

## GRASSLAND NESTING BIRD POPULATION SURVEYS IN PENNSYLVANIA<sup>a</sup>

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**Abstract:** Since prior to the 1900s the expansion of agriculture across the Eastern landscape and in native grasslands to our west brought huge changes in bird populations. Many grassland-associated species colonized the newly created open habitats, but changing agricultural practices sometimes rendered these lands unsuitable or created ecological sinks. Agricultural set-asides (e.g., CREP lands) have provided reservoirs of grassland habitat that have helped sustain populations of some grassland birds and reclaimed surface mines have inadvertently become a source of grassland bird habitat, but these new habitats have failed to replace the almost complete loss of native grasslands. In the past 30 years, grassland bird communities have experienced the most consistent declines of any group of birds monitored by the U.S. Fish and Wildlife Service's Breeding Bird Survey (BBS). Fewer than 30% of grassland species on BBS routes show increasing populations nationally. To evaluate long-term declines, the Grassland Breeding Bird Survey (GBBS) was initiated in 1989 and established a quantitative system of monitoring grassland species at scattered locations across the Commonwealth. GBBS routes were established in agricultural and reclaimed mine habitats in an effort to focus on grassland species. Stops were selected by volunteers based on the presence of agricultural or grassland habitats. Data were collected over the 16-year period (1989-1994). An average of 34 routes was completed per year, ranging from a high of 46 routes the first year to 14 in 2004. Of these, 46 routes contributed data for at least 5 years. Treating each stop as a point count, over 15,000 point counts were conducted at least 5 times from 1989 through 2004. Over 44,000 individual birds of 17 species were counted during the course of this survey. Grassland bird species were detected on 76% of points and an average number of birds per route varied from 10.6 to 144 birds per route across routes run at least 5 years. Routes in which reclaimed mine habitat was found are the top 7 routes in terms of bird counts, averaging 123 in contrast to 39 birds per route. Included in this total were detections of state-listed birds, including 10 short-eared owls, 5 sedge wrens, 66 upland sandpipers, and 69 dickcissels. Dickcissel, upland sandpiper, and ring-necked pheasants were reported at lower rates on routes containing mine habitat, but all other regularly detected species were found at significantly higher rates on routes with mine habitat. On agricultural routes, the most abundant species were the meadowlark (19 birds/route), bobolink (17 birds/route), and the savannah sparrow (15 birds/route). On mineland, savannah sparrow and meadowlark were more frequently reported and bobolink was the most abundant bird. For routes run at least 10 years, the number of grassland birds counted trended downward on 16 (67%, n=24) routes. The average trend for those routes was -0.86 birds per year. This trend was significant for ring-necked pheasant, killdeer, and field, grasshopper, and henslow's sparrows. Horned lark showed a significant increase on agricultural routes, the only species to be expanding, while on mine routes, horned lark was declining. Most mine routes had not been run the requisite 10 years for trend analysis. For most of these species there was a negative correlation between the relative abundance on the route and the slope, suggesting that routes supporting higher numbers of a given species were more likely to be in decline. The GBBS was successful in demonstrating the differences in abundance between selected agricultural and reclaimed mine habitats, and highlighting the importance of reclaimed mine habitats to grassland bird populations that has led to additional research and conservation, such as the purchase of the "Piney Tract", SGL 330. This survey has been more effective at detecting rare grassland birds than any other effort since the Breeding Bird Atlas, providing the key to successful listing of dickcissel as a state-endangered species in 2004.

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<sup>a</sup> Final report for Project 06750, Job 70002, October 2006.

## INTRODUCTION

The historical extent of grassland habitat in Pennsylvania is not known, but there is ample evidence that open habitat and native grasslands have been part of the landscape for thousands of years (Askins 2000, Bolgiano 2006). Native Americans maintained open areas for farming, villages, and enhanced hunting opportunities, many of which were maintained by fire. Bird populations associated with these aboriginal grasslands are unknown because most ornithological study was conducted following European settlement.

As European colonists settled Pennsylvania, they cleared additional land, and by the end of the 1800s only about 25% of Pennsylvania remained forested. Many grassland bird species adapted to newly created agricultural habitats and those that exploited these habitats expanded their ranges eastward with the felling of Eastern forests during the 19th Century (Askins 2000). Historically, Pennsylvania's small family farms situated within a forested landscape provided abundant and diverse wildlife habitat. The earliest ornithological records list grassland-associated birds apparently associated with these opened habitats. The upland sandpiper, for example, was included on Audubon's list of the Philadelphia area in the early 1800, and was called "abundant" by Baird (1845) in Cumberland County. The number of farms and amount of land devoted to farms peaked in 1900 when about two-thirds of Pennsylvania was farmland (McWilliams and Brauning 2000), creating extensive acreage for grassland-associated birds.

