenarios for the biomass production fields (See Table 3). These requirements were outlined in the literature, much of which came from the Partners in Flight Plan of 1999 and 2000. The four grassland birds have some similar characteristics, such as the need for natural disturbances from grazing, burning or mowing. They also have variables that differ, such as the density of litter cover, litter depth, and grass cover. That is the reason that some requirements have to be generalized to be effective to a wider array of grassland birds. In the rest of this section, I have outlined the habitat requirements that would create the best possible management unit that would be the most beneficial for a wide variety of grassland birds

The grassland birds that I chose to research require fairly diverse habitats. Through all of the studies that I have reviewed, there have been many suggestions about how a near-ideal habitat should be constructed for a diversity of grassland birds. With regards to plant community composition, it has been widely suggested that in order to maintain a diverse array of bird species, a diverse plant community is the key (Tilman et al. 2006; McCoy et al. 2001; Walk & Warner 1999). The greater amount of plant species within a management unit, the greater the suitability for the grassland birds because of greater heterogeneity and more complex vertical structure.

Another common theme in the literature is the need to reduce fragmentation. Fragmentation causes grassland birds to be exposed to both area and edge effects (Herkert 1994; Winter et al. 2000). There are many grassland birds that are area-sensitive and require wholly connected swaths of land in order to nest (Johnson & Igl 2001; Herkert 1994). The area-sensitivity may be due to edge effects, which are caused by brood parasitism and predation (Winter et al. 2000). Also, small management units can cause an increase in competition among and within species (Johnson & Igl 2001; Herkert 1994; Winter et al. 2000; Fitzgerald 2000).

Since grassland birds experienced disturbances in their native prairies such as grazing and burning, it is necessary to also include similar disturbances in order to attract a variety of grassland birds. Grazing, burning, and mowing are recommended techniques because it creates a diverse array of vegetative structure within a management unit (Horn & Koford 2000; Walk & Warner 2000; Van Dyke et al. 2007). Different grassland birds require different amounts of grass cover, forb cover, litter depth and grass height (Fitzgerald 1999; Fitzgerald 2000). Moderate grazing creates a heterogeneous vegetation structure that is appealing to more grassland birds (Walk & Warner 2000). Burning reduces the amount of woody vegetation, which is beneficial since woody vegetation attracts predators and brood parasites (Van Dyke et al. 2007). Mowing has been shown to attract select species of birds, such as ground nesters, within the first year to nest (Horn & Koford 2000).

Since haying is necessary for biomass harvest, disturbances in biomass production fields is imminent annually. However, it has been suggested that biomass production fields can be split into mowed and unmowed sections that alternate every other year, which has also been shown to be most beneficial to a variety of grassland birds (Horn & Koford 2000). Horn and Koford (2000) found that alternating larger parts of a plot each year between mowed and unmowed would be more beneficial to a variety of grassland birds than alternating mowed and unmowed strips over the entire area.

Section 5: Discussion

In the three scenarios that I outlined in Table 1 for the biomass production fields, I found no perfect match for the habitat requirements for the four grassland birds that I chose. However, each scenario had its benefits for each different grassland bird group. The specific recommendations that I made for each grassland bird group is outlined in Table 3, but below, I have included some broad recommendations for each of these scenarios.

The first scenario that I outlined in Table 3 was a Conservation Reserve Program land that may also be used as biomass production. In this scenario, I would recommend that the manager of the unit introduce some grazing to the field in order to increase heterogeneity to the vegetative structure and, if possible, either expand the field or combine it with neighboring fields to reduce the effect of edge effects near the shrubby edges. In the Tallgrass Prairie Center scenario, I would recommend that the manager of this field reduce fragmentation by combining neighboring plots, introduce either burning or grazing in order to establish more heterogeneity to the vegetative structure, and reduce the acreage that is harvested annually. In John Sellers scenario, I would recommend that the manager of this unit reduce the use of fertilizers and chemicals to the first two years after establishment and reduce the acreage that is harvested annually.

Unfortunately, some of these recommendations may not be in the interest of biomass producers. Biomass producers will have competitive yields from their fields if they a) plant a more diverse array of seeds, b) use chemicals, fertilizers, and soil tillage, c) harvest once a year in late summer/early fall and d) harvest the entire area of their field. From the perspective of the grassland birds, most of this list creates a feasible habitat for them to live.

