FINAL REPORT

EFFECTS OF HABITAT MANIPULATIONS ON GRASSLAND BIRD POPULATIONS

Challenge Cost Share Agreement No. 1448-5018-98-J-047 between the United States Fish and Wildlife Service and the Research Foundation of State University of New York

Dr. Christopher Norment
Department of Biological Sciences
SUNY College at Brockport
Brockport, NY 14420
(716) 395-5748
cnorment@brockport.edu

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INTRODUCTION

In 1994 I began a long-term study of grassland bird populations in western New York, with primary funding support provided by the United States Fish and Wildlife Service (USFWS), under Challenge Cost Share Agreement No. 14-48-0005-94-9005 between the USFWS and The Research Foundation of State University of New York. Research supported by this Cost Share Agreement occurred mostly between 1994 and 1997, and focused on grassland bird populations and related management activities at Iroquois and Montezuma National Wildlife Refuges (NWRs). Major objectives of the study were to determine grassland bird species richness and abundance, breeding biology, and habitat relations in the region. Breeding biology studies focused on determining nest success and chronology, while bird-habitat relations were examined at the local (vegetation) and landscape levels, in both unmanipulated and manipulated upland habitats. Results of the study were used to evaluate the status of grassland bird populations on public lands in the Great Lakes Plain of western New York, and to suggest management alternatives to increase grassland bird populations in the region (Norment, 1999).

Because of continuing concern over the decline of grassland bird populations in the Northeast, and the fact that many management activities designed to increase grassland habitat were undertaken in 1996 and 1997, I received a second Challenge Grant (Challenge Cost Share Agreement 1448-5018-98-J-047) to fund additional research on grassland birds in USFWS project areas in 1998 and 1999. These areas included Iroquois and Montezuma NWRs, and portions of the St. Lawrence Wetlands and Grassland Management District in Jefferson County, New York. Results of research conducted in

1998 and 1999 are presented in this report, along with some data gathered in July 1997 by Mr. Sean Keenan, who contracted with the USFWS to survey grassland birds in the St. Lawrence River Valley. This report is not meant to be a comprehensive document on grassland bird ecology and management in the study area, but rather a discussion of: 1. Recent grassland bird population trends at Iroquois and Montezuma NWRs; 2. effects of recent USFWS management activities on grassland birds and their habitat; and 3. abundance of grassland birds, especially Henslow's Sparrow (*Ammodramus henslowii*), in the Jefferson County area of the St. Lawrence River Valley. The Henslow's Sparrow surveys were conducted in conjunction with ongoing Department of Defense-funded research on the species at Fort Drum Military Reservation. For details on grassland bird ecology and management in western New York, readers can consult the final report on the earlier Cost Share Agreement (Norment 1999), and the literature cited in that document. Two recently published papers also deal with grassland bird ecology at Iroquois and Montezuma NWRs (Norment et al 1999, Ardizzone and Norment 1999).

STUDY AREAS

I have described the grassland habitats at Montezuma and Iroquois NWRs in detail (Norment 1999) and will not repeat that information here. A smaller number of refuge fields was censused for grassland birds in 1998 and 1999, as compared to 1994-1997. I focused refuge survey work on fields not undergoing rapid succession, which thus could be used to monitor trends in grassland bird abundance (grassland management units C and I at Iroquois NWR), and on fields that had recently, or were being, actively managed

to promote grassland habitat. My students and I censused 40 points in 22 fields in 1998, and 24 points in 12 fields in 1999.

The second study area was located in the Saint Lawrence Wetlands and Grassland Management District. This management district contains a mosaic of grassland, wetland, and agricultural habitats, most of which are in private ownership. The USFWS estimates that approximately 160,000 ha (400,000 acres) of grassland habitat occur in the St. Lawrence Valley in the area from Malone to Henderson Harbor, and east of the Adirondack foothills (USFWS, no date). Studies in the St. Lawrence Valley covered under the Cost Share Agreement occurred on private lands in Jefferson County, NY within approximately 22 km of Watertown, primarily to the west of Fort Drum Military Reservation in the towns of Philadelphia, Leray, Clayton, Pamelia, Orleans, Theresa and Brownville. Twenty-one fields surveyed by Sean Keenan for grassland birds in 1997 were censused in 1998 and 1999; an additional 11 fields also were censused in 1998 and 1999 (Table 1). In all years, most fields censused in the Jefferson County study area were classified as hayfields; a smaller number were fallow or grassland, or used for pasture or row crops (Table 1).

CHRONOLOGY OF ACTIVITIES SUPPORTED BY THE CHALLENGE COST SHARE AGREEMENT

1998: Between late April – June, two students and I censused grassland birds and conducted vegetation surveys at Iroquois and Montezuma NWRs, and on surrounding lands administered by the New York State Department of Environmental Conservation and the Monroe County Parks Department. One student and I surveyed Jefferson County grasslands between 11-12 June and 16-18 June.

1999: In late March, I presented a summary of my research on grassland birds at a meeting of USFWS Region 5 biologists at the National Conservation Training Center in Shepardstown, West Virginia. Although this trip was not supported by the current

Table 1. Number of fields, area and habitat type of sites censused for grassland birds in Jefferson County, St. Lawrence River Valley, 1997-1999. Percentages given in ( ).

	1997	1998	1999
Number of fields censused	21	32	32
Field size (ha)			
1-5	1 (4.7)	1 (3.1)	Same as
5-10	4 (19.1)	5 (15.6)	1998
10-20	5 (23.8)	6 (18.7)	
20-50	10 (47.6)	19 (59.4)	
50-100	1 (4.7)	1 (3.1)	
100+	0 (0.0)	0 (0.0)	
Habitat type			
Native grassland	1 (4.7)	1 (3.1)	1 (3.1)
Fallow field	1 (4.7)	6 (18.7)	7 (21.9)
Pasture	2 (9.5)	3 (9.4)	1 (3.1)
Hayfield	17 (80.9)	22 (68.8)	22 (68.8)
Row crop	0 (0.0)	0 (0.0)	1 (3.1)

Challenge Grant, my presentation dealt with work funded by a previous Challenge Grant. Between mid-May and late June, one student and I censused grassland birds and conducted vegetation surveys at Iroquois and Montezuma NWRs. We surveyed Jefferson County grasslands between 14-18 June. Two papers covering work funded by the earlier Challenge Grant were published in September (Norment et al. 1999, Ardizzone and Norment 1999).

METHODS

Bird Species Richness and Abundance.-- We determined grassland bird species richness and abundance at Iroquois and Montezuma NWRs using fixed, 50-m radius point counts. The 50-m radius was chosen instead of the 100-m radius recommended for standardized grassland bird censuses in the northeast (Vickery 1995) so that fields < 200 m in width could be included in the study. Each point was censused for 10 min/census between 0600 and 1000 hours EST from 15 May to 1 July. Each point was censused three times/year in 1998 and 1999. In fields with > 1 point, points were located at least 200 m apart to minimize recounts.

Fields in Jefferson County were censused for obligate grassland birds (see Vickery et al. 1999) using the protocol developed for the 1997 Northeast Grassland Bird Survey (Shriver et al. 1997). Briefly, at each grassland site chosen for the study, 100 m radius points were established. All grassland birds detected within 100 m radius of each point were counted for 5 min. However, any Upland Sandpipers (*Bartramia longicauda*) seen beyond the 100 m radius were included in the counts because the species has large territories and is very mobile (Shriver et al. 1997). Also, we recorded any Henslow's Sparrows detected beyond the 100-m radius because of the relative rarity of the species in the Northeast, and concerns about its continuing decline in the region (Pruitt 1996, Sauer et al. 1997, Shriver et al. 1997). All bird surveys in Jefferson County were conducted as

roadside surveys, because the fields of interest were located on private lands. In addition to standard daylight censuses, we also searched some fields for Henslow's Sparrows using nighttime listening surveys to detect singing males.

Habitat Characteristics.-- We used two methods to sample vegetation at Iroquois and Montezuma NWRs. First, we used a Robel pole (Robel et al. 1970) to derive an estimate of vegetation height and density within 50 m of each bird census point. We took Robel pole readings at four points, each located 25 m from the census point in a cardinal direction. At each sample point we took four measurements, for a total of 16 measurements/bird census point. At each Robel pole sample point, we also measured the height and distance to the nearest shrub in each quadrant.

Second, we used a more intensive vegetation sampling method for bird census points located in fields undergoing succession or being actively managed for grassland habitat. In these areas we sampled vegetation at five points along 50-m transects extending outward from each bird census point in the four cardinal directions (n = 20 samples/point); sampling points were located 49, 41, 33, 25, and 15 m from each census point. These distances were selected to produce approximately equal sampling intensity, on an area basis, within each circular plot. At each point, a 3-mm diameter, 1-m rod was passed vertically through the vegetation perpendicular to the ground and the number of contacts in 0-25 cm and > 25 cm height intervals were counted. In addition, we measured litter depth to the nearest 1 cm at the point where the rod intersected the ground. We then centered a 0.25 m^2 (50 cm X 50 cm) sampling frame on the point to visually estimate coverage classes for various vegetation variables. For each variable, the following six

coverage classes were used: < 5%; 5 to < 25%; 25 to < 50%; 50 to < 75%; 75 to < 95%; > 95%. The variables that we measured were: percent total cover; percent legume cover; percent goldenrod (*Solidago* spp.) cover; percent dead grass cover; percent dead forb cover; % live grass cover; percent live forb cover; percent shrub cover; and % canopy cover. Midpoint values for each cover class then were used in subsequent statistical analyses. We also counted the number of plant genera, and measured the tallest shrub, within the quadrat. Finally, we tallied the number of shrub species (without attempting to distinguish among species of willow [*Salix*] or hawthorn [*Crataegus*]), and visually estimated total shrub cover within a 50-m radius of the bird census point.

Only limited habitat data were gathered in the Jefferson County study area; types of data collected followed Shriver et al. (1997). For all fields surveyed for grassland birds, we estimated area (categories = 1-5, 5-10, 10-20, 20-50, 50-100, and 100+ ha), habitat type (native grassland, fallow field, pasture, hayfield, and row crop), shrub cover (categories = 0-5, 5-15, 15-25, 25-50, and >50%), shrub height (categories = 0-1, 1-2, and 2-4 m), and general soil moisture (categories = dry/sandy, average, and moist). Any relevant management activities also were recorded.