Several species, most notably the horned lark, Henslow's sparrow, and ring-necked pheasant, expanded into Pennsylvania's opened agricultural habitats during the late-19<sup>th</sup> Century. Before 1888 the horned lark was unknown as a breeding bird in Pennsylvania. The western race, the prairie horned lark (*A. a praticola*), was reported by Warren (1890) as a regular summer resident "in the region of Lake Erie" and "more or less established throughout the western and central parts of the state." Todd (1904) corroborated by describing it as one of the more common and characteristic birds of Presque Isle. The breeding range of this race was documented to undergo a dramatic expansion across eastern U.S. in the late 1800s and early 1900s in response to expanding agriculture (Beason 1995). Acceptable Pennsylvania breeding records of Henslow's Sparrow were first reported in 1913 in Huntingdon County (Harlow 1913). A small breeding group was located in Crawford County in 1922 by Sutton (1928b), including a nest with young. In subsequent decades, Henslow's were reported breeding in widely scattered locations across the state, although in only a few places where they found for more than a few years. Todd (1940) stated that, "the extremely local distribution and general inconspicuousness of this sparrow have created the impression that it is rare."

Since the early 1900s, the total number of farms and the land devoted to farming has declined. As settlers moved to better farming areas in the Midwest, many Pennsylvania farms were left to revert to forest. Both cropland and pastureland acreage have been reduced since the 1940s. The steepest decline in acreage occurred from the 1950s through late 1960s, a time when declines in farmland wildlife also were occurring. The loss of farmland habitat continues apace. Between 1982-1997 more than 420,000 acres of cropland were lost to development, while more than 767,000 acres of pasture were lost. These losses have been especially marked in southern Pennsylvania, where overall losses of agricultural land were estimated at as high as 37% in areas around Philadelphia between 1969 and 1992 (Goodrich et al. 2002). Losses of farmland continued through the 1990s.

The expansion and decline in agriculture in Pennsylvania brought concurrent changes in bird populations. In addition, mechanization of agricultural methods during the past 50 years and conversion of pastures and hayfields to row crops,

made much agricultural habitat unsuitable for native grassland species that had acclimated to this new habitat (Warner 1994). While greatly increasing farming efficiency and turning the U.S. into the breadbasket of the world, wildlife populations declines in grassland bird species observed today reflect those changing practices and the loss of agricultural areas to urban sprawl (Vickery et al. 1999).

Agricultural set-asides (e.g., CRP lands) provide reservoirs of grassland habitat that may help support remaining populations of some grassland bird species (Delisle and Savidge 1997, Koford 1999, Coppedge et al. 2001, Johnson and Igl 2001). In addition, reclaimed surface mines have inadvertently become a source of grassland bird habitat. Whitmore and Hall (1978) documented the presence of grassland birds on reclaimed surface mines 25 years ago, although the contribution of those populations was not recognized for many years. Recent studies have confirmed the existence of substantial grassland bird populations on reclaimed mines throughout the Midwest and Northeast, which indicates these habitats may be important for conserving many grassland species (Yahner and Rohrbaugh 1996, Bajema et al. 2001).

In the past 30 years, grassland bird communities have experienced the most consistent declines of any group of birds monitored by the U.S. Fish and Wildlife Service's Breeding Bird Survey (BBS). This national bird-monitoring network was established in 1966 with randomly distributed road-based point counts completed annually by volunteer birders. The BBS is the primary national bird-monitoring network, and it has effectively tracked changes in grassland bird populations. Fewer than 30% of the species on BBS routes show increasing populations nationally. Many North American grassland bird species continue to experience severe and consistent population declines during the past 30 years (Herkert 1994, Sauer et al. 1996). In fact, since 1966 the guild of grassland bird species had the lowest percentage of increasing species in the U.S. Breeding Bird Survey (Pardieck and Sauer 2000). Population trends in Pennsylvania range are all negative, from -0.5% to -12% annually (USFWS BBS web site).

For example, grasshopper sparrow (-7.2%), vesper sparrow (-5.6%), ring-necked pheasant (-5.4%) and eastern meadowlark (-6.4%) are all declining at alarming annual rates (BBS 1966-1999). Several listed species are grassland associates, including upland sandpiper and short-eared owl. Because of strong populations on reclaimed surface mines, Henslow's sparrow, has maintained its populations here in Pennsylvania whereas it is listed in most other states in which it occurs. In addition to Henslow's sparrow and upland sandpiper, Schneider and Pence (1992) identified northern harrier and sedge wren as non-game species of management concern in the Northeast.