However, there are certain management regimes from the grassland bird's perspective that must be reconciled in order to create a more appealing habitat out of a biomass production field. For a diverse community of grassland birds to inhabit a field, the field should be moderately grazed and/or burned at repeated intervals. These management techniques help create a diversity of vegetative structure at various stages that is better suited to a diversity of grassland birds. Alternating mowed and unmowed plots each year have also shown to create a more heterogeneous vegetative structure that is appealing to some grassland birds within the first year after mowing (Horn & Koford 2000). There could be more research done in this area to compare prescribed burning, grazing, and harvesting and if these different management regimes can create the necessary mosaic habitat needed by a variety of grassland birds.

Trying to reconcile economic motivations with wildlife requirements has always been a struggle while humans drive for economic success. While it is important to provide habitat for wildlife, it is difficult to do so while trying to obtain the most from biomass production fields. In order to utilize biomass production fields in such a way that they can also be useful for grassland birds, biomass producers must be willing to compromise. In order to achieve this compromise, a financial incentive may have to be provided in order to successfully boost the grassland bird population while appeasing the biomass producers. Some examples that could be used as models for such a financial incentive can be found in the conservation programs of the latest Farm Bill (United States 2008).

If biomass producers were given a financial incentive to set aside parts of their biomass production fields to be used for prescribed burnings or remain idle for a year, then this would increase the chance that a higher diversity of grassland birds will nest there. The money for the financial incentive could come from the funds that were once used for Conservation Reserve Program lands and become a new part of the Farm Bill program called the Grassland Energy Reserve Program. If old CRP lands are converted to biomass production field lands, then parts of the once idle fields can be generating a profit while a financial incentive is still granted for the parts of the field that remain idle. Also, some biomass producers may already have the incentive to allow parts of their fields to be set aside for grazing if they own the grazing animals. If not, then perhaps they could rent out their fields to be grazed. If biomass producers set up their field in a quadrant, each section could go through a regime that consisted of it being harvested, unharvested, grazed and burned. Effectively, a section would be harvested each year while the profits lost in other sections not being harvested could be compensated, as aforementioned.

Also, grassland birds require a fairly large area (30+ ha) of wholly connected field with minimal edge habitat in order to nest successfully. If a large enough area cannot be secured, then a substantial grass cover should be established along the edge habitat to reduce edge effects. These management techniques are necessary in order to reduce the risks of predation, brood parasitism and competition among and within species. This is where biomass production could step in to increase the percentage of land occupied by native grasses. A part of the Grassland Energy Reserve Program could give priority to larger sites in order to encourage several small scale biomass producers to combine their land to produce a larger tract of land, which would be more appealing to grassland birds.

If biomass producers are willing to compromise on these details, then there is a distinct possibility that biomass production fields would provide a secure habitat for grassland birds to live and nest. From my correspondences, I discovered that biomass producers are willing to do what they can in order to increase the habitat value of their biomass production field. Both Sellers and the TPC are aware of the conservation potential of their biomass production fields and how they can potentially benefit grassland birds. The four grassland birds that I have chosen to research have different habitat requirements, and by using the aforementioned management techniques, these habitat requirements could be fulfilled by biomass producers.

Section 6: Conclusion

In recent years, grassland birds have experienced serious population declines. The four grassland birds that I chose to research (Dickcissel, Sedge Wren, Bobolink and Grasshopper Sparrow) are all species that are viewed as being in precarious positions in Iowa. The reason for their decline is the destruction of their habitat. By creating artificially constructed habitats that are best suited for their habitat requirements, the possibility to boost their declining population trend and bring them back from their precarious positions is very real. In the process, this human-made habitat has the potential of generating a profit on agricultural lands through biomass production while also providing a renewable energy resource.

One of the biggest problems that biomass production faces right now is generating the incentive to convert marginal agriculture lands to biomass production fields. If a financial incentive is granted to farmers that is similar to the kind that was granted for CRP lands, then perhaps the path to large scale biomass production can be laid. From my correspondences with biomass producers, I discovered that that some producers are eager to increase the conservation value of their land. If more agricultural farmers can be persuaded that biomass production is feasible and also that biomass production can go hand-in-hand with wildlife conservation, then the struggle for wildlife and environment conservation may become much easier. That is a path that has endless possibilities of rejuvenating ecosystems, bettering the environment, and providing a safe haven for more than just grassland birds, but also an abundance of local wildlife.

Table 1. Characteristics and management of biomass production fields under three scenarios: harvest of switchgrass monocultures established specifically for biomass production, harvest of diverse prairie plantings established for multiple benefits, and harvest of perennial vegetation from existing Conservation Reserve Program field including biomass production. Information on management scenarios was obtained during interviews with John Sellers (switchgrass and CRP scenarios) and Dave Williams (diverse prairie scenario) and from McCoy *et al.* 1999 and McCoy *et al.* 2001.

	Switchgrass Monoculture (Sellers)	**Diverse Prairie (TPC)**	**Moderate diversity CRP**
Plant diversity	Low; monoculture switchgrass stands	High; 32 species mix	Moderate; typically 8-24 species mix
Area planted	12 ha	40 ha in 0.2-0.8 ha units	Variable; typically 5-15 ha units
Fragmentation	Relatively unfragmented	High fragmentation	Limited fragmentation
Burning/Grazing	Some grazing	No burning or grazing	Prescribed burning common; may be grazed
Chemicals/Fertilizers	Pesticides and fertilizers applied each year	No fertilizer application. Herbicides only if needed to control noxious weeds during establishment.	No fertilizer application. Herbicides infrequently applied to control noxious weeds
Mowing	No mowing	Establishment mowing during first 1-2 years	Generally not mowed
Harvest	Nearly complete harvest once per year after first killilng frost.	Complete winter harvest after third year of growth	Portion of unit harvested each year on rotational basis
Edge habitat	50% woody, 20%shrubby, 15% road, and 15% crop/hay fields	Shrubby hedgerows and row crop fields.	Variable; frequently crop/hay fields, shrubby woodland edges, and waterways

Table 2. Habitat requirements for four grassland birds: Bobolink (*Dolichonyx oryzivorus*), Dickcissel (*Spiza Americana*), Grasshopper Sparrow (*Ammodramus savannarum*), and Sedge Wren (*Cistothorus platensis*). Data from Fitzgerald 1999, Fitzgerald 2000, Herkert 1994, Dyke 2007, and Horn & Koford 2000.

	Dickcissel	Bobolink	Grasshopper Sparrow	Sedge Wren
Grass cover	Dense	Dense	Sparse to moderate	Dense
Forb cover	Dense	Sparse	Light to moderate	Dense
Litter	Thick	Thick	Light to moderate	Thick
Vegetation height	Moderate	Moderate	Short to moderate	Tall
Optimal disturbance frequency (fire, grazing, or mowing)	Moderate	Moderate	Frequent	Infrequent
Area sensitivity	Nesting success increases with area	>50 ha	>30 ha	Not area sensitive
General habitat requirements	Prefers large areas of dense vegetation with a high forb component	Prefers moderately dense grasslands with high ratio of grass:forb cover;	Prefers sparse open grasslands; avoids tall, dense grasses and shrubs	Prefers densely vegetated wetter sites; not area sensitive
Species with similar requirements	Sprague's Pipit (*Anthus rubescens*) Eastern Meadowlark (*Sturnella magna*) Baird's sparrow (*Amnodramus bairdii*) Short-eared Owl (*Asio flammeus*)		Vesper sparrow (*Pooectes gramineus*) Horned Lark (*Eremophilia alpestris*) Savannah Sparrow (*Passerculus sandwichensis*) Western Meadowlark (*Sturnella neglecta*) Upland Sandpiper (*Bartramia longicauda*)	Le Conte's Sparrow (*Amnodramus leconteii*) Henslow's sparrow (*Amnodramus henslowii*) Northern Harrier (*Circus cyaneus*) Ring-necked Pheasant (*Phasianus cochicus*)

Table 3. Bird versus biomass field characteristics. Outlined below are the specific recommendations for each grassland bird group compared to each biomass producer scenario. The bottom of each comparison evaluates the sufficiency of each scenario for the grassland birds.

Dickcissel Requirements	**Switchgrass Monoculture (Sellers)**	**Diverse Prairie (TPC)**	**Moderate diversity CRP**
Dense grass cover	Sufficient grass cover	Sufficient grass cover	Sufficient grass cover
Heavy forb cover	Insufficient forbs	Excellent forb cover	Insufficient forbs
Thick litter cover	Annual harvest; insufficient litter cover	Sufficient litter cover	Sufficient litter cover
Annual mowing	Sufficient frequency of mowing	Require mowing after first two years	Requires mowing
Light grazing	Requires grazing	Requires grazing	Sufficient frequency of grazing
OK with prescribed burning	Sufficient frequency of burning	Burning not required	Burning not required
Success increases with area	Sufficient area, but fragmented	Sufficient area, but fragmented	Sufficient area
Prefers large areas of dense vegetation with a high forb component	Overall, less than sufficient habitat; fragmentation, no mowing/grazing/burning,	Overall less than sufficient habitat, fragmentation increases risk of edge effects, lack of	Overall sufficient habitat, needs a higher forb component..

Table 3 (cont.)

Bobolink Requirements	Switchgrass Monoculture (Sellers)	Diverse Prairie (TPC)	Moderate diversity CRP
Dense grass cover	Sufficient grass cover	Sufficient grass cover	Sufficient grass cover
Light forb cover	Insufficient forbs	Fewer forbs required	Sufficient forb cover
Thick litter cover	Annual harvest; insufficient litter cover	Sufficient litter cover	Sufficient litter cover
Annual mowing	Sufficient frequency of mowing	Require mowing after first two years	Sufficient frequency of mowing
Light grazing	Sufficient frequency of grazing	Requires grazing	Requires grazing
OK with prescribed burning	Burning not required	Burning not required	Sufficient frequency of burning
Area sensitivity = 50 ha	Requires more area	Requires more area	Requires more area
Prefers moderately dense grasslands with high ratio of grass:forb cover; avoids	Insufficient habitat; needs more forb cover, litter cover, mowing/grazing and area	Insufficient habitat; too much forb cover, needs more mowing/grazing and area	Overall sufficient habitat, could have an increase in mowing or grazing and an expansion of area

Grasshopper Sparrow Requirements	Switchgrass Monoculture (Sellers)	Diverse Prairie (TPC)	Moderate diversity CRP
Sparse to moderate grass cover	Sufficient grass cover	Sufficient grass cover	Sufficient grass cover
Light to moderate forb cover	Insufficient forbs	Fewer forbs required	Sufficient forb cover
Light to moderate litter cover	Sufficient litter cover	Sufficient litter cover	Sufficient litter cover
Annual mowing	Requires mowing	Requires mowing	Requires mowing
Light to moderate grazing	Sufficient frequency of grazing	Requires grazing	Requires grazing
OK with prescribed burning	Burning not required	Burning not required	Burning not required
Area sensitivity = 30 ha	Requires more area	Requires more area	Requires more area
Prefers sparse open grasslands; avoids tall, dense grasses and shrubs	Insufficient habitat; switchgrass is too tall/dense, lacks forb cover, requires mowing/grazing and more	Overall sufficient habitat, requires less grass/forb cover but this could be provided by annual harvest;	Overall sufficient habitat, requires less grass cover which could be provided by

Table 3 (cont.)

Sedge Wren Requirements	Switchgrass Monoculture (Sellers)	Diverse Prairie (TPC)	Moderate diversity CRP
Heavy grass cover	Sufficient grass cover	Sufficient grass cover	Sufficient grass cover
Dense forb cover	Insufficient forbs	Sufficient forb cover	Insufficient forbs
Thick litter cover	Annual harvest; insufficient litter cover	Sufficient litter cover	Sufficient litter cover
Nonannual mowing	Requires mowing	Sufficient frequency of mowing	Sufficient frequency of mowing
Light to moderate grazing	Sufficient frequency of grazing	Requires grazing	Requires grazing
OK with prescribed burning	Burning not required	Burning not required	Burning not required
Not area sensitive	Sufficient area	Sufficient area	Sufficient area
Prefers densely vegetated wetter sites; not area sensitive	Overall insufficient habitat; lacks sufficient forb and litter cover.	Overall sufficient habitat, could be improved with more frequent grazing	Sufficient habitat; forb cover could be increased

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