RESULTS AND DISCUSSION

I. Iroquois and Montezuma National Wildlife Refuges

Grassland Bird Species Richness and Abundance. -- Grassland bird abundance showed some evidence of increases from 1996-1997 to 1998-1999 on unmanipulated areas not experiencing major changes in plant community structure and composition due to shrub invasion (Upland Management Units C and I at Iroquois NWR; Figure 1). As in 1994-

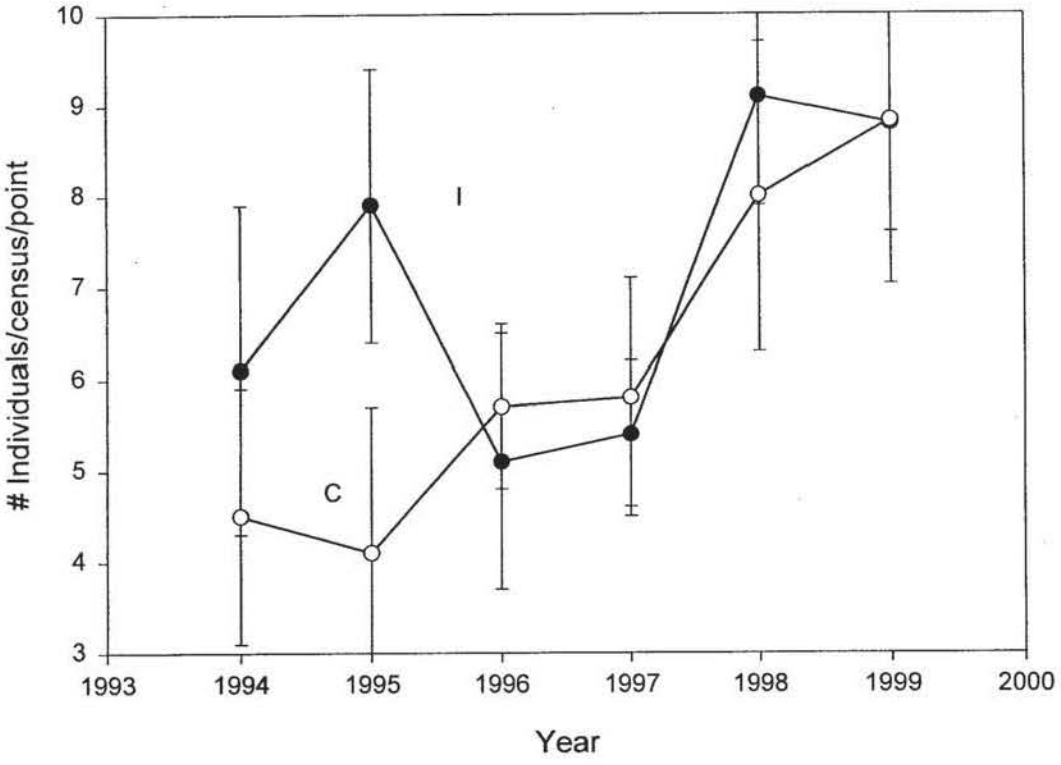

Figure 1. Mean number of grassland birds/census/point, I and C5 fields, Iroquois National Wildlife Refuge, 1994-1999. Error bars = ± 1 SD.

1997, Savannah Sparrows (*Passerculus sandwichensis*) and Bobolinks (*Dolichonyx oryzivorous*) were the most abundant and widely distributed grassland bird species in the study area. In 1998 and 1999 both species occurred in all fields of sufficient size (> ca. 5 ha) and with low shrub cover (< ± 5 %) (see Norment 1999). Eastern Meadowlarks (*Sturnella magna*), which were relatively uncommon in the study area in 1994 and 1995 (Norment 1999), were observed in 59% of the fields censused in 1998 ($n = 22$) and 42%of the fields censused in 1999 ($n = 12$). Grassland species of management concern at either the federal or state level were generally absent from Iroquois and Montezuma NWRs, or present in very low numbers. In 1998 five territorial male Grasshopper Sparrows (*Ammodramus savannarum*) occurred in recently restored fields at Iroquois NWR near Long Marsh (Upland Management Unit B) in 1998, and one unsuccessful nest was found in field B12. However, the species was absent from Unit B in 1999, as fields in the unit were either tilled or prescribe burned in 1999. Henslow's Sparrows (*Ammodramus henslowii*) were not found at either Iroquois or Montezuma NWRs, although they were present in 1998 at one field at Mendon Ponds County Park. Northern Harriers (*Circus cyaneus*) were not observed hunting over any fields at Iroquois or Montezuma NWRs in 1998 or 1999.

Effects of Succession and Management Activities on Grassland Bird Populations. -- In this section I discuss effects of succession and management activities on grassland bird populations at Iroquois and Montezuma NWRs on a field-by-field basis.

Iroquois NWR, Unit P, Field 4

This field was last planted in 1993 and became fallow in 1994. Grassland bird abundance reached a peak in 1996 and has since declined with increasing forb cover (primarily goldenrod, *Solidago* spp.; Figure 2). In 1998 and 1999, only one or two territorial male Bobolinks were present in the field; all other grassland species were absent.

Iroquois NWR, Unit K, Fields 6 and 9

K9 (13.6 ha) provided good habitat for grassland birds in 1994 (Figure 3). However, increases in shrub cover since 1994, particularly in the northern part of the field, negatively affected grassland birds. Data for one census point, which was not subject to shrub removal and subsequent replanting in 1996-1997 (see below), show a consistent decline in number of individuals/census/point, coupled with an increase in shrub cover (Figure 3).

According to Iroquois NWR files, the portion of K9 that was revegetated in 1996-1997 was planted with a mixture of yellow sweet clover (*Melilotus officinalis*), Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), and tall fescue (*Festuca arundinacea*) in the portion of K9 nearest headquarters, and a mixture of eastern gama grass (*Tripsacum dactyloides*), yellow sweet clover, and Virginia wild rye (*Elymus virginicus*) in the area nearest the cattails. Grassland birds increased in the revegetated portion of the field to 4.66 individuals/census/point in 1998, although they tended to avoid areas dominated by the taller (>1 m) grasses and forbs. Although mean vegetation height was lower in 1999 (55 cm) than in 1998 (83 cm), forb cover remained high (48%; including *Solidago*, milkweed [*Asclepias*], and thistle [*Cirsium*]), grass cover was

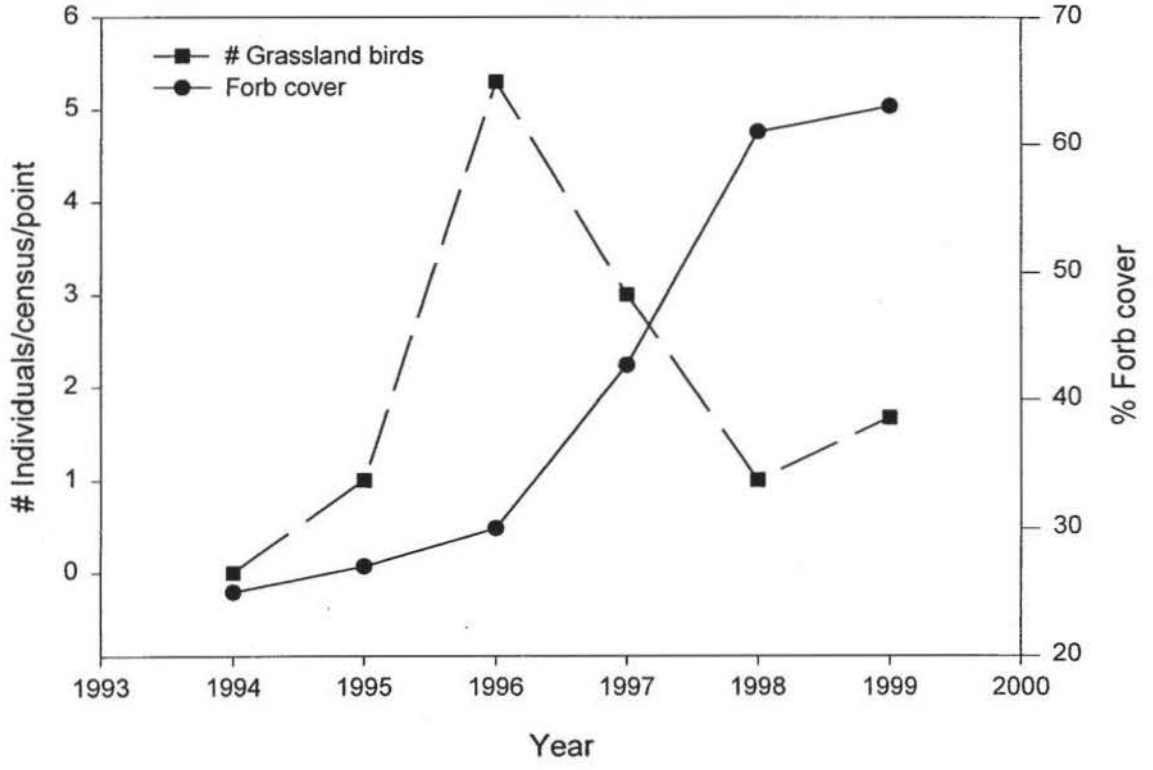

Figure 2. Mean number of grassland birds/census/point, and % forb cover, P field, Iroquois National Wildlife Refuge, 1994-1999.

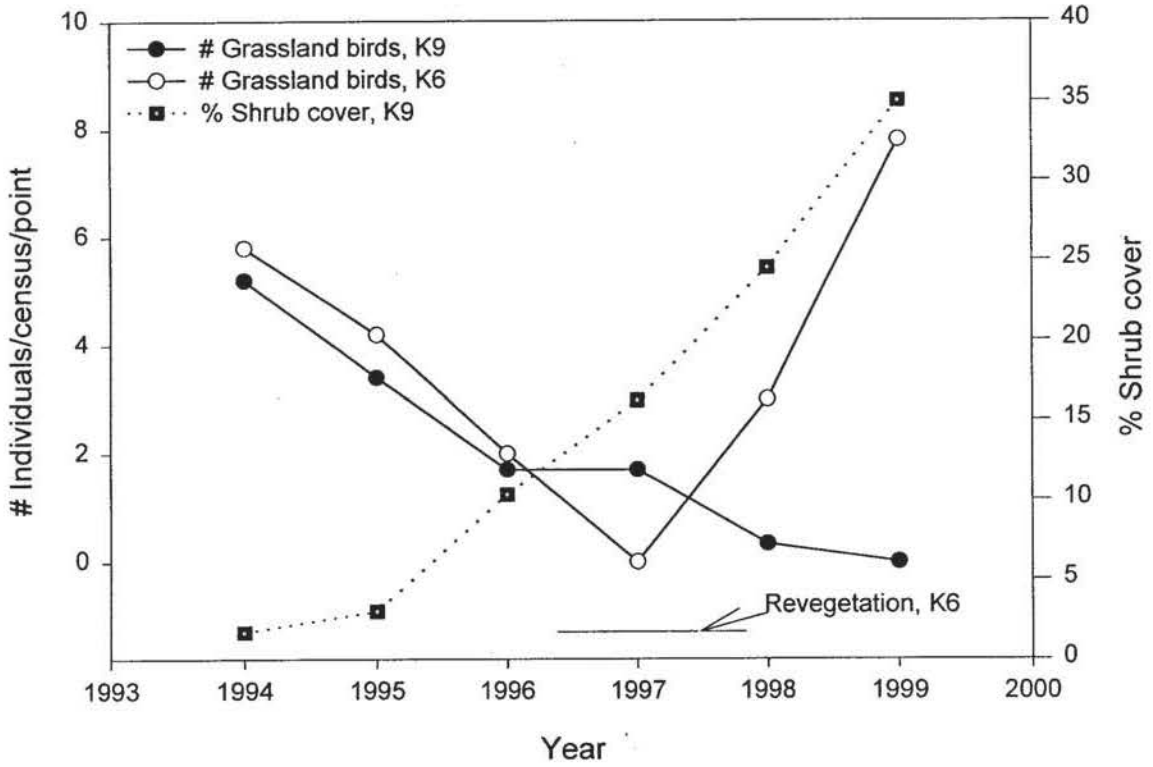

Figure 3. Mean number of grassland birds/census/point, fields K6 and K9 (undisturbed portion), Iroquois National Wildlife Refuge, 1994-1999; % shrub cover for undisturbed portion of K9 also shown.

relatively low (19%), and grassland bird abundance declined to 1.33 individuals/ census/point in 1999.

Revegetation appeared to be somewhat more successful in K6 (13.6 ha). A portion of the field was tilled to remove shrubs in late 1996 and planted to big bluestem, Virginia wild rye, tall wheat grass (*Agropyron elongatum* [?]), and Indian grass in the summer of 1997. Although introduced mustard was abundant in some parts of K6 in 1998, 3.0 grassland individuals/census/point were observed, including Savannah Sparrows, Bobolinks, and Eastern Meadowlarks, while 7.9 individuals/census/point were counted in 1999 (Figure 3). Concurrently, grass cover increased from 13% in 1998 to 33% in 1999, and introduced mustard was much less common than in 1998. Finally, it should be pointed out that although warm season grasses were planted in 1997 in both K6 and K9, almost none were noted in either field in 1999 (personal observation; Steve Kahl, Iroquois NWR, personal communication).

Iroquois NWR, Unit Q

An ambitious grassland vegetation and hedgerow removal effort, which began in 1995, resulted in creation of a relatively large (69 ha) grassland dominated by introduced cool season grasses in 1998. Beginning in the summer of 1995 and continuing through 1996, shrubs were removed from Q16, fields were tilled, and all except Q16 were planted in various mixtures of clover (*Trifolium)*, alfalfa, birdsfoot trefoil (*Lotus corniculatus*), tall wheatgrass, and several warm season grasses, including Indian grass. In some parts of Q, the initial seeding produced poor results, and in 1997 the vegetation was dominated by a tall (> 1 m) mixture of several exotic mustard species that supported few grassland birds; the mustard had almost completely disappeared by the spring of 1998. Average

grassland bird abundance increased from a low of 1.3 individuals/census/point in 1995 to 3.5 individuals/census/point in 1999 (Figure 4), although the efficacy of management treatments varied from field to field within Q. For example, after revegetation no grassland birds have been observed at Q16, a former shrubby field bordered on two sides by tall deciduous trees, and dominated by tall (> 1.0 m) forbs and cool season grasses. Conversely, ± 6 grassland individuals/census/point were counted in 1998-1999 at census point 50, located in field Q5, an increase of approximately 5 individuals/ census/point from a low in 1997, when the area surrounding the point was mostly bare ground following tillage (Figure 4). Prior to 1996, Q15 was dominated by shrubs and forbs, and Red-winged Blackbirds (*Agelaius phoeniceus*) were the most abundant species. The field was mowed three times in 1996, and grassland bird abundances increased to 2.67 individuals/census/point in 1998. By June 1998, management efforts had resulted in a large grassland dominated by grasses up to 1 m tall. Finally, in 1998 and 1999 grassland birds were absent from Q13, a 3.4 ha field dominated by switchgrass (*Panicum virgatum*). Bobolinks had been present in the field until 1997, but recent increases in dead grass cover apparently created unsuitable habitat for the species (Figure 5).

In both 1998 and 1999, there was an inverse relationship between grassland bird abundance and both vegetation height and density, with more grassland birds tending to occur at points in Q with lower, less dense vegetation. This relationship was stronger, and statistically significant, in 1998 (Figures 6 and 7).

Montezuma NWR, Waugh 1 and 2

Up until 1995, when Waugh 2 (14.3 ha) was acquired by the United States Fish and Wildlife Service, it had been maintained as a hayfield, and was dominated by introduced

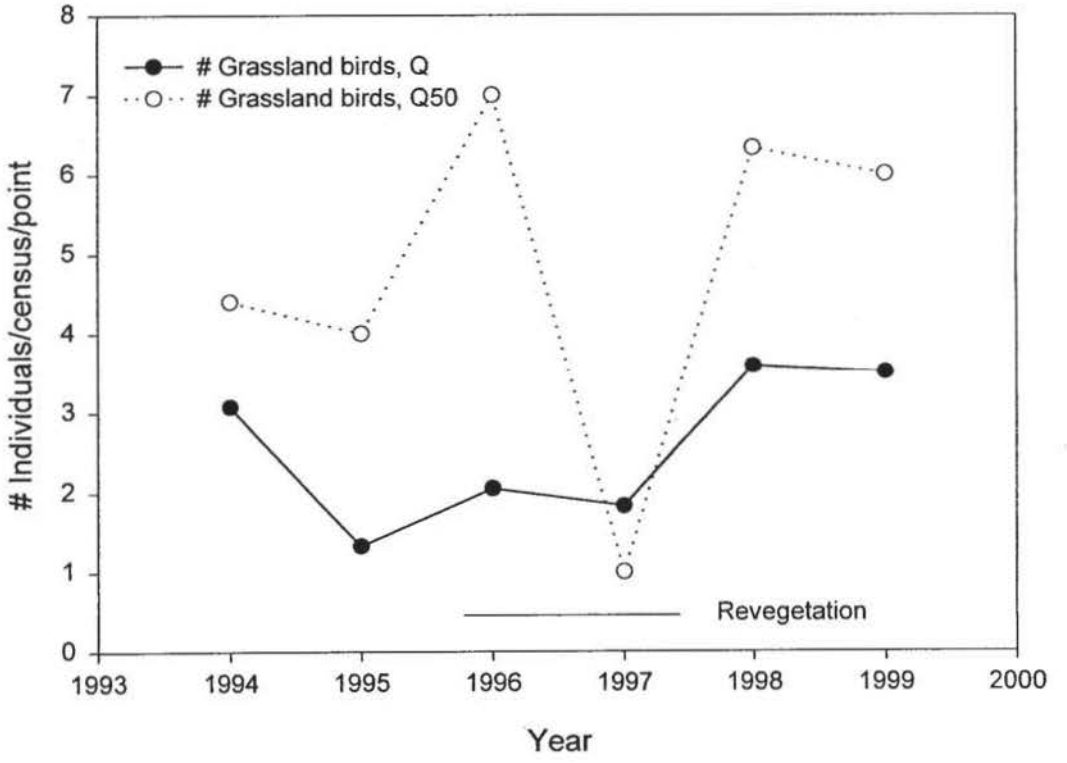

Figure 4. Mean number of grassland birds/census/point for Unit Q, and for one census point within Q (Q50), Iroquois National Wildlife Refuge. Timing of revegetation work also shown.

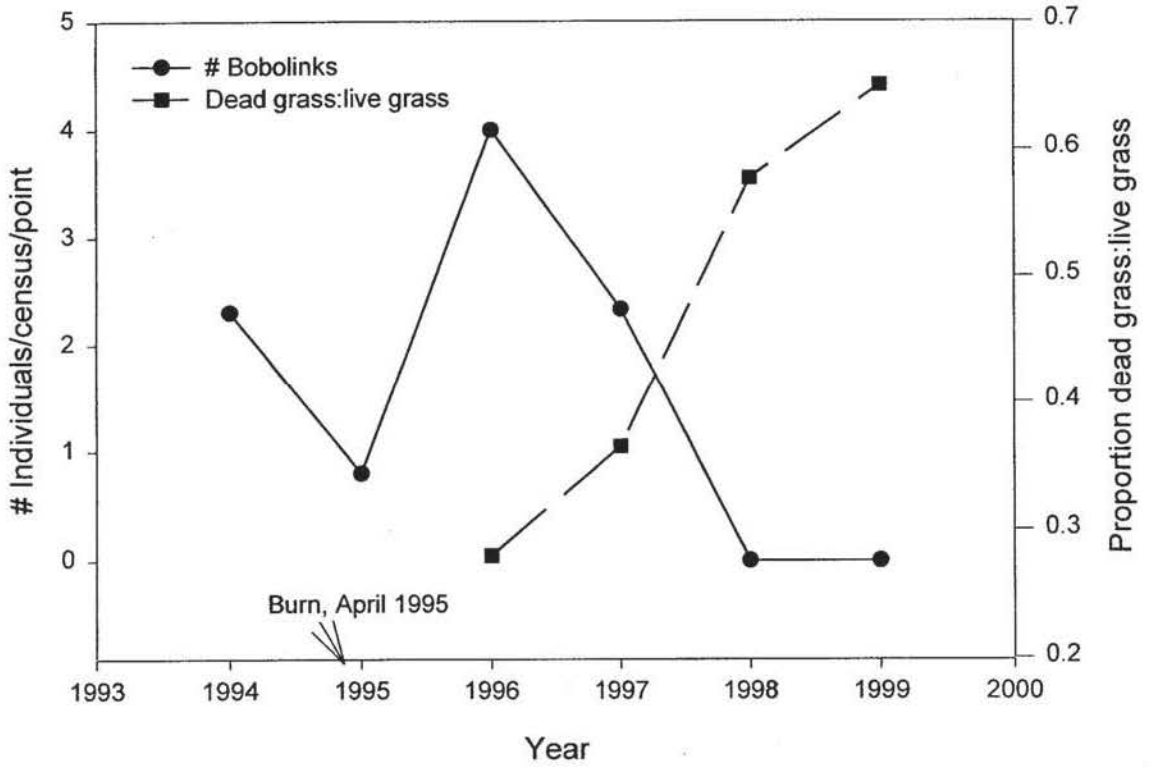

Figure 5. Mean number of Bobolinks/census, and proportion dead grass: live grass, Q 13 field, Iroquois National Wildlife Refuge.