Despite these challenges, agricultural habitats still are widely used by grassland birds in Pennsylvania. Since almost no native prairie exists in the state, grassland bird populations present occupy anthropogenic habitats. During the first Breeding Bird Atlas, the most widespread grassland associate (Eastern meadowlark), occupied as many as 73% of blocks. Most other grassland obligates were found in no more than 38% of blocks, and specialist such as Henslow's sparrow occupied only 9% of blocks. Results of the 2<sup>nd</sup> Breeding Bird Atlas are preliminary, but suggest that the long-term declines will be apparent in species' distributions (2<sup>nd</sup> BBA).

Reclaimed surface mines provide more than 2 million acres of non-agricultural grassland habitat within the Commonwealth (Yahner and Rohrbaugh 1996a). Though once considered wastelands created by resource extraction, these sites can provide quality habitat for grassland-associated species (Mattice, et al. 2004). The acidic, nutrient-poor soils of reclaimed sites provide little potential for agricultural or timber production, and grasses and legumes tend to be the most successful and persistent vegetation types. These relatively undisturbed fields have a slow rate of ecological plant succession and are ideal

for grasshopper sparrows, as well as compatible for many other grassland-associated birds (Bajema *et al.* 2001). Their suitability for grassland-associated species from other taxa (i.e., herptiles, invertebrates) has yet to be fully investigated.

While extensive mine lands continue to provide habitat for grassland birds, the older, grass-covered mines (from the 1970s-1980s) are now slowly converting to tree cover. Also, the 1977 Surface Mining and Reclamation Act required that the surface of mined sites be replaced in-kind with the cover-type that existed prior to mining (e.g., forest must be replaced with tree cover). Because trees were generally hard to establish in these sites and because poor soils inhibit succession, trees and shrubs remained sparse on most reclaimed mine sites. The large grassy habitat patches that grassland-associated species rely upon will slowly degrade over time. At the same time, new strip-mines will not replace succeeding grassland habitats at the rate they are experiencing succession. All of these factors contribute to declining grassland cover across Pennsylvania.

### **Focus on Henslow's Sparrow**

The national bird-conservation initiative, Partners in Flight, has identified grassland-nesting birds as a priority for conservation nationally and in the northeast. One of the highest-rated conservation priorities among passerines is the Henslow's sparrow. Pennsylvania has nearly 9% of the global population of Henslow's sparrows, and thus has high responsibility for their recovery (Mattice *et al.* 2004).

To address these declines, the Grassland Breeding Bird Survey (GBBS) was initiated during the last year of the first Breeding Bird Atlas in 1989 (Brauning 1992), and established a quantitative system of monitoring grassland species at scattered locations across the Commonwealth. This project complemented the U.S. Geological Survey's nation-wide Breeding Bird Survey (BBS) in that habitat information was collected as well as bird numbers, and routes were established in agricultural and reclaimed mine habitats in an effort to focus on grassland species.

### **METHODS**

The Grassland Breeding Bird Survey (GBBS) was modeled after the U.S. Fish and Wildlife Survey's Breeding Bird Survey (BBS) as a 3-minute point count separated by at least 0.5 mile. Each grassland route consisted of 30 3-minute stops. Stops were selected based on the presence of agricultural or grassland habitats. Routes were begun at 5:30 a.m., and were run once annually in June by a volunteer. At each stop the observer recorded, on prepared forms, the number of each grassland-associated bird species heard or seen within 0.25 miles. Table 1 provides a list of route completed for at least 5 years. Sky conditions, wind speed, and temperature were recorded at the beginning and end of each route. The data form is provided in Appendix A.

On a subsequent visit, primary habitat features were recorded as the percent of the area around each stop, in Anderson habitat categories. The percentage of land cover types was recorded at Anderson level 2. These are referred to herein as land cover habitats. For all agricultural and open land habitats (a combination of agricultural and 'old field' habitats) were further broken down by percentage at Anderson level 3 categories. These are herein referred to as detailed habitat types. In 1997, the data form was modified to identify reclaimed mine features of agricultural and old-field cover types. This enabled observers to distinguish open habitats generated by mining history from those established by agriculture. This difference was established in part to evaluate wide differences in abundance being reported by various observers. The

habitat form is provided in Appendix B.

Table 1. Number of years and average counted birds per route for grassland breeding bird survey routes, 1989-2004.

Route #	County	# Years	Years	Mine	Average birds per route
1-1-89	Adams	16	1989-2004		49.6
1-2-95	Adams	10	1995-2004		41.5
1-3-95	Adams	10	1995-2004		44.1
3-1-96	Armstrong	6	1996-2001	X	124.5
3-2-96	Armstrong	6	1996-2001	X	123.3
6-2-89	Berks	5	1989-1993		33.2
6-3-89	Berks	12	1989-2001		34.4
7-1-89	Blair	11	1989-1999		43.1
8-1-91	Bradford	12	1991-2004		50.8
9-1-89	Bucks	6	1989-1995		40.2
13-1-89	Carbon	9	1989-1999		10.6
13-2-89	Carbon	16	1989-2004		16.3
14-1-94	Centre	10	1994-2003		34.2
15-1-96	Chester	8	1996-2003		13.4
16-1-91	Clarion	9	1991-2004	X	120.9
16-1-97	Clarion	4	1997-2001	X	148.8
17-1-89	Clearfield	6	1989-1994		13.8
21-1-89	Cumberland	10	1989-1998		51.4
21-2-97	Cumberland	8	1997-2004		51.5
25-1-89	Erie	6	1989,90 1997-2000		33.8
26-1-89	Fayette	9	1989-1997		31.8
26-2-95	Fayette	10	1995-2004		42.4
27-1-95	Forest	9	1996-2004	X	106.4
30-1-89	Greene	16	1989-2004		51.3
32-2-90	Indiana	14	1990-2004	X	60.6
33-1-97	Jefferson	8	1997-2004	X	143.9
34-1-89	Juniata	5	1989-1994		56.0
34-1-94	Juniata	10	1995-2004		39.3
35-1-95	Lackawanna	9	1995-2003		67.0
37-1-89	Lawrence	14	1989-2003		22.3
40-1-95	Luzerne	9	1995-2003		64.7
44-1-90	Mifflin	10	1990-1999		38.0
47-1-96	Montour	6	1996-2002		37.8
48-3-89	Northampton	15	1989-2003		31.7
49-1-89	Northumberland	14	1989-2002		21.8
55-1-89	Snyder	10	1989-1998		35.2
56-1-89	Somerset	6	1989-1994		43.0
57-1-95	Sullivan	9	1995-2003		65.1
59-1-91	Tioga	9	1993-2002		28.1
60-1-89	Union	6	1989-1994		27.5
61-1-91	Venango	10	1991-2002		42.7
62-1-89	Warren	12	1989-2003		27.7
62-2-89	Warren	16	1989-2004		47.5
63-1-89	Washington	13	1989-2001		37.1

## **Survey establishment**

Volunteers established surveys locations and as a result, survey routes were not randomly distributed across the landscape. Volunteers were advised to place routes in agricultural landscapes and to pick stops that include agricultural habitats. This provides a stratified sampling of grassland bird populations that is designed to reflect populations in these open habitats and not for Pennsylvania as a whole. Location of all routes run at least 5 years is provided in Figure 1.

The GBBS differs significant from the USFWS BBS in several important respects. Volunteers completing this survey recorded only grassland birds seen or heard. Focusing on the shorter list of grassland-associated birds reduces the complexity of this survey in comparison to the federal BBS approach that includes all species. The stratification of route locations would be expected to result in detection rates of grassland birds much higher than the randomized BBS.

## **Analysis**

Tabular summaries of birds reported on the GBBS include both frequency data (numbers of stops detecting species) and relative abundance (numbers of individuals counted) for each species. The relative abundance of each species is presented both as the average number of birds per route and, for comparison with other point-count projects, the average number per stop. Relative abundance by route is reported based only on those routes reporting the species to compensate for differences among observers.

The numbers of birds counted on a route are influenced both by observers' ability and habitat characteristics. Observers contribute as much or more variability to point counts as does annual variation (Sauer et al. 1994). To remove that variability, only comparisons that involve the same individual on a given route over time were used to statistically assess population trends. Routes were assigned a new number and treated as a different route when a new observer completed the survey of an existing route.

Relative abundance of birds in reclaimed surface mine habitats was found in previous reports to be greatly different from routes without mined habitats (Brauning 1998), so this analysis of every aspect of grassland bird surveys compared with that on other grassland (agricultural and openland) habitats. Previous reports found significantly higher abundance on routes that included reclaimed mine habitat (Brauning 1998). For this reason, some analysis distinguish routes in which species tend to be more common.

Habitat sub-types that comprise grasslands were aggregated, including hay fields (habitats 1630, 1631 and 1632), old fields (1660 and 1910), reclaimed fields (all reclaimed types).

Declining grassland bird populations provided an important impetus for establishing the GBBS project. Only routes for which 5 or more years were completed are used herein for trend analysis and routes established on reclaimed mineland are analyzed separately from those in agricultural landscapes. Routes completed 10 or more years by the same individual are referred to as "long-term" routes. The slope of the line was calculated on the number of birds per year of each species using Excel's "slope" statistic. The number of routes with increasing and decreasing were computed and tested with chi-square against a uniform distribution.

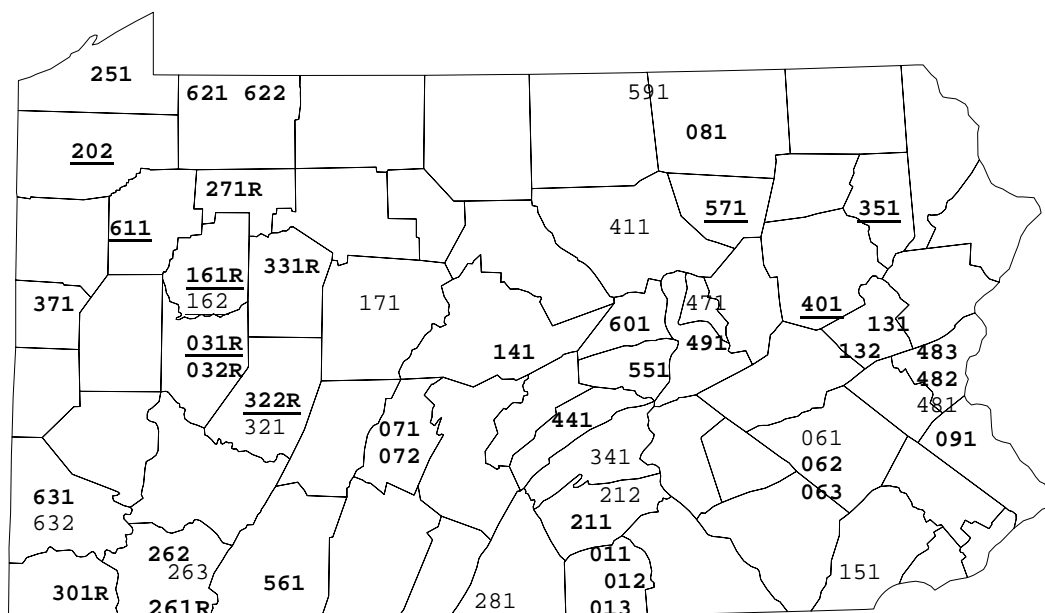


Figure 1. Location of grassland BBS routes completed between 1989 to 2004 for at least 5 years. Routes in bold type were included reported 10 or more years of bird and habitat data. Underlined routes have averaged over 100 birds per year and those ending in "R" support reclaimed mine habitat.

## RESULTS

### Summary

Bird and habitat data were collected as part of the Grassland Breeding Bird Survey (GBBS) over a 16-year period (1989-1994) on a total of 94 routes. An average of 34 routes was completed per year, ranging from a high of 46 routes the first year to 14 in 2004. Of these, 46 routes contributed data for at least 5 years. Treating each stop as a point count, over 15,000 point counts were conducted at least 5 times from 1989 through 2004.

Over 44,000 individual birds of 17 species were counted during the course of this survey. Grassland bird species were detected on 76% of those point counts with 5 years of coverage, for a total of 35,140 individual birds.

Average number of birds per route varied from 10.6 to 144 birds per route across routes run at least 5 years. Routes in which reclaimed mine habitat was found are the top 6 routes in terms of bird counts, resulting in significantly higher average birds per route (123) than routes without mine habitat (39) (Wilcoxon test,  $p=0.028$ ).

Included in this total were 10 short-eared owls, 5 sedge wrens, 66 upland sandpipers, and 69 dickcissels. This survey has been more effective at detecting rare grassland birds than any other effort since the Breeding Bird Atlas (Brauning 1992). In fact, dickcissels were largely unreported in the birding community (e.g., Brauning 1998) during these years while the Grassland BBS continue to document their presence. This documentation was key to successful listing of dickcissel as a state-endangered species in 2004.

On agricultural routes, the most abundant species were the meadowlark (19 birds/route), bobolink (17 birds/route), and the savannah sparrow (15

birds/route). On mineland, savannah sparrow and meadowlark were most frequently reported and bobolink was the most abundant bird.

Routes run at least 5 years produced widely ranging numbers of birds (Table 2). The average number of individuals counted ranged across a normal distribution up to about 150 birds per year on 39 routes, with 6 routes averaging over 250. This disparity has been associated with reclaimed surface mine habitats in previous reports (e.g., Brauning 1998), and this final assessment corroborates the strong influence of mine habitat on grassland bird numbers for most species. Dickcissel, upland sandpiper, and ring-necked pheasants were reported at lower rates on routes containing mine habitat, but all other regularly detected species were found at significantly higher rates (t-test,  $p < 0.05$ ).

### **Trends**

For routes run at least 10 years, the number of grassland birds counted trended downward on 16 (67%,  $n=24$ ) routes. The average trend for those routes was -0.86 birds per year.

The 10-year trends in abundance on agricultural routes were significantly downward for ring-necked pheasant, killdeer, and field, grasshopper, and henslow's sparrows (t-test,  $p < 0.05$ , Table 4). Horned lark showed a significant increase on agricultural routes, the only species to be expanding, while on mine routes, horned lark was declining (t-test,  $p = 0.008$ ). Most mine routes had not been run the requisite 10 years for trend analysis. For most of these species there was a negative correlation between the relative abundance on the route and the slope, suggesting that routes supporting higher numbers of a given species were more likely to be in decline.

Randomly established BBS routes, administered by the U.S. Fish and Wildlife Service, reported fewer birds, on average, than most GBBS routes because GBBS were selected to occur on grassland habitat. Detection rates of grassland birds on GBBS mineland routes were generally more than an order of magnitude higher than detection rates on BBS routes. Grassland-associated birds have been experiencing significant long-term trends in Pennsylvania and across the country based on these routes since. That decline continued for most of these species during this period that overlaps roughly with the GBBS (Bolgiano 2006; USFWS BBS 2006-web site).



Table 2. Average individuals per route and number of routes completed for Grassland Breeding Bird Surveys completed 5 or more times, 1989-2004 for each grassland-associated species. English names for species codes are provided in Table 3.

Route	N	Mine	Species																	
			174	210	224	263	284	455	565	625	795	814	816	819	825	827	828	853	857	
1189	16			7.2	0.1	5.9				3.4		0.3		3.8	8.8	8.1	15.9		2.3	15.9
1295	10			2.6	0.5	2.8				0.7	0.1	1.4		8.7	6.4	6.6	9.5	0.1	3.2	14.0
1395	10			1.7	0.6	7.4	0.2			1.1		0.9		10.4	2.5	2.2	9.8		4.5	26.1
3196	6	M	0.5	5.3	0.3	24.0	0.3			12.2				20.5	12.8	76.2	16.0	3.0	44.7	57.8
3296	6	M		4.0	1.2	31.7	0.2			10.7				17.3	12.7	91.2	27.2	5.8	25.5	64.0
6289	5			9.4		6.6				1.4				15.2	0.2	3.4	2.8			2.2
6389	12			9.6		13.0				0.3		0.2		8.6	0.9	3.9	4.2		0.9	9.2
7189	11		0.1	4.8		8.7				1.3		0.1		9.0	3.7	6.3	7.2	0.6	0.5	10.0
8191	12			0.3		4.9				0.1				7.1		10.1	3.2	0.7	32.0	20.5
9189	6			18.8	1.0	2.8				0.2				14.5	0.5	0.2	0.8		1.5	18.3
13189	9			0.1	0.2	4.8								4.9	0.7	0.9	1.7		1.4	1.6
13289	16			1.0		2.4								8.1	4.1	1.6	2.4			0.8
15196	6			0.1	0.6	3.4				2.6				4.1		1.3	3.1			5.9
17189	6			0.2	1.0	5.2				0.3				1.7		0.5			2.0	8.0
21189	10		0.3	3.6	0.1	9.3	0.1			9.2		0.2		2.9	10.7	3.8	12.2			19.7
21297	8			3.0	0.6	8.9				2.1		2.4		26.4	3.1	0.2	8.4	0.4	1.1	24.6
21992	10					2.2				4.0				6.2	5.2	2.2	14.8	0.6	2.4	5.4
25189	6			0.5	0.5	5.7				0.5		0.7		5.7	2.7	6.3	3.3	2.3	8.8	5.3
26189	9			4.8	0.1	4.1						0.1		6.9	0.3	2.7	3.8		0.1	15.3
26295	10			2.4		10.5						0.4		5.5		11.5	11.2		6.0	25.6
27195	9	M		0.8	0.2	26.3	0.8			14.3		0.2		12.2	10.9	84.6	11.8	2.2	72.9	38.2
30189	16			2.0	0.3	5.1								17.9	0.1	5.2	15.1	0.2	3.8	35.4
32189	15			2.3	1.3	4.0								15.3	0.8	5.3	5.3			4.3
32290	15	M	0.2	4.7	0.2	7.6				1.5				18.0	3.7	9.8	10.1	9.2	2.9	26.2
33197	8	M	0.6	1.9	0.9	14.4	0.3	0.1		10.9		0.1	0.2	28.3	10.0	79.5	34.8	28.8	91.0	90.0
34189	6			6.0	1.0	19.0				1.2				14.8	2.4	2.0	6.0		0.4	21.0
34194	10			5.6		15.4				0.8				14.7	6.0	1.7	4.2			12.2
35195	9			2.0	0.1	12.7				3.6				7.1	4.8	21.2	1.0		51.8	32.0
36189	6			9.0	3.5	4.5								19.5			1.5			7.5
37189	14			3.7	0.1	4.8	0.5			0.4				1.5	0.1	14.4	0.6	0.1	5.3	2.2
40195	9		0.1	3.2		20.8				3.3				13.0	9.3	14.3	3.6	0.1	18.4	24.3

Table 2 cont. Average individuals per route and number of routes completed for Grassland Breeding Bird Surveys completed 5 or more times, 1989-2004 for each grassland-associated species. English names for species codes are provided in Table 3.

Route	N	Mine	Species																
			174	210	224	263	284	455	565	625	795	814	816	819	825	827	828	853	857
41494	10		0.1	0.7		5.9			2.3			4.1	2.6	20.0	9.0			1.9	6.2
44190	10		0.1	0.5	0.2	7.8			1.9		0.1	3.8	6.2	6.4	7.3	0.1	0.1		11.9
47196	6			3.0	0.3	12.0			1.5			12.7	5.2	7.3	1.2			4.2	3.7
48389	15			3.9	0.2	6.8			0.7			12.6	4.3	0.3	3.9			13.3	8.0
49189	14		0.1	2.4		2.4			0.1		0.1	27.6			2.4			5.6	1.2
55189	10			2.6	0.8	7.3	0.2		0.4			7.1	11.4	2.2	5.6	0.4	0.3		3.3
56190	6			6.5	0.3	2.7						13.7		7.7	7.2			13.3	17.0
57195	8		0.3	0.8		7.3						13.6		16.4	2.2	0.9	67.7		20.0
59191	9			0.3		3.3			0.2			8.2	0.1	7.0	1.3	0.1	19.0		9.3
60189	6			0.2	0.3	7.2			1.2			7.7	3.8	5.8	4.0				4.2
61191	10		1.8	0.9	0.3	5.1	0.4	0.1	2.2			1.4	22.0	17.2	40.6	46.9	27.0	50.9	48.3
61191	10					9.9			1.4			3.3	0.6	10.4	2.5	1.4	31.9		21.9
62189	9			0.8	0.2	1.9					0.3	9.0	2.0	5.6	1.4			5.0	7.3
63189	9			2.5	0.1	5.5			0.3			15.5		9.2	9.8	0.1	4.8		17.4
63289	10			13.3	1.0	33.7			1.0			47.3	28.3	23.7	34.7	11.0	1.0		62.0

Table 3. Average and total number of individuals and number of routes for all routes and for mine Grassland Breeding Bird Surveys routes reporting the species run 5 or more times between 1989-2004.

Species Code	English Name	# of Routes	Average birds per route	Range	Ave for mine rts	Sum of records
174	Northern harrier	9	0.5	0.09-2.1	1.1	41
210	Ring-necked pheasant	42	3.2	0.1-18.8	2.9	1261
263	Killdeer	45	8.8	1.9-31.7	17.8	3585
284	Upland sandpiper	11	0.3	0.1-0.8	0	31
455	Short-eared owl	2	0.3	0.1-0.6	0.6	7
565	Horned lark	37	2.8	0.08-14.3	8.2	861
625	Sedge wren	1	0.2			1
795	Dickcissel	15	0.5	0.08-2.4	0.3	69
816	Field sparrow	45	11.6	1.5-50.3	23.2	4793
819	Vesper sparrow	36	5.4	0.07-19.1	12.1	1697
825	Savannah sparrow	44	15.2	0.2-91.2	12.1	5720
827	Grasshopper sparrow	44	9.0	0.4-69.3	27.8	3556
828	Henslow's sparrow	22	4.5	0.08-34.1	15.0	889
853	Bobolink	39	17.6	0.1-91.0	49.9	6142
857	Eastern meadowlark	45	19.9	1.2-90.0	53.3	7901

Table 4. Number of routes, proportion of routes declining, and average trend for species reported on Grassland Breeding Bird Surveys run 10 or more times between 1989-2004 not including those with reclaimed mine habitat, significance against 0 with a t-test ( $p < 0.05$ ) marked with "\*".

Species	Number Routes	Proportion declining (%)	Average trend (birds/route)	t-test (t, p)
Ring-necked pheasant	20	80	-0.36*	-0.35, 0.003
Killdeer	22	48	-0.09*	-2.47, 0.023
Horned lark	16	25	0.13*	2.27, 0.038
Field sparrow	19	74	-0.27*	-3.46, 0.002
Vesper sparrow	15	53	-0.03	-0.24, 0.813
Savannah sparrow	19	53	0.00	0, 1.000
Grasshopper sparrow	20	70	-0.32*	-2.98, 0.008
Henslow's sparrow	7	100	-0.13*	-2.94, 0.026
Bobolink	18	61	-0.25	-1.88, 0.077
Eastern meadowlark	21	62	-0.21	-1.14, 0.269

### Habitat

Habitat was collected on 64 routes for a total of 228 times. Agricultural cover types were the most frequently reported category, making up 58% of the estimated cover of all stops. Of agricultural types, row crop was the most widespread type and 'other hay' was next (Table 5). Grassland cover about 42% of all stops surveyed. Of these routes, just 8 routes provided habitat data 9 or more times. Trends of grassland cover evaluated using this sub-set. Grassland cover actually increased at more stops than it decreased ( $t=6.2$ ,  $p < 0.01$ ).

Table 5. Count and average percentage cover of habitat categories reported on stops of Grassland Breeding Bird Surveys completed 1989-2004, with habitat sub-types representing grassland cover identified with a "\*."

Habitat Code	Habitat Type	Count on stops	Ave. % Cover
10	Urban, Suburban - Residential	319	0.9
11	Urban, Suburban - Non- Residential	81	0.2
12	Rural - Residential	4702	7.6
13	Rural - Commercial	461	0.9
14	Hardtop road right-of-way	623	0.6
15	Utility rights-of-way	156	0.4
16	Agricultural	8137	58.5
16R	Agricultural - Mine	176	0.9
17	Agricultural-Orchard	271	0.9
18	Agricultural - Other	98	0.4
19	Openland, herbaceous	1937	7.9
19R	Openland - Mine	273	1.6
20	Openland - Transitional	1222	2.8
21	Forest Transitional	1351	2.8
22	Forest - Deciduous	4238	9.0
23	Forest - Evergreen	206	0.4
24	Forest Mixed	622	1.2
	Other		1.3
	Other mine		0.8
Sub-types			
1610	Small Grain	2062	5.3
1620	Row crops	4738	17.1
1630	Alfalfa*	1390	4.2
1631	Timothy and red clover*	1172	3.8
1632	Other hay*	3769	13.9
1640	Pasture*	2553	8.3
1650	Plowed soil	713	1.7
1660	Fallow field*	1402	3.6
1910	Old field, perennials*	1375	4.3
1920	Old field, brambles	952	2.0
	Mine		2.1

## DISCUSSION

Grassland BBS routes were established in an attempt to document trends of a group of species that were widely recognized to be facing the most broad-based and severe declines of any group in North America. The incorporation of habitat assessment with the bird surveys was an innovative feature at its time. The fact that routes were located non-randomly weakens the ability to interpret these results beyond the locations selected. The resulting increase of grassland cover types and failure to document the significant declining trends in grassland bird populations are likely explained by the picking of routes in prime grassland areas. These patterns are not bourn out in other bird population surveys or agricultural statistics. In fact the association with declining bird numbers and agricultural habitats in central and eastern U.S. has been well documented (Murphy 2003).

The GBBS was successful in demonstrating the differences in abundance between selected agricultural and reclaimed mine habitats. In addition, the survey provided long-term documentation of populations of dickcissels that provided support for the listing of this species as Endangered by the Pennsylvania Game Commission.

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Appendix A.

GRASSLAND BREEDING BIRD DATA FORM

Observer:		Route #:												
STOP Number	Ring- necked Pheasant	Northern Bobwhite	Upland Sand- piper	Horned Lark	Dick- cissel	Field Sparrow	Vesper Sparrow	Savannah Sparrow	Grass- hopper Sparrow	Henslow Sparrow	Bobolink	Eastern Meadow- lark	Kill- deer	Other*
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
Total														
# Stops														

\* Other grassland associated species (e.g., northern harrier, short-eared owl, sedge wren) may be written in here.

Appendix B.

**GRASSLAND BREEDING BIRD SURVEY HABITAT FORM**  
**PGC Form GBS-2**

Estimate the percentage (to nearest 10%) of the common habitat and field types within ¼ mile (400 m) radius around each survey stop. Unless accompanied by an assistant, DO NOT survey breeding birds and habitat at the same time. Generally habitat can be described after 9AM (on the way back home) or on another day. NOTE: It is important that bird survey and habitat stops coincide exactly.

C O D E	HABITAT TYPE	STOP NUMBER											
		_1	_2	_3	_4	_5	_6	_7	_8	_9	_0	Total	
00	<b>NO DIFFERENT HABITAT</b> < 150 Ft of Stop												
10	<b>URBAN, SUBURBAN</b> - Primarily residential												
11	<b>URBAN, SