Grassland Bird Conservation in Agricultural Hayfields

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Abstract

Despite the implementation of federal habitat conservation programs like the Conservation Reserve Program and Wildlife Habitat Incentive Program, North American grassland bird populations continue to decline. As the goals of these programs do not require economic viability, grassland conservation often fails to integrate high-quality bird habitat and profitable agriculture. This study analyzes the grassland bird populations and hayfield management of seven farms in New York and Pennsylvania though hayfield surveys of bird populations and crop composition, as well as survey site characteristics and cropping phenology. Bobolink, Savannah Sparrow, and Red-winged Blackbird densities were greatest in fields dominated by Timothy and Red Clover, as well as in fields with high plant species abundance. Conversely, fields dominated by Orchardgrass had lower bird densities. Timothy-dominated fields were mowed later than Orchardgrass-dominated fields. Mowing displaced Bobolinks and Red-winged Blackbirds, though not Savannah Sparrows. I developed best management practices based on these results, in order to integrate successful bird reproduction and crop production in the region's agricultural hayfields.

Introduction

Habitat selection is a critical aspect of animal behavior (Bollinger 1995). Good habitat selection, which is defined by high fitness outcomes, can be passed on to offspring and promote species survival and ecological function. Agriculture affects the fitness of many species, but the cultivation of plant crops maintains the potential to preserve (or recreate) biological communities and niches (Pimentel et. al. 1992). In an

increasingly unnatural world, the ability to succeed in human-altered habitats is important for wildlife survival and biodiversity as a whole.

For grassland bird species, agricultural practices can be devastating to reproduction through the destruction of nests and nest sites (Basore et al. 1986, Best 1986, Bollinger et al. 1990, Frawley and Best 1991). Conventionally tilled row crops have nesting rates as low as 0.04 nests per acre; many reduced-tillage fields have nest predation rates over 50% (Basore et al. 1986). Nest success across all tillage methods is less than 25% (Basore et al. 1986). Furthermore, row crops could act as an ecological trap by attracting birds to seemingly suitable nest sites early in the season, only to destroy nest sites later via machinery and herbicides (Best 1986). While success rates vary by species, it is unlikely that grassland birds can be sustained in row crop fields, regardless of management practices.

Hayfields have overall higher populations of grassland birds than row crops (Bollinger et al. 1990). However, the mowing dates of hayfields have been pushed earlier in the season over the past half century in order to maximize production (Bollinger et al. 1990). Mowing date can affect the nesting success of Bobolinks (*Dolichonyx oryzivorus*) by as much as 400%, as early mowing is devastating to nesting attempts in some species (Bollinger et al. 1990). Furthermore, Alfalfa (*Medicago sativa*) fields are mowed early and frequently during the nesting season, making grassland bird conservation “difficult, if not impossible” with the current and projected management of some hayfield crops (Frawley and Best 1991).

As would be expected, current estimates for regional grassland bird populations are not promising. In the latter half of the 20th century, North American grassland bird populations declined more than that of any other bird guild, with some studies estimating population reductions as high as 65% (Samson and Knopf 1994). While part of this decrease is due to successional habitat loss in former hayfields, changes in hayfield management have also played a detrimental role (Bollinger et al. 1990). Thus, increased conservation efforts are necessary for sustainable populations of many grassland bird species.

Grassland management systems like the Conservation Reserve Program (CRP), Wildlife Habitat Incentive Program (WHIP), and state/federal wildlife areas have been used for grassland bird conservation, with higher bird reproduction rates than conventional agriculture fields (Norment et al. 1999, Patterson and Best 1996). However, the stringent conditions on management of fields in these programs often make the resulting hay crop less desirable for livestock feed, as preventing mowing before mid-July reduces crop digestability. Given the growing global demand for cropland, economically unproductive fields are becoming an exorbitant luxury, and conservation fields that do not produce a usable crop may, in effect, simply push detrimental hayfield cropping from one area to another. Successful conservation practices and modern agricultural systems have thus yet to be fully merged Furthermore, since seemingly stable grassland bird populations in refuges have been unable to stop regional population declines, conservation in economically productive areas is required (Norment et al. 1999).

In the Twin Tiers region of New York and Pennsylvania, many grassland areas are harvested for hay, largely for dairy cattle feed. The cool-season grasses Orchardgrass (*Dactylis glomerata)* and Timothy (*Phleum pratense*) are the most commonly planted hay crops, along with legumes like Alfalfa (*Medicago* sativa) and several clover species (*Trifolium* sp.). Warm-season grasses are not a widely utilized crop, and many growers are cautious with crop species changes. However, Switchgrass (*Panicum virgatum*) has demonstrated annual yield capabilities of over 9 tons per acre, which is well over typical annual yields of ~3 tons per acre for Orchardgrass and Timothy (Di Virgilio et al. 2007, Hall 2008). However, Switchgrass yields are highly variable due to lack of management knowledge, even within a single field; yields in some conditions can be less than 2 tons per acre (Di Virgilio et al. 2007). Thus, there is significant research to be done before warm-season hay crops become reliable.

Nevertheless, alternative hay crops are a potential element of grassland bird conservation. As native warm-season grasses like Switchgrass and Big Bluestem (*Andropogon gerardi*) display later growth than introduced grasses like Timothy and Orchardgrass, their use could result in later mowing dates and increases in nesting success (Giuliano and Daves 2002). Timothy also displays later maturation than Orchardgrass, with higher leaf and seed head digestibility throughout the summer and growing season, respectively (Pritchard et al. 1962). Thus, Timothy may be a more productive grassland bird habitat in agricultural systems. Furthermore, legume/grass crop mixtures could elongate the lifespan of hayfields through nitrogen fixation, which may reduce the need to rotate or fertilize. These fields have also demonstrated higher

yield when combined than when grown separately (Sleugh et al. 2000). Crop selection and mowing phenology, as crucial elements of hayfield agriculture, present an opportunity for bird population increases. In fact, it was the relatively late mowing of the mid-20th century that allowed Bobolinks to expand east from their former Midwestern range (Bollinger et al. 1990).

However, nesting results in various grass crops are highly variable. Despite producing greater bird success overall, warm-season grass fields fostered equal amounts of reproduction to cool-season fields in a high precipitation year (Giuliano and Daves 2002). Furthermore, some conservation fields and refuges have displayed higher bird abundances in cool-grass fields (Delisle and Savidge 1997, Norment et al. 1999). This speaks to the high variation in grassland bird abundance. For example, local dispersal can drastically affect perceived survival rates, particularly for males (Perlut et al. 2008). So while several grassland bird population studies have been done in the New York/Pennsylvania region, local differences in weather, population structure, and grass species may cause large differences in reproductive success (Bollinger et al. 1990, Giuliano and Daves 2002, Norment et al. 1999, Perlut et al. 2009).

Overall, grassland bird conservation in the northeastern U.S. will likely require multiple actors, including both refuge and agricultural land. Locally determined BMP's (best management practices) which take into account the needs of hayfield farmers can be more readily utilized in agricultural operations than the BMP's of many federally-designed programs, while still accounting for the local nesting phenologies of grassland bird populations. In Western New York, grassland bird studies have focused on refuge

and conservation areas; thus, local populations of grassland birds in non-refuge areas are little studied (Norment et al. 1999).

This study seeks to determine the distribution of nesting grassland birds in farm hayfields in the Twin Tiers region of New York and Pennsylvania, as well as their correlations with hay crop species, mowing phenology, and other management practices. Through this data, fine-tuned conservation methods will be developed that can foster sustainable bird reproduction as well as usable hay crops. In this manner, grassland birds may be successfully conserved in agricultural systems.

Methods

Figure 1. a. Bobolink (female and male), Savannah Sparrow, and Red-winged Blackbird (female and male), the primary study species.
b. Orchardgrass, Timothy, and Red Clover, the most abundant crops in the study.

(Image sources: convergentevolution.wordpress.com, dec.ny.gov, birdsnews.com, gettingmoreontheground.com, seedworldusa.com, malag.aes.oregonstate.edu)

The field study encompassed 11 weeks, from May 14 to August 1, 2015, utilizing 25 agricultural hayfields owned by 7 farms in Allegany County, NY, Steuben County, NY, Wyoming County, NY, and Potter County, PA. These farms included 5 dairies, a

swine operation, and a vegetable/crop producer, and receive crop planning and monitoring from Western New York Crop Management, a local farm consultation business utilized by many modernized farms in the region.

Twenty-two fields were surveyed before they were mowed for the 2015 growing season. Field surveys consisted of both bird surveys and plant composition estimates, conducted in fair weather between 9 A.M. and 6 P.M. Bird surveys consisted of walking a loop transect through a majority of the field, which was an attempt to maximize the proportion of the field passed through within a bird identifiable distance (~ 100m). All individuals of species known to nest in hayfields were recorded in the surveys, whether seen perched, flushed from the grass, heard calling in the field, or flying low over the survey area. Sixteen fields were subjected to a second, post-mowing bird survey after the first mowing. This was done to determine any bird population differences before and after mowing, a primary indicator of the trap hypothesis (Best 1986).

Plant composition surveys consisted of identification of plant species and estimates of their proportions observed while walking the bird survey route. As plant structure in fields is spatially variable, typical standardized sampling techniques would have increased the chance of omitting uncommon plant species confined to small areas of the field. Plant species estimates were defined to the nearest 5%. Total plant species richness was recorded as the number of observed plant species.

Results

Six bird species were found were found in the surveys: Red-winged Blackbird (*Agelaius phoeniceus*), Bobolink (*Dolichonyx oryzivorus*), Savannah Sparrow (*Passerculus sandwichensis*), Song Sparrow (*Melospiza melodia*), Grasshopper Sparrow (*Ammodramus savannarum*) and Eastern Meadowlark (*Sturnella magna*). Song Sparrows, however, were found only on the edges of the survey fields and were not included in the analysis, since it is unlikely that this species was nesting in the survey fields. Additionally, Eastern Meadowlark and Grasshopper Sparrow were found in only 1 and 2 fields respectively. Thus, Red-winged Blackbird, Bobolink, and Savannah Sparrow were the primary study species, although Eastern Meadowlark and Grasshopper Sparrow were included in analyses across species.

In the pre-mowing surveys, Bobolinks were found in 73% of fields, Savannah Sparrows were found in 59% of fields, and Red-winged Blackbirds were found in 50% of fields. The number and density of birds across species was positively correlated to the date of the first mowing, but not significantly so (Figure 2, $P = 0.15$). There were significant differences between the average densities of birds between some farms; Four Winds Dairy had fewer than 0.25 birds/acre surveyed on average, while Fink Produce had the highest bird density, at nearly 0.75 birds/acre (Figure 3). Field size and bird density were not correlated.

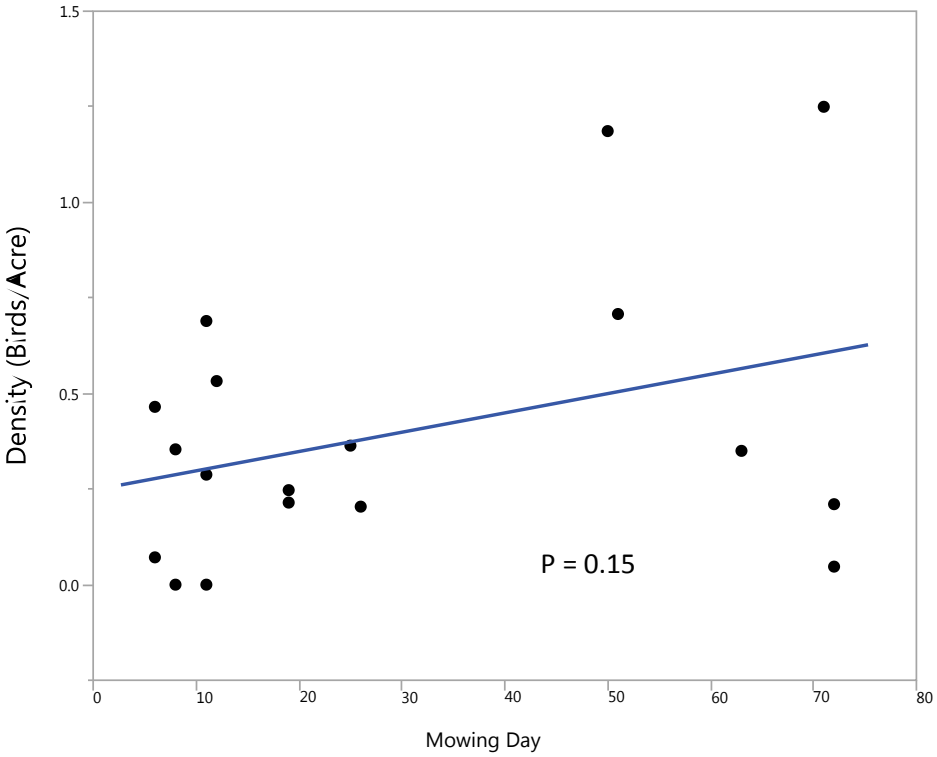

Figure 2. Date of first mowing in days since May 14 vs. Pre-mowing bird density (birds/acre).

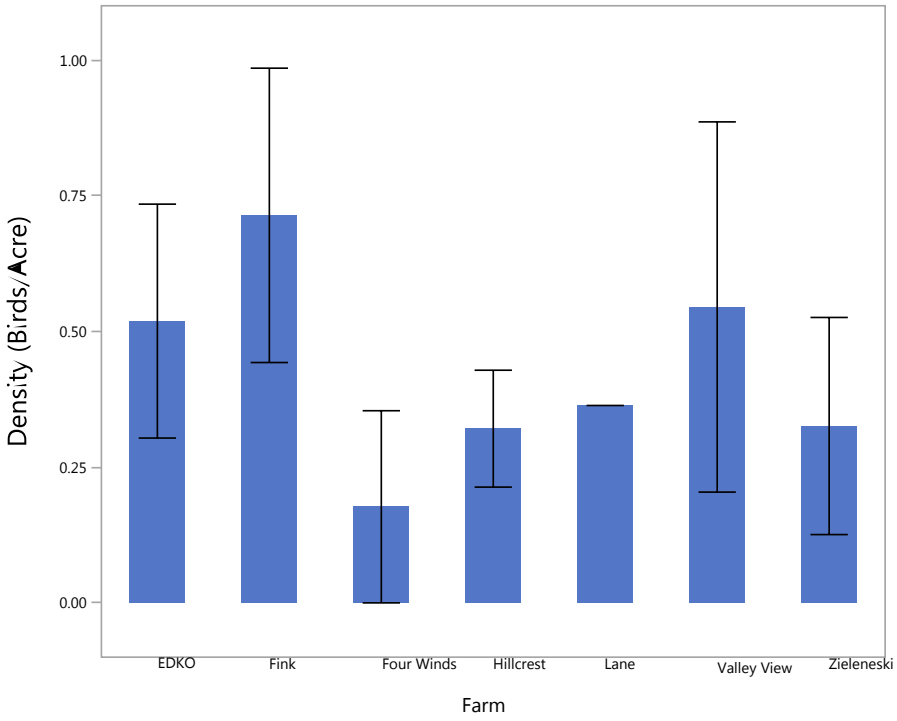

Figure 3. Mean bird density (birds/acre) by farm, showing standard error.

Plant surveys exhibited relatively high homogeneity in vegetation. Three species comprised more than 95% of total field composition, on average, with Orchardgrass (*Dactylis glomerata*), Timothy (*Phleum pratense*), and Red Clover (*Trifolium pratense*) constituting 47%, 27%, and 9% of average field composition, respectively. Individual fields were relatively homogenous as well. Three-quarters of the survey fields consisted primarily of one species (≥ 60% composition), and interspersed with a small percentage of other plants.

Orchardgrass, overall, was associated with reduced bird presence in pre-mowing surveys. Bobolink totals, Savannah Sparrow totals, Red-winged Blackbird totals (though not significantly), and overall species abundance were negatively correlated to Orchardgrass proportions in survey fields ($P = 0.03, 0.05, 0.10, 0.02$, Figure 4). Fields with high proportions of Orchardgrass were mowed earlier than those with low Orchardgrass content ($P = 0.06$, Figure 5). Conversely, fields with high Timothy content were mowed later than those with low Timothy content ($P = 0.02$, Figure 5). Bobolink were also more common in Timothy-rich fields ($P = 0.03$, Figure 6).

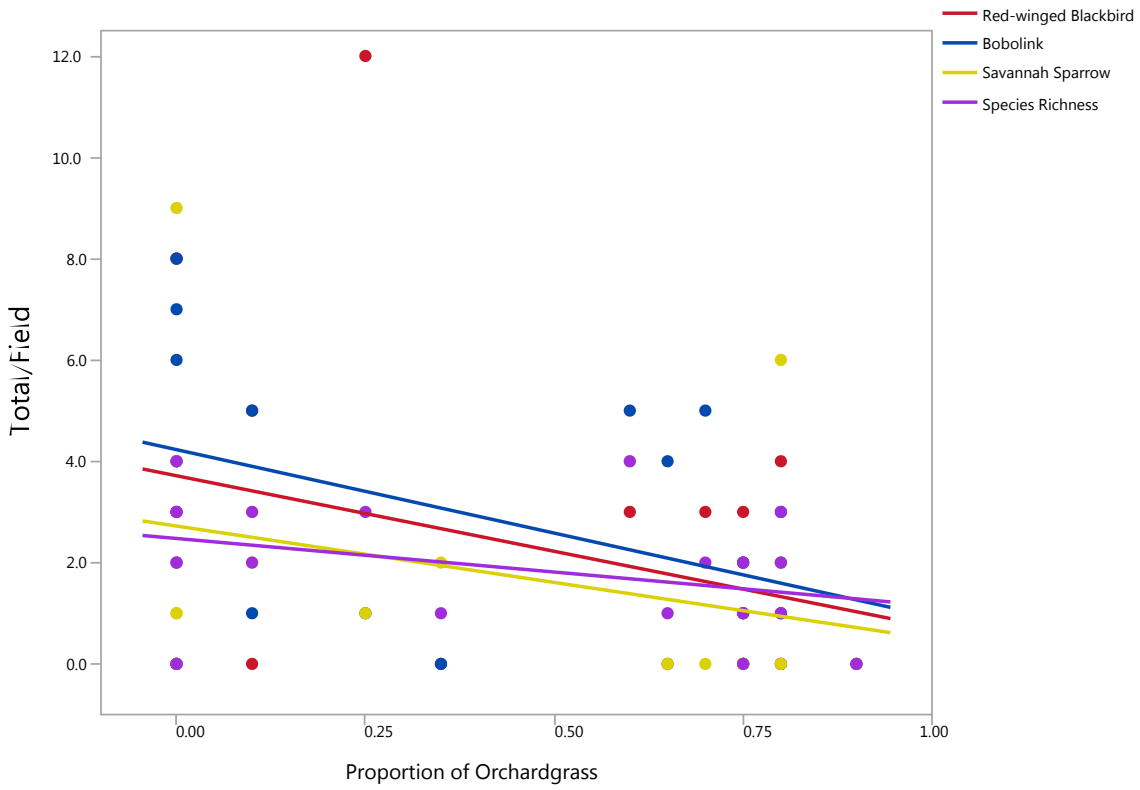

Figure 4. Proportion of Orchardgrass vs. Bird survey totals by species and overall species richness.

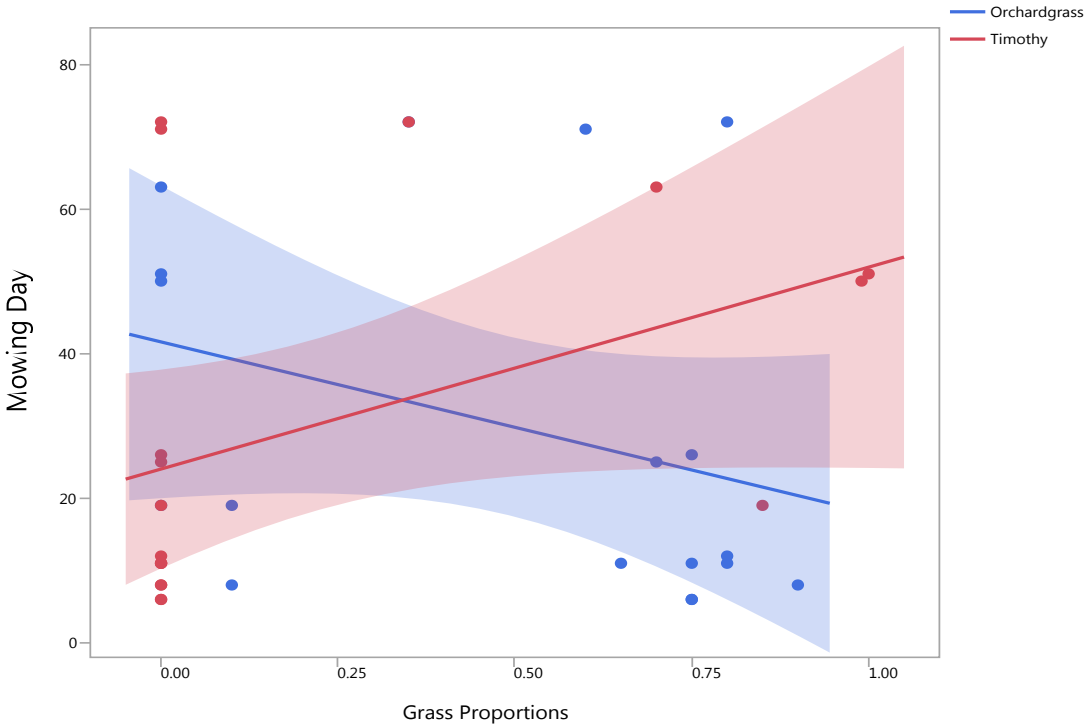

Figure 5. Proportions of Timothy and Orchardgrass vs. Date of First Mowing, in days since May 14.

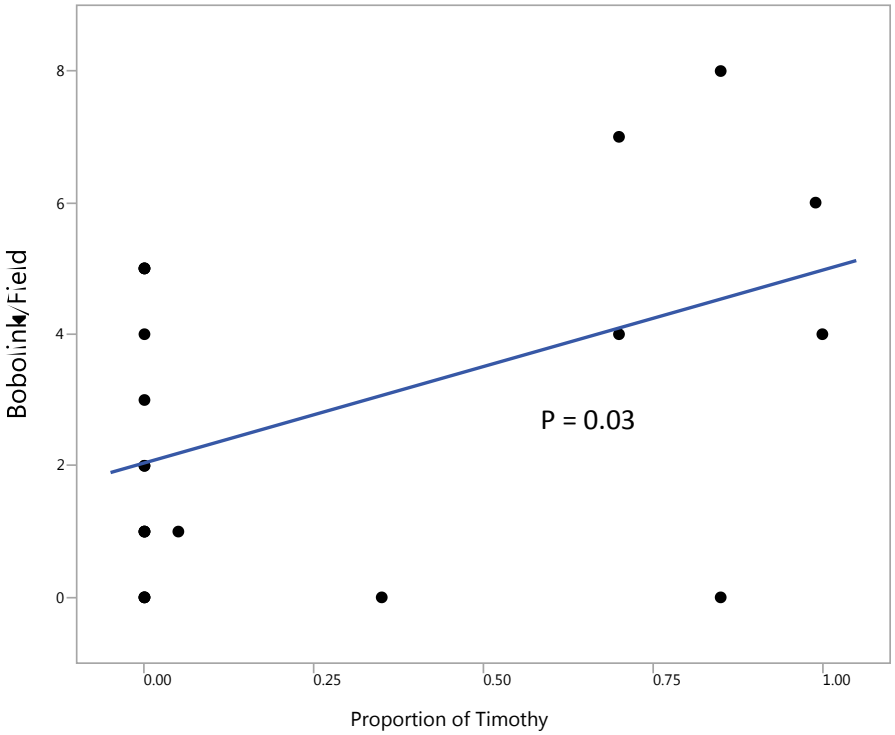

Figure 6. Proportion of Timothy vs. Pre-mowing survey totals for Bobolink.

Multiple regression analysis produced many significant results and accounted for 61% of variation (Table 1). Hayfields with high plant species richness showed high bird densities, as did those with high proportions of Timothy and Red Clover (Table 1, P = 0.02, 0.01, 0.04). As a result, Orchardgrass proportion showed minimal effects. Field size also had strong negative effects, which was most likely an artifact of my inability to detect all birds present in the largest fields (Table 1, P = 0.01).

Term	Estimate	Std Error	t Ratio	Prob>|t|
Timothy	0.8762195	0.265836	3.30	0.0064*
Acres	-0.029324	0.009651	-3.04	0.0103*
Richness	0.163554	0.059531	2.75	0.0177*
Red Clover	1.2801539	0.554477	2.31	0.0396*
Year	-0.027775	0.021051	-1.32	0.2116

Table 1. Results of multivariate analysis, including Timothy and Red Clover (plant species), Acres (field size), Year (field age), and Plant Species Abundance. $R^2 = 0.61$

Mowing affected bird abundances differently for various species. Only 13% of post-mowing surveys produced Bobolink; no Red-winged Blackbirds were found post-mowing (X^2 = -3.00, -3.38, P ≤ 0.01). However, there was no significant difference between the pre and post-mowing populations of Savannah Sparrow (Figure 7, X^2 = 0.28). Savannah Sparrows and Bobolinks were also more common in young fields. (Figure 8, P = 0.01, 0.04).

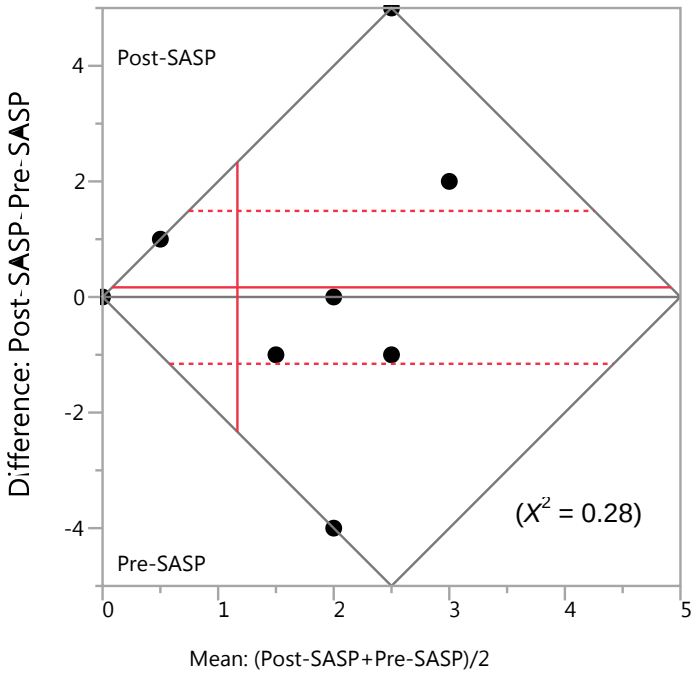

Figure 7. Matched pairs test of Savannah Sparrow totals before and after mowing.

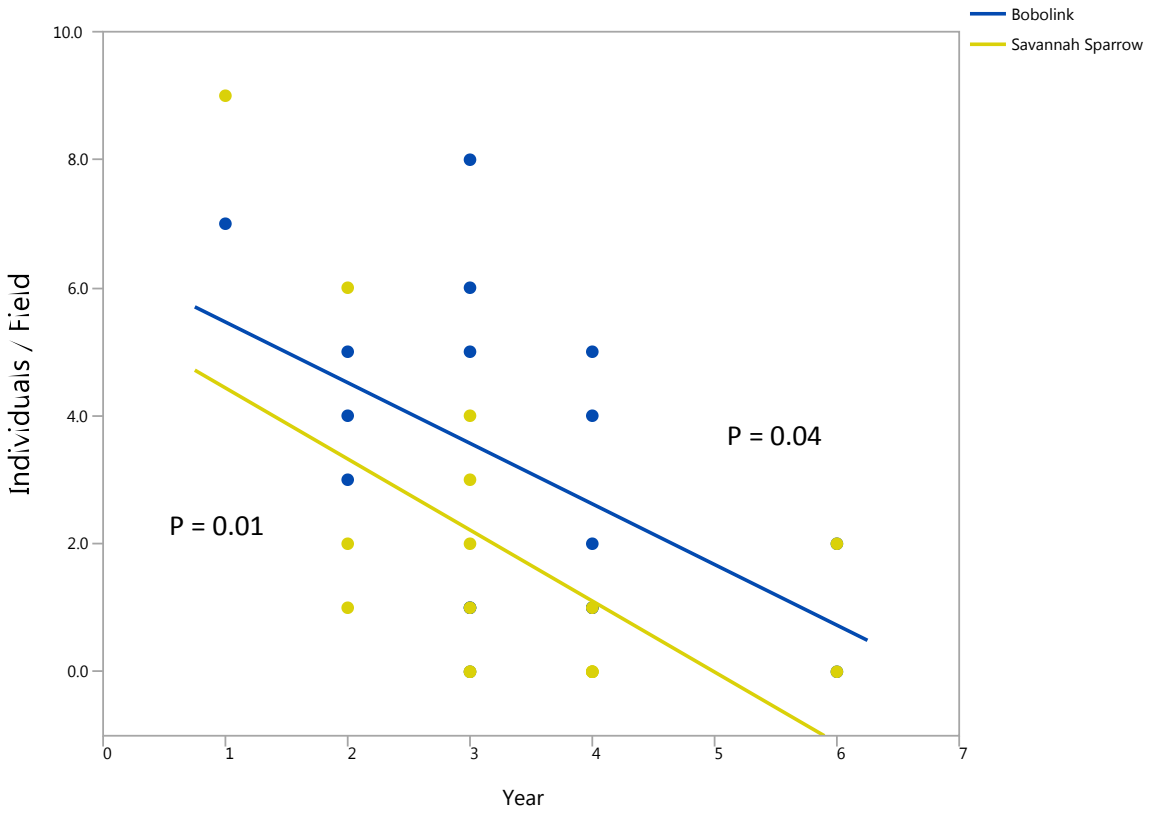

Figure 8. Field Age vs. Survey totals of Bobolink and Savannah Sparrow.

Discussion/Best Management Practices

This study found that overall, pre-mowing grassland bird densities are not correlated to the timing of mowing (Figure 2). Since birds have no way of determining when a field will be mowed, fields mowed during the nesting season will cause reproductive failure, and act as an ecological trap (Best 1986). However, various species demonstrated tendencies to favor certain plant types, as Orchardgrass-rich fields have fewer birds, while Timothy-rich fields had more birds, on average (Figures 4, 6). Furthermore, Orchardgrass fields were mowed consistently earlier than Timothy fields because of lower rates of temporally-induced digestability (and resulting increase in lignification) in the former (Figure 5, Pritchard et al. 1962). Bobolinks and Savannah

Sparrows were more abundant in younger fields, the latter of which is supported in other studies (Bollinger 1995).

Thus, my results suggest that species like Bobolink may have developed a selection bias, based on decades of diverging mowing phenologies of Orchardgrass and Timothy. Multivariate analysis revealed strong bird preference for Timothy and Red Clover, with avoidance of Orchardgrass (Table 1). Thus, positive selection of Timothy, Red Clover, and non-Orchardgrass fields may be occurring, consequently reducing bird presence in Orchardgrass fields and creating bird density disparities between crop types. This selection, combined with the effects of observed variation in mowing date between crops, is supported by philopatry in Savannah Sparrows and increased rates of site fidelity in Bobolink after a successful reproductive season (Bollinger and Gavin 1989, Wheelwright and Mauck 1998). So while the trap hypothesis is a major detriment to suitable habitat selection in hayfields, management of plant varieties could play a significant role in grassland bird conservation (Best 1986).

Because of these selection biases, I have developed several best management practices (BMP's) that are likely to improve conditions for grassland bird reproduction in agricultural hayfields in the study region. Overall, Red-winged Blackbird abundance did not show correlations to field characteristics, besides plant species richness and selection against Orchardgrass abundance (Figure 4, $P = 0.15$, $P = 0.10$). However, Red-winged Blackbirds were not found in post-mowing surveys; thus, delaying the first mowing date while promoting mixed crop seedings is the best way to preserve habitat selection for this species. Red-winged Blackbirds are declining but still very abundant,

and as hayfields are not their primary nesting habitat, agricultural hayfield BMP's should not focus on this species.

Bobolinks did not return to fields after mowing, so delaying the first mowing is also vital for nesting in this species. Bobolink also had strong selection bias for Timothy and Red Clover (Figure 6, $P = 0.03$), which can be used advantageously in conservation management. Fields with plentiful Orchardgrass should be mowed very early (before June) in order to limit eggs destroyed by mowing and to give adults ample time to establish territories and nests elsewhere, after displacement by mowing. Since all bird species showed reduced presence in Orchardgrass fields, fewer Bobolink will be displaced by early Orchardgrass mowing than would be by early mowing of fields dominated by other plant species (Figure 4). Furthermore, fields with Timothy and Red Clover should have mowing delayed as much as possible, in order to maximize the number of young successfully fledged before harvesting.

Savannah Sparrow habitat selection was markedly different than the other study species. Mowing did not drive this species from fields, as this species was commonly observed in fields within a week after mowing (Figure 6). Ensuring that mowing dates are spaced at least 30 days apart will allow time for some nesting and fledging between mowings (Dixon 1978). In fact, early mowing (before June) could increase Savannah Sparrow nesting in those fields by displacing other grassland bird species who have yet to nest.

Overall, Timothy and Red Clover acreage should be increased. Mowing dates should be delayed as late as possible, optimally until the second week of July; however,

any delay in mowing past mid to late June will immensely benefit the nesting of multiple species (Norment et al. 1999). Transitioning fields from Orchardgrass to species like Timothy, with longer lasting digestability, will allow for agricultural operations to harvest usable hay, despite spaced out mowing dates (Pritchard et al. 1962). Alfalfa monocultures should also be limited; although largely excluded from this study, this crop is commonly regarded as unsuitable for grassland bird reproduction due to early and frequent mowing (Frawley and Best 1991). If mowing before July is necessary, the first mowing should occur in early to mid-May, optimally with no second mowing until July.

Success in preserving grassland bird species of greatest concern in agricultural systems, such as Grasshopper Sparrow, Henslow's Sparrow, and Eastern Meadowlark, is still fleeting. The nesting preferences of these species are either not fully understood, or prefer fields greater than ten years in age (Bollinger 1995). Thus, it is unlikely that modern agricultural operations will be able to sustain these species unless plant varieties are utilized that can succeed without crop rotation. Grassland bird nesting success in legume/grass mixture fields should also be studied, as these fields may be longer-lived and possess the capability to support more at-risk species (Sleugh et al. 2000).

Further research needs to be done to maximize the conservation abilities of agricultural systems, however. Local studies could determine precise nesting and fledging dates for each species. As they are likely to vary by region, clarification of local nesting phenologies is fundamental to establishing proper mowing guidelines, particularly for highly at risk species. It is possible that current hayfield management practices are not sustainable for any species, which may explain the decreasing

abundance of Bobolinks and Savannah Sparrows as fields age, if nesting birds are not returning to the same field the year after failed clutches (Bollinger and Gavin 1989, Wheelwright and Mauck 1998).

It should be noted that the mowing dates of fields owned by EDKO (Figure 3) were not typical, as lack of a buyer for the crop delayed mowing of certain fields. Thus, surveys in following years would be necessary to determine the effect of the previous year's mowings on bird habitat selection. Furthermore, direct calculations of nesting success in non-Orchardgrass fields would also help to determine which plant species are truly beneficial to grassland bird reproduction. Lastly, further experimentation with warm-season, later maturing hay species should be implemented, in order to identify those species with yields competitive to those of cool-season grasses, as well as to determine nesting frequencies in these crops (Norment et al. 1999).

Nevertheless, this study determines best management practices for the three primary grassland bird species found in New York and Pennsylvania. My BMP's can be more readily utilized in agricultural operations than the BMP's in the Conservation Reserve Program (CRP) and Wildlife Habitat Incentive Program (WHIP). These less stringent guidelines maintain the usability of hayfields as dairy forage, allowing for their implementation in privately managed fields and improving the reproductive potential of grassland birds in the region.

Literature Cited

Basore NS, Best LB, Wooley JB Jr. 1986. Bird Nesting in Iowa No-Tillage and Tilled Cropland. *The Journal of Wildlife Management*. 50:19-28.

Best LB. 1986. Conservation Tillage: Ecological Traps for Nesting Birds? *Wildlife Society Bulletin*. 14:308-317.

Bollinger EK. 1995. Successional Changes and Habitat Selection in Hayfield Bird Communities. *The Auk*. 112:720-730.

Bollinger EK, Bollinger PB, Gavin TA. 1990. Effects of Hay-Cropping on Eastern Populations of the Bobolink. *Wildlife Society Bulletin*. 18:142-150.

Bollinger EK, Gavin TA. 1989. The Effects of Site Quality on Breeding-Site Fidelity in Bobolinks. Faculty Research & Creative Activity. Paper 78. Retrieved at http://thekeep.eiu.edu/bio_fac/78.

Delisle JM, Savidge JA. 1997. Avian Use and Vegetation Characteristics of Conservation Reserve Program Fields. *The Journal of Wildlife Management*. 61:318-325.

Di Virgilio N, Monti A, Venturi G. 2007. Spatial variability of switchgrass (*Panicum virgatum* L.) yield as related to soil parameters in a small field. *Field Crops Research 101*. 232-239.

Frawley BJ, Best LB. 1991. Effects of Mowing on Breeding Bird Abundance and Species Composition in Alfalfa Fields. *Wildlife Society Bulletin*. 19:135-142.

Giuliano WM, Daves SE. 2002. Avian response to warm-season grass use in pasture and hayfield management. *Biological Conservation*. 106:1-9.

Hall MH. 2008. Agronomy Facts 25 – Orchardgrass. Pennsylvania State University. Retrieved from <http://extension.psu.edu/plants/crops/forages/species/orchardgrass/extension_publication_file>.

Norment CJ, Ardizzone CD, Hartman K. 1999. Habitat Relations and Breeding Biology of Grassland Birds in Western New York: Management Implications. Environmental Science and Biology Faculty Publications. Paper 66. Retreived from http://digitalcommons.brockport.edu/env_facpub/66.

Norment CJ 2002. On Grassland Bird Conservation in the Northeast. *The Auk* 119:271–279

Patterson MP, Best LB. 1996. Bird Abundance and Nesting Success in Iowa CRP Fields: The Importance of Vegetation Structure and Composition. *American Midland Naturalist*. 135:153-167.

Perlut NG, Strong AM, Donovan TM, Buckley NJ. 2008. Grassland Songbird Survival and Recruitment in Agricultural Landscapes: Implications for Source-Sink Demography. *Ecology.* 89:1941-1952.

Pimentel DM, Stachow U, Takacs DA, Brubaker HW, Dumas AR, Meaney JJ, O'Neil JAS, Onsi DE, Corzilius DB. 1992. Conserving Biological Diversity in Agricultural/Forestry Systems. *BioScience.* 42:354-362.

Pritchard GI, Folkins LP, Pigden WJ. 1962. The *in vitro* digestability of whole grasses and their parts at progressive stages of maturity. *Canadian Journal of Plant Science* 43: 79-87.

Samson F, Knopf F. 1994. Prairie Conservation in North America. *Bioscience*. 44:418-421.

Sleugh B, Moore KJ, George R, Brummer EC. 2000. Binary Legume–Grass Mixtures Improve Forage Yield, Quality, and Seasonal Distribution. *Agronomy Journal.* 92:24-29.

Wheelwright NT, Mauck RA. 1998. Philopatry, Natal Dispersal, and Inbreeding Avoidance in an Island Population of Savannah Sparrows. *Ecology*. 79:755-767.