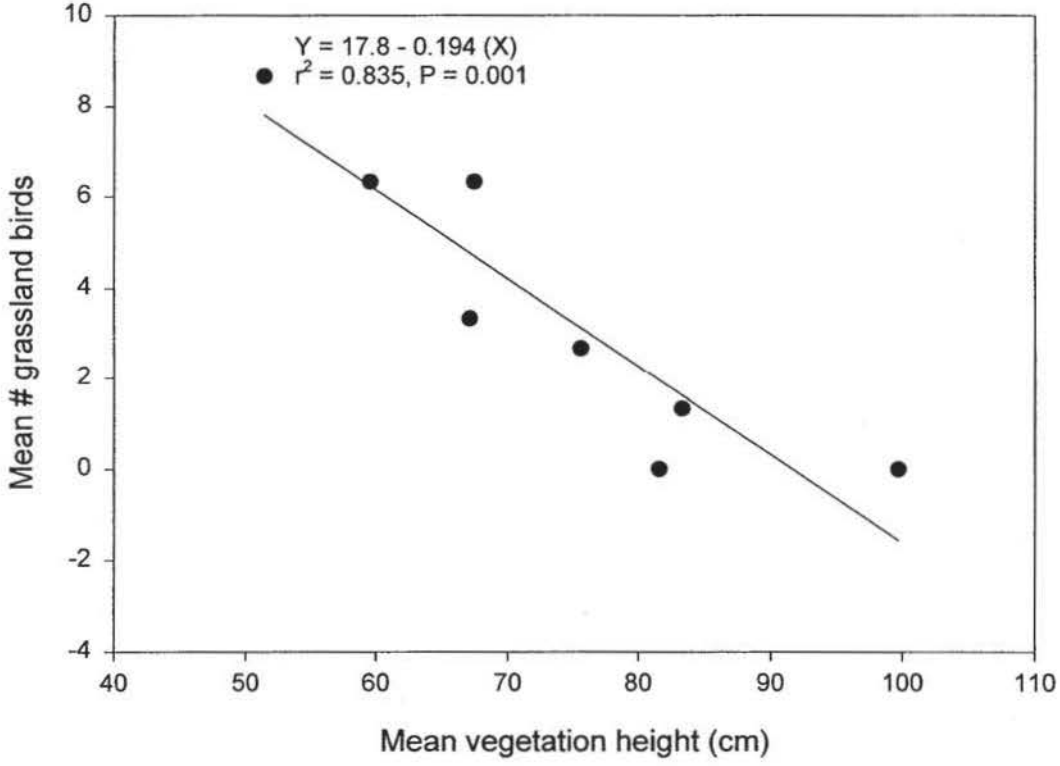

Figure 6. Mean number of grassland birds/census/point vs. mean vegetation height for Unit Q, Iroquois National Wildlife Refuge, 1998.

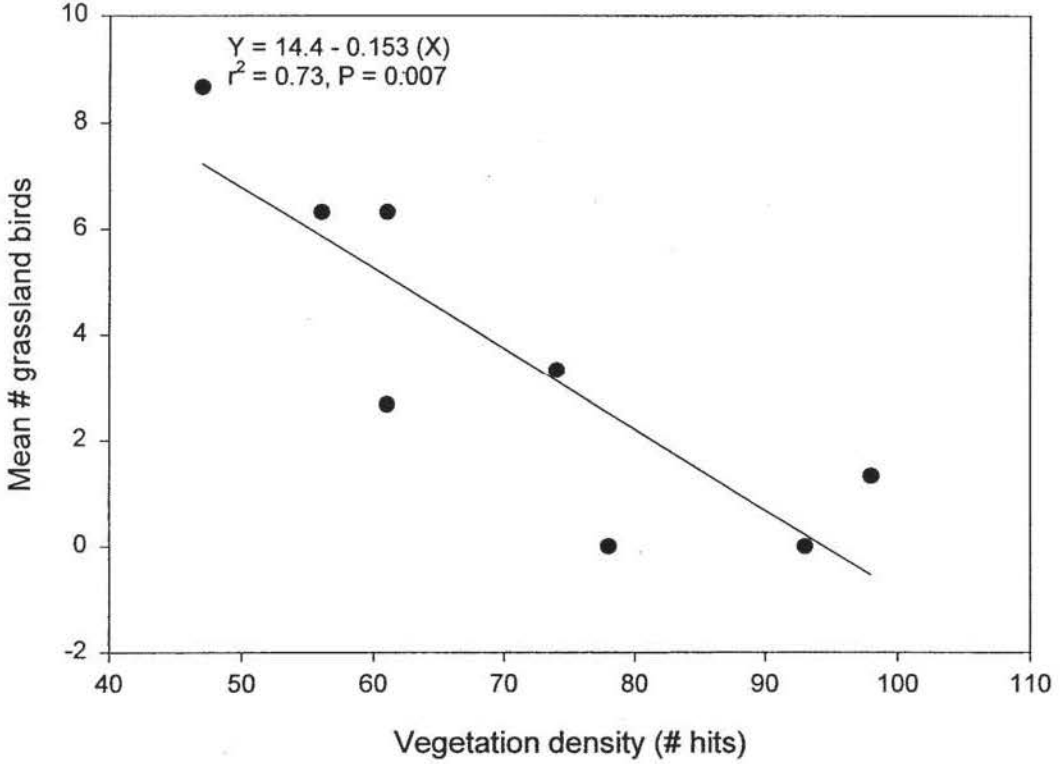

Figure 7. Mean number of grassland birds/census/point vs. vegetation density for Unit Q, Iroquois National Wildlife Refuge, 1998.

cool season grasses [timothy (*Phleum pratense*); orchard grass (*Dactylis glomerata*); brome grass (*Bromus ciliatus*)], along with some alfalfa. Grassland bird abundance was among the highest in the study area, when forb cover was approximately 25%, but began to decline as forb cover (primarily goldenrod and milkweed) increased to 40% by 1997 (Figure 8). A control burn in April 1998 actually increased forb cover (primarily goldenrod) over 1997 levels, to an average of 62% (Figure 8). By June 1999, forb cover on Waugh 2 approached 70%, and vegetation height in the field averaged 115 cm. Shrubs (*Cornus*, *Rosa*, and *Lonicera*), brambles (*Rubus*), and vines (*Vitis*) also were more common in 1999 than in 1998. These changes in vegetation were accompanied by changes in the birds using the field. Grassland bird abundance increased from 2.6 individuals/census/point in 1997, prior to burning, to 4.4 individuals/ census/ point in 1998 (Figure 8), but decreased to 2.0 individuals/census/point in 1999. Three old field species were present in Waugh 2 in 1998 (Red-winged Blackbirds, Song Sparrows [*Melospiza melodia*], and Common Yellowthroats [*Geothlypis trichas*]), with an average abundance of 1.67 individuals/census/point. By 1999, the bird community using Waugh 2 was comprised almost entirely of oldfield species, which had increased to five species (Red-winged Blackbirds, Song Sparrows, Common Yellowthroats, Swamp Sparrows [*Melospiza georgiana*], and American Goldfinches [*Carduelis tristis*]) and 10.0 individuals/census/point.

Waugh 1, a 21.5 ha cool season grassland adjacent to Waugh 2, was mowed in the late summer of 1996. This was followed by an increase in grassland bird abundance to 4.8 individuals/census/point in 1997 from low levels in 1995 and 1996 (2.2 and 1.0 individuals/census/point, respectively) (Figure 8). In 1997, the year after mowing, Waugh

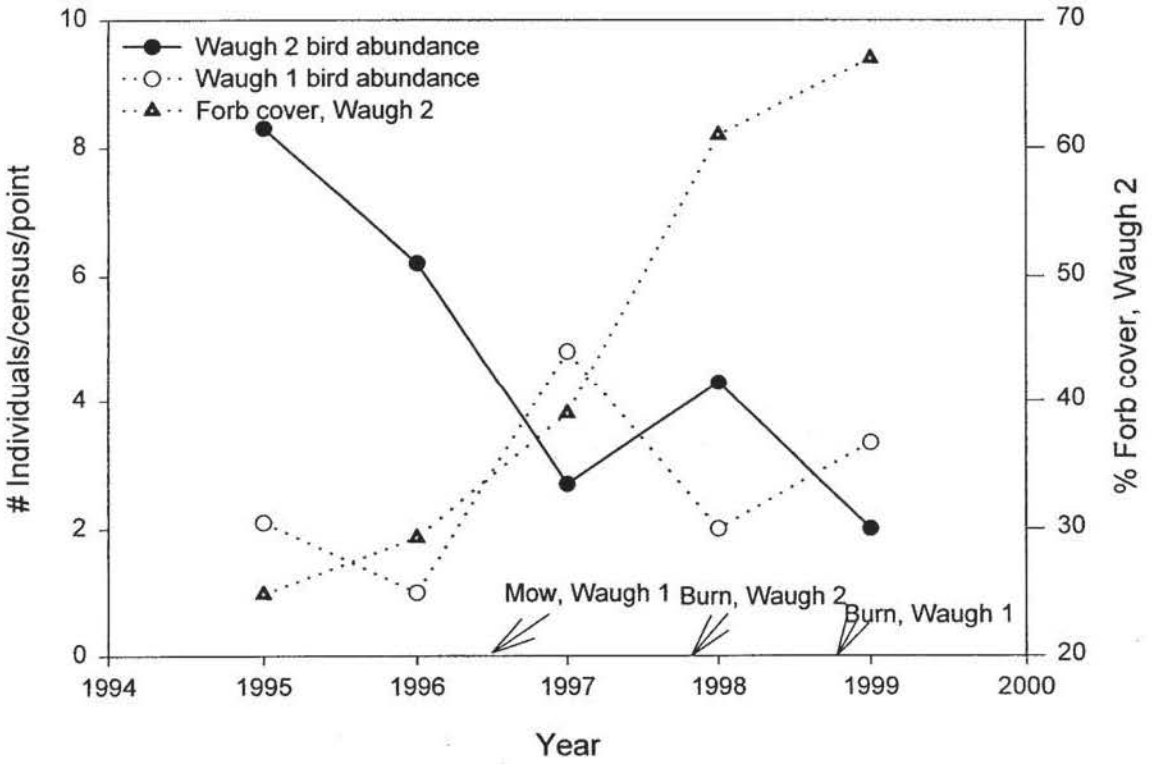

Figure 8. Grassland bird abundance, forb cover, and habitat manipulations, Waugh 1 and Waugh 2 fields, Montezuma National Wildlife Refuge, 1995-1999.

1 experienced an increase in grass cover, and a decrease in shrub and forb cover. However, forb and shrub cover began to increase again in 1998, with grassland bird abundance declining again to 2.0 individuals/census/ point. The field was subsequently burned in April, 1999. Grassland bird abundance did increase to 3.3 individuals/census/ point in 1999, but forb cover (mostly goldenrod, with some milkweed [*Asclepias*]) in June averaged 51% at the three points in the field. Some areas of the field had grass cover approaching 30%, but the predominance of forbs and the fact that some woody species (*Rubus, Vitis, Robinia, Elaeagnus, and Cornus*) were already sprouting from burned plants suggest that the burning will not be effective in creating good grassland bird habitat.

Montezuma NWR, Esker Brook

The Esker Brook field is a long, narrow field of ± 17 ha running in a north-south direction; distance from the middle of the field to the nearest field-forest edge is nowhere greater than ca. 75 m. It is divided into three management units: South, Central, and North, each of which contains a bird census point established in May 1995. Prior to 1995, the units were last mowed in 1992 or 1993. In May 1995 all three management units had vigorous growths of shrubs (*Cornus stolonifera* and *C. racemosa*, *Lonicera* spp., *Rosa* spp., *Rubus*, *Spirea alba*, *Viburnum* spp., *Prunus virginiana*, *Fraxinus americana*, and *Crataegus* spp.) and forbs (primarily *Solidago*), and no grassland birds were present in the field. Since 1995 the three management units have been subjected to various management treatments, primarily mowing. Some of these treatments created habitat suitable for grassland birds – primarily Bobolinks and Savannah Sparrows, along with an occasional Eastern Meadowlark – although the effects were temporary, and were

followed by vigorous regrowth of shrubs and forbs. A detailed description of management histories of the three units follows, because it illustrates the difficulty of maintaining grassland habitat in the region.

The Central unit was mowed in August 1996; shrub cover decreased and grassland bird numbers increased to 3.0 individuals/census in 1997. However, grassland bird abundance declined to almost 0 in 1998, following regrowth of shrubs; after mowing in 1998, grassland bird numbers once again increased to moderate levels in 1999 (Figure 9). The North unit was mowed in August 1995. Shrub cover was low in 1996, but we counted few grassland birds in the unit, and by 1997 shrub cover had once again increased. However, a second mowing in August 1997 resulted in an increase in grassland birds the following summer. Another mowing in August 1998 controlled shrub invasion, but few grassland birds (1.0 individuals/census) were counted in the North unit in 1999. The South unit was mowed in August 1996, and grassland birds responded favorably the following summer. In June and July 1997 different parts of the South unit were either mowed, mowed and sprayed with an herbicide, sprayed with an herbicide, or not mowed, and shrub growth was retarded in treated sections of the unit; mowing in the South unit occurred three times between 5 June and 31 July in 1997. Finally, the central portion of the unit was burned in April 1999. These treatments were followed by an increase in grassland bird abundance in 1998, to 2.0 individuals/census. However, only 1.67 grassland individuals/census were counted in 1999, with vigorous shrub growth occurring in the unburned part of the unit.

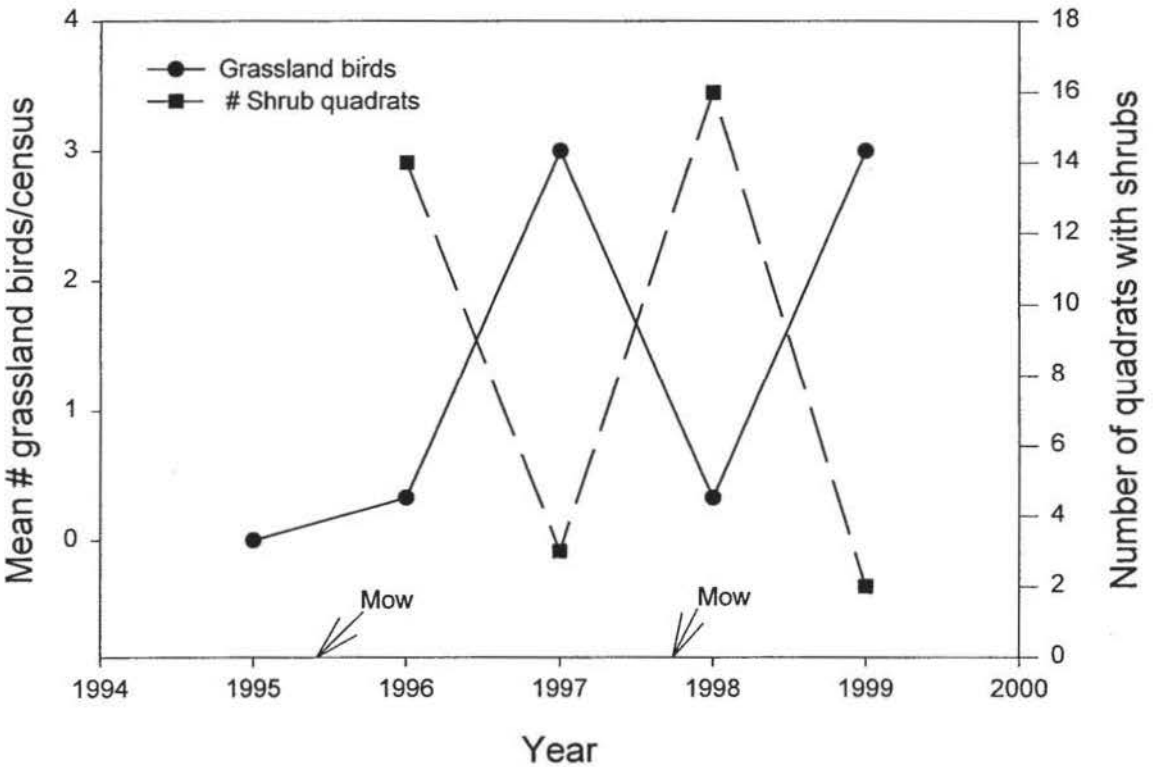

Figure 9. Grassland bird abundance and number of quadrats with shrubs, Esker Brook Central Unit, Montezuma NWR, 1996-1999. Data on number of quadrats with shrubs not gathered in 1995.

Habitat Variables as Predictors of Grassland Bird Abundance. -- The methods that I used to sample vegetation at bird census points from 1994 to 1998 were time consuming. Although these methods produced sets of 13 (1994-1995) and 19 (1996-1998) variables for use in analyzing grassland bird-habitat relationships, relatively few of these variables explained a significant amount of the variation in grassland bird species richness and abundance across fields in the study area (Norment 1999). Overall, the most important explanatory vegetation variables for grassland bird species richness and abundance were those related to vegetation density and height (Norment 1999, Norment et al. 1999), along with various indices of shrub cover. Vegetation height and density are also important in determining the abundance of many grassland species in the Midwest (Herkert 1994a) and in New York hayfields (Bollinger 1995). Given this important relationship, I analyzed the reliability of using a Robel pole (Robel et al. 1970) to speed the process of gathering data on vegetation height and density. Accordingly, for comparative purposes in 1998 I gathered vegetation data at each bird census point using both "standard" methods from earlier field seasons, and a Robel pole.

I then regressed mean Robel pole scores against variables related to vegetation height and density: mean vegetation height, maximum vegetation height, vegetation contacts ≤ 25 cm, vegetation contacts > 25 cm, and total vegetation contacts. Relationships with mean Robel pole scores were strongest for mean vegetation height (Figure 10; $r^2 = 0.569$, $p < 0.001$) and contacts > 25 cm (Figure 11; $r^2 = 0.531$), but were also significant for total contacts ($r^2 = 0.339$, $p < 0.001$) and maximum vegetation height ($r^2 = 0.343$, $p < 0.001$). Fitting the data to second-order polynomials increased correlations between

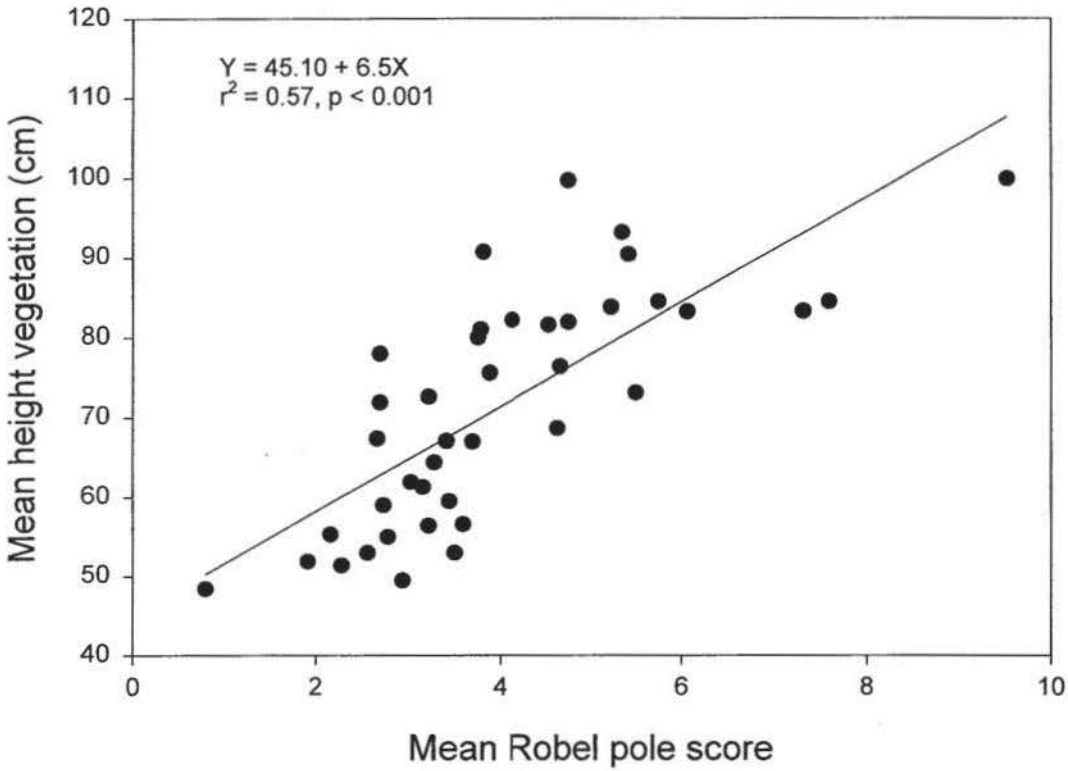

Figure 10. Scatter plot showing the relationship between mean Robel pole score and mean vegetation height at bird census points, 1998. See methods for description of how data were gathered.

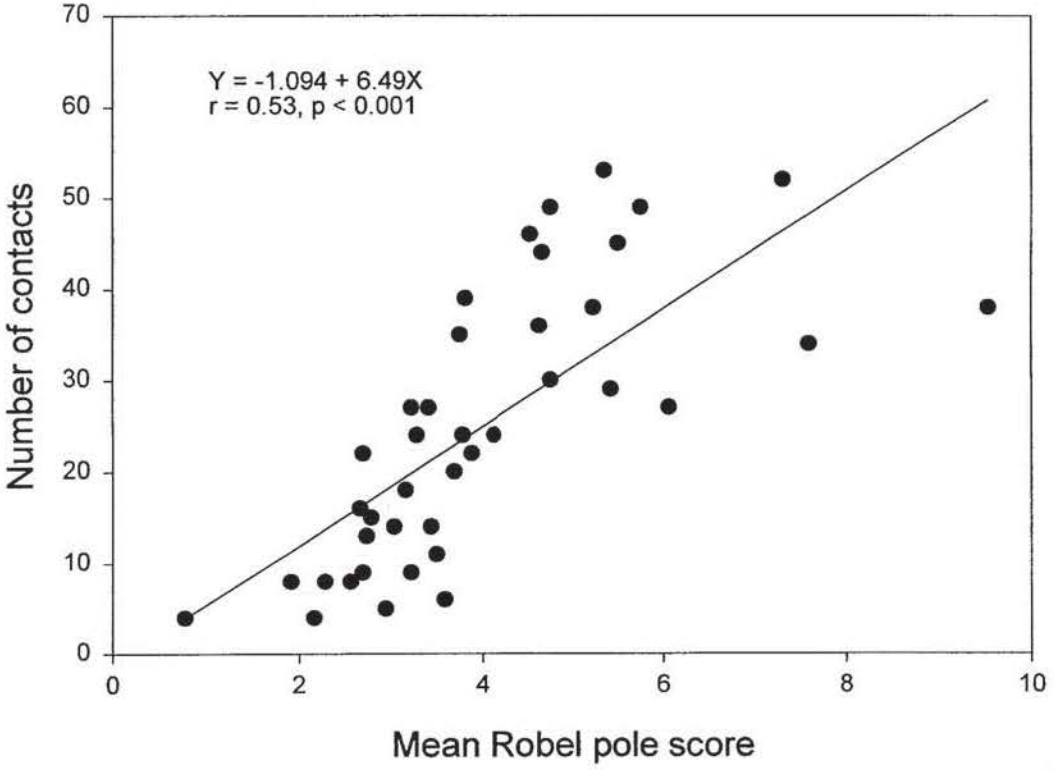

Figure 11. Scatter plot showing the relationship between mean Robel pole score and number of vegetation contacts at > 25 cm height for bird census points, 1998.

Robel pole scores and mean height of vegetation ($r^2 = 0.615$) and vegetation contacts > 25 cm ($r^2 = 0.646$).

As in previous years log of field area consistently was the best predictor of grassland bird response variables in 1998, with mean species richness and abundance, and mean abundance of Savannah Sparrows and Bobolinks increasing with field area (Table 2). Relationships between mean species richness, or between mean abundance, and predictor variables related to vegetation density, height, and shrub cover were also significant, although generally weaker than for log of field area (Table 2). However, few habitat variables other than area were good predictors of abundance for individual species, and Robel pole scores were no better than variables such as mean vegetation height and contacts > 25 cm at predicting grassland bird richness and abundance (Table 2). The types of relationships observed in previous years of the study between vegetation variables and grassland bird richness and abundance were also observed in 1998; fields with taller, more dense vegetation tended to have fewer species and individuals (Table 2; see also Figures 12 and 13). Although relatively few fields were surveyed for grassland birds in 1999, a similar relationship between vegetation height and density, and grassland bird abundance, existed (Figure 14).

For 1998 data, stepwise multiple regressions entering a maximum of either three variables (log field area, Robel pole scores, and # of quadrats with shrubs) or five variables (log field area, mean vegetation height, total contacts, contacts > 25 cm, and # of quadrats with shrubs) into the model explained more of the variation in mean species richness and mean abundance than did single-variable models, but not for abundance of individual grassland species (Table 3). A model incorporating log of field area and

Table 2. Linear correlations (r^2) between grassland bird variables and habitat variables in 1998; (+) or (-) indicates if the relationship was positive or negative. * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

Habitat Variable	Mean species richness	Mean abundance (#/census/point)	SAVS[1]	BOBO[2]	EAME[3]
Log area (+)	0.299**	0.528***	0.632***	0.439***	
Mean Robel pole score (-)	0.271*	0.256*			
Mean vegetation height (cm) (-)	0.403**	0.351**	0.170*	0.251*	
Total contacts (-)	0.320**	0.185*			
Contacts ≥ 25 cm (-)	0.331**	0.230*			0.190*
# Shrub quadrats (-)	0.173*	0.197*		0.171*	

1. Mean number of Savannah Sparrows/census/point.
2. Mean number of Bobolinks/census/point.
3. Mean number of Eastern Meadowlarks/census/point.

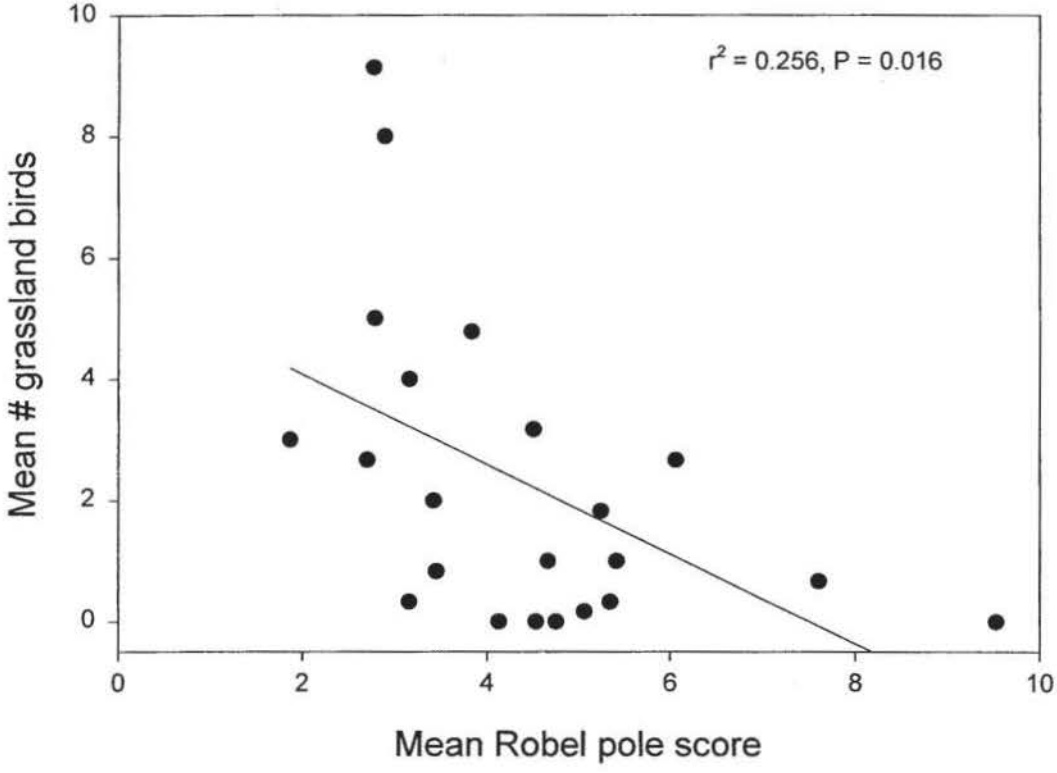

Figure 12. Mean number of grassland birds/field vs. mean Robel pole score for fields censused in 1998.

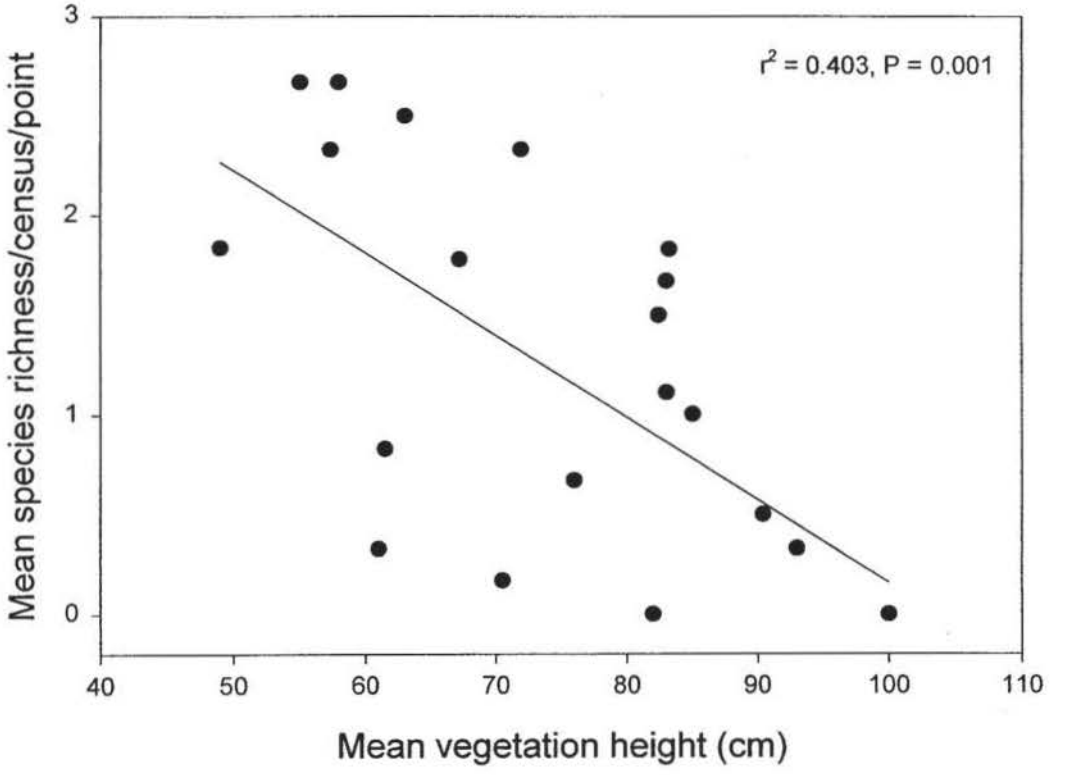

Figure 13. Mean number of grasland bird species/census/point vs. mean vegetation height for fields censused in 1998.

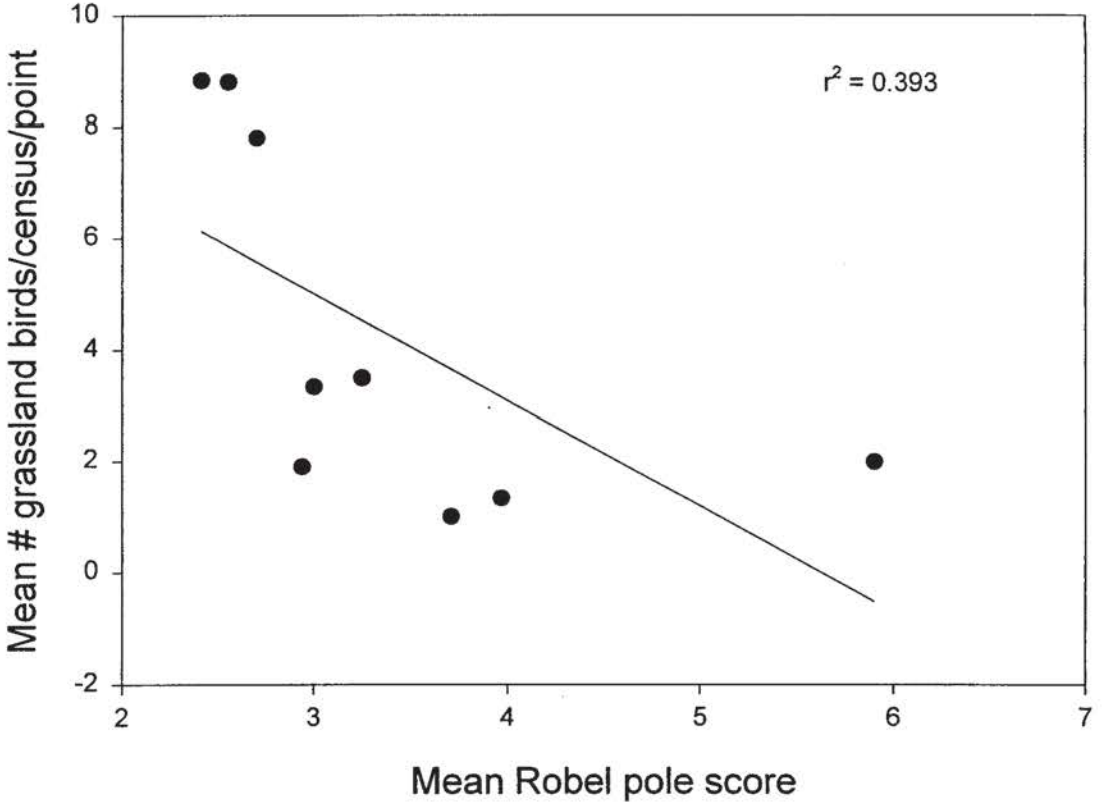

Figure 14. Mean number of grassland birds/census/point vs mean Robel pole score for fields censused in 1999.

Table 3. Grassland bird-habitat models for 1998 data generated by stepwise multiple regression. All variables given have $P < 0.05$; r^2 is the proportion of the total variation in the particular bird variable explained by the model. Partial r^2 values are given in ( ). Values are reported for models generated from one of two sets of variables: a five-variable set (log field area, mean vegetation height, total contacts, contacts > 25 cm, and number of quadrats with shrubs) or a three-variable set (log field area, mean Robel pole scores, and #quadrats with shrubs).

Bird variable	Five-variable set	Three-variable set
Mean species richness	$r^2 = 0.53$ -Vegetation height (0.40) + Log area (0.13)	$r^2 = 0.49$ +Log area (0.30) - Robel score (0.19)
Abundance	$r^2 = 0.70$ +Log area (0.53) -Contacts > 25cm (0.17)	$r^2 = 0.68$ +Log area (0.53) -Robel score (0.15)
Bobolink	$r^2 = 0.44$ + Log area (0.44)	$r^2 = 0.44$ + Log area (0.44)
Eastern Meadowlark	$r^2 = 0.19$ - Contacts > 25 cm	$r^2 = 0.19$ - Contacts > 25 cm
Savannah Sparrow	$r^2 = 0.63$ + Log area (0.63)	$r^2 = 0.63$ +Log area (0.63)

contacts > 25 cm explained 70% of the variation in grassland bird abundance, while a model incorporating mean vegetation height and log field area explained 53% of the variation in mean grassland bird species richness (Table 3). Models using Robel pole scores instead of direct vegetation height and density measurements were almost as successful at predicting grassland bird richness and abundance (Table 3). Overall, it thus appears that Robel pole scores may be equally useful in predicting grassland bird richness and abundance as are variables that require more time to gather.

II. St. Lawrence River Valley

Eight obligate grassland species, as listed by Vickery et al. (1999) were detected in the 21 fields surveyed each year between 1997 and 1999: Northern Harrier, Upland Sandpiper, Vesper Sparrow (*Pooecetes gramineus*), Savannah Sparrow, Grasshopper Sparrow, Henslow's Sparrow, Eastern Meadowlark, and Bobolink. Eastern Meadowlarks, Bobolinks, and Savannah Sparrows were the most widely distributed species in the area (Table 4), as has been found elsewhere in the Northeast (Shriver et al. 1997, Jones and Vickery 1997, Norment 1999). Grasshopper Sparrows were widely distributed in 1997 and 1998 (48% and 43% of the fields surveyed, respectively), but were less commonly encountered in 1999 (10% of fields surveyed). Henslow's Sparrows were found in 43% of the fields surveyed in 1998, but in only 19% of the fields in 1999. Upland Sandpipers were found only in 1997, when they were present in 19% of the fields surveyed. Conversely, Northern Harriers were more widely distributed in 1999 (24% of fields) than in 1997 or 1998 (10% of fields). Vesper Sparrows were not detected in 1997 or 1998 and were seen in only 1 of 21 fields in 1999.

Mean number of species/field differed significantly among years (ANOVA; $F_{2, 60} = 13.89$, $P < 0.001$), with significantly fewer species observed in 1999 (Table 4). Mean number of grassland individuals/census/field also differed significantly among years (ANOVA, $F_{2, 60} = 13.62$, $P < 0.001$), with significantly fewer individuals also occurring in 1999 (Table 4).

In 1998 and 1999, we paid particular attention to the Henslow's Sparrow, given its status as a Federal species of management concern in the Northeast (Schneider and Pence 1992), and interest in the possibility of adding the species to the Federal Endangered Species List (Pruitt 1996). In addition to surveying fields where Henslow's Sparrows were detected in 1997 ($n = 21$), we also searched for other fields with the species in the area to the west of Fort Drum Military Reservation, and eleven additional fields with Henslow's Sparrows were located in 1998, of which six were also occupied in 1999. Data provided by Mr. Nick Leone of Watertown, NY (personal communication), who has been searching for Henslow's Sparrows in the Jefferson County area since 1994, also adds to information concerning the distribution of the species. Mr. Leone and my students and I have thoroughly searched an area of approximately 800 km^2, in a rough rectangle delimited by the Ashland Wildlife Management Area to the west, the village of Theresa to the north, Fort Drum to the east, and the town of Brownville to the south. Within this area, a total of 87 different fields are known to have contained Henslow's Sparrows in at least one year between 1994 and 1999. In 1998, the most thorough year of searching, Henslow's Sparrows were found in 58 fields in the area. Summing the maximum number of singing males detected at each site (including both day and night surveys) gives a total of 151 males in the 58 fields. Given an additional ± 50 territorial

Table 4. Summary data for grassland bird censuses, Jefferson County, St. Lawrence River Valley, 1997-1999. Includes data only for those fields surveyed in all three years (n = 21).

Year	Mean # species/field (x ± 1 SD)	Mean # birds/ census/field (x ± 1SD)	Mean # HESP/ census/field (x ± 1SD)	Proportion of fields with: NOHA	UPSA	BOBO	EAME	SAVS	HESP[1]	GRSP
1997[1]	4.2 ± 1.0	12.9 ± 4.4	3.31 ± 2.07	0.14	0.19	0.86	0.95	0.71	1.00[1]	0.48
1998	4.6 ± 0.8	10.4 ± 3.2	0.57 ± 0.86	0.14	0.00	0.90	0.81	0.90	0.43	0.43
1999	3.1 ± 1.0	7.1 ± 2.8	0.43 ± 1.03	0.24	0.00	0.90	0.81	0.81	0.19	0.10

1. 1997 fields were censused by another worker, prior to the start of the current project. All fields selected for subsequent surveys in 1998-1999 had Henslow's Sparrows present in 1997.

males on Fort Drum Military Reservation (Robin Krebs, personal communication), there were at least 200 territorial male Henslow's Sparrows in the 800 km^2 area surveyed in 1998.

Although we surveyed relatively few fields in the smallest and largest size classes, the data available for 1998 and 1999 suggest that Henslow's Sparrows most frequently occupy fields ≥ 10 ha, with a higher proportion of fields in the 20-50 ha and above size range occupied in both 1998 and 1999 (Figure 15). This pattern has been found elsewhere; although the species may occur in fields as small as 3.6 ha (Graber 1968), in most areas they apparently prefer fields ≥ 30 ha (Zimmerman 1988, Herkert 1995, Smith 1997).

There are several possible reasons for the observed among-year differences in grassland bird abundance and species richness in the St. Lawrence study area. First, the census data may reflect actual differences in numbers among years, with conditions for grassland birds being less favorable in 1999 than in 1997 and 1998. 1999 was a year with less than average spring rainfall, which could have negatively affected vegetation structure or phenology in the area. It is difficult to evaluate this hypothesis, although Robin Krebs noted fewer grassland birds during standardized censuses at Fort Drum in 1999 than in 1998 (R. Krebs, unpublished data). Second, between-year differences could have been due to differences in the timing of surveys; 1997 surveys were conducted during the last week of June and first week of July, while 1998 and 1999 surveys were conducted in mid-June. For example, in 1997 flocks of Upland Sandpipers (up to eight birds) were seen in some fields; these may have represented post-breeding birds (see Andrle and Carroll 1988). This explanation does not seem likely for some of the more

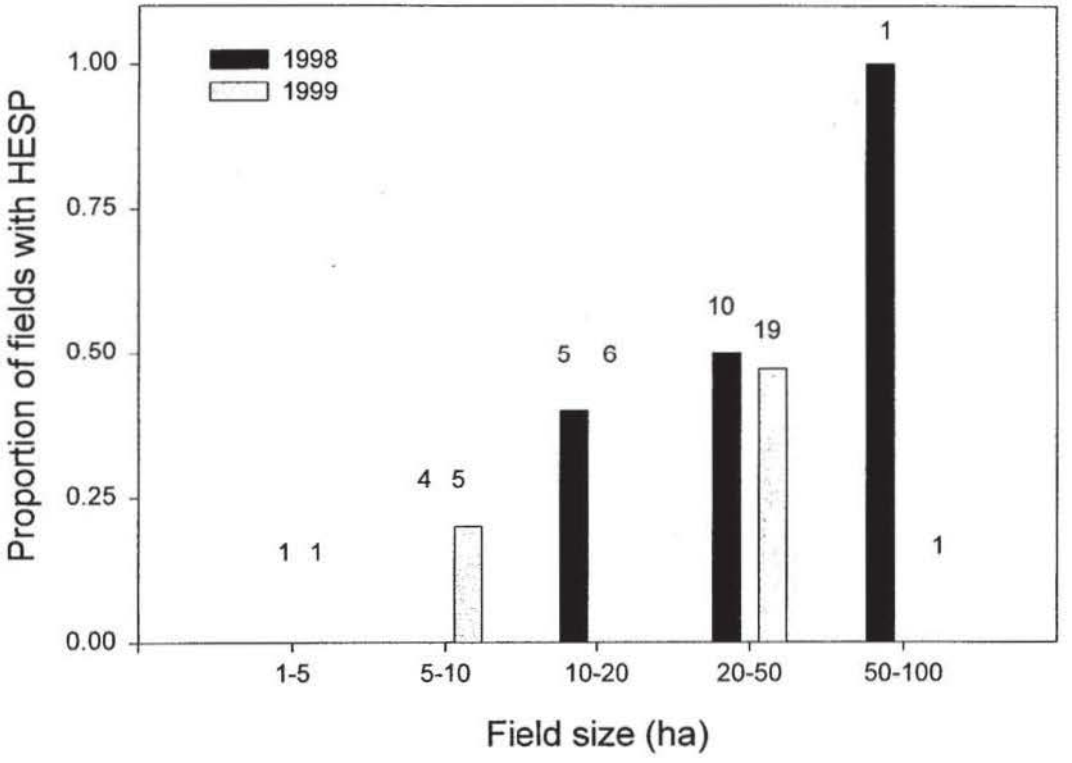

Figure 15 . Proportion of fields in size classes (ha) occupied by Henslow's Sparrows in 1998 and 1999. Numbers above bars indicate sample size for each size class; n = 21 in 1998, n = 32 in 1999.

common grassland passerines, however, as their singing rates decline after early to mid-June and they become less detectable (personal observation). Finally, among-year differences in observer ability may account for some of the differences in grassland bird richness and abundance. Different individuals conducted most of the censuses in each year of the study, and although I trained all of them and am confident that they were competent at identifying and counting grassland birds, I cannot dismiss possible confounding effects due to inter-observer biases. I suspect that any inter-observer differences would have affected counts of individuals, rather than species detection; thus the apparent differences in the proportion of fields occupied by Grasshopper Sparrows and Henslow's Sparrows are probably real. Robin Krebs also noted fewer stations at Fort Drum with Henslow's Sparrows in 1999 (present at 25% of 48 point counts) than in 1999 (present at 47% of 49 point counts).

Management Recommendations. – Extensive comments on grassland management practices in the Northeast are given in Norment (1999) and in several publications by the Massachusetts Audubon Society (Jones and Vickery, no date a, b, and c), and will not be repeated here. The major conclusions in these documents were that most grassland species in the region will benefit from practices that increase field area and heterogeneity of the vegetation; decrease litter, vegetation height and density; and maintain shrub cover at < 2-3%. However, observations collected in 1998 and 1999 from fields at Iroquois and Montezuma NWRs do suggest or clarify several important points about grassland management practices in the region:

1. Preventing shrub invasion or regrowth is difficult without frequent disturbance. Experiences at Montezuma (Esker Brook) and Iroquois (G, L3) show that, once shrubs are established, mowing will "buy" only one year of decent grassland habitat before shrubs reestablish sufficiently to discourage grassland birds. Fields that remain in the best condition, such as I and C5 at Iroquois NWR, are those that have been either grazed and mowed, or mowed, on an annual or biennial basis. The lack of recent disturbance in C5, however, has led to vigorous growth of shrubs in some parts of the field, which will lead to a decline in the quality of the grassland habitat unless action is taken. The bottom line is simply that grasslands are an artificial habitat in almost all parts of the Northeast, and to maintain them generally will require intensive management (Norment 1999). If mowing is the only management technique used on a field, then it probably will have to be done yearly if large numbers of shrubs are present. If few shrubs are present, then mowing may be scheduled at 2 year intervals in many areas.
2. Spring burns do not appear to have beneficial effects on cool season grasslands. In both Waugh 1 and 2, April burns led to a decrease in grass cover, and an increase in forbs, primarily *Solidago*. This is probably because cool season grasses have already initiated growth in April, and are thus sensitive to fire, while forbs such as *Solidago* have not yet begun producing above-ground tissues. Although there apparently are few published data on the effects of spring burns on cool season grasslands in the Northeast, several studies in the region have examined in the efficacy of spring vs. summer burns. For example, Niering and Dwyer (1989) found that spring burns had negative effects on Connecticut grasslands dominated by little bluestem, with clonal

shrub cover increasing in treatment plots relative to control plots. Dunwiddie et al. (1997) also found that August burns were more effective than spring burns at increasing herbaceous cover, and decreasing shrub cover, in coastal sandplains grasslands. It is noteworthy to mention that other spring treatments, such as mowing, may also disturb cool season grasses more than forbs or shrubs, and thus lead to increases in unwanted species (Laura Mitchell, USFWS, personal communication). Anderson (1997) also has suggested that summer burns may be an effective management tool for controlling shrub invasion in Midwestern tallgrass prairies, although he emphasized the need for more research on the subject.

Research conducted by Laura Mitchell at Iroquois and Montezuma NWRs suggests that summer burns and mowing may be more effective than spring burns at controlling forbs and shrubs in cool season grasslands (personal communication). At Iroquois NWR, she subjected a field undergoing invasion by *Lonicera*, *Cornus*, *Solidago*, and *Aster* to either spring burn, summer burn and mow, or control treatments. The most effective treatment for encouraging the growth of cool season grasses such as timothy (*Phleum pratense*) and smooth brome (*Poa pratensis*) was the summer burn and mow (Laura Mitchell, personal communication). If summer management activities are to be undertaken on refuges, these manipulations should occur after most grassland birds have fledged their first broods, which should occur by early July (Norment 1999). It also should be remembered that different grassland bird species respond differently to fire; species such as Henslow's Sparrow and Sedge Wrens will decline after fire, while Grasshopper Sparrows, Savannah Sparrows and Bobolinks tend to be more abundant after fires (Herkert 1994b).

3. It generally is more difficult to establish warm season than cool season grasses in the region. For example, most fields at Iroquois NWR planted with warm season grasses (large portions of Q, K6 and K9) following shrub removal and tillage remain dominated by cool season grasses and forbs. One exception appears to be B12 and B13 at Iroquois, along the north side of Long Marsh. In the spring of 1997 these fields were tilled and planted with a mixture of warm season grasses and legumes. A few grassland birds were present in 1998, although warm season grass growth was poor. The field was burned in April 1999 (Steve Kahl, Iroquois NWR, personal communication), and now supports thick stands of Indian grass, big bluestem, little bluestem, and switchgrass. However, height and density of the vegetation in portions of the field dominated by the taller warm season grasses other than little bluestem may prevent their use by grassland birds if the dead vegetation remains standing over the winter (personal observation).
4. The USFWS should thoroughly and carefully evaluate decisions to emphasize warm season grasses in their management activities. There are several reasons for this. First, as mentioned above, in many areas warm season grasses are more difficult to establish than are cool season grasses. Second, warm season grasslands may be no better than cool season grasses for grassland birds – and in some cases, they may be worse. Monocultures of switchgrass (*Panicum virgatum*) at Iroquois NWR, as well as Tonowanda, Oak Orchard, and Braddock Bay Wildlife Management Areas, support few, if any grassland birds except for a few Sedge Wrens (*Cistothorus platensis*) and nesting Northern Harriers (Norment 1999). In the Midwest, Conservation Reserve Program fields planted in cool season grasses and legumes (CP1) support as many, or

more, grassland birds than do fields planted in native warm-season grasses (CP2 fields; Delisle and Savidge 1997). CP1 fields supported more Bobolinks than CP2 fields, while CP2 fields supported more Sedge Wrens and Common Yellowthroats (Delisle and Savidge 1997). Perhaps more important, though, than the grass composition of the field was how it was managed in relation to vegetation structure. In general, CP1 (cool season grasses and legumes) fields provided good habitat for birds that require low vegetation height and nest of the ground, such as Bobolinks and Grasshopper Sparrows, while CP2 fields (warm season grasses) provided better habitat for birds that nest off the ground and require higher vegetation. However, CP2 fields that were opened up by mowing and burning did provide good habitat for native grassland birds (Delisle and Savidge 1997). Species such as Bobolinks and Savannah Sparrows also achieve higher densities in alfalfa (*Medicago sativa*) – wheatgrass (*Agropyron* spp.) fields than in grazed and unmanipulated prairie habitats in North Dakota (Renken and Dinsmore 1987).

Of course, management decisions must be based upon overall management objectives. Thus, if the ultimate goal of USFWS grassland management activities is to create grassland with some native warm season grasses (at least at the regional level), then fields should be planted and managed to this end. However, if the primary management goal is to create good habitat for grassland birds, then planting nonnative cool season grasses may be a more effective strategy, at least in cooler parts of the Northeast.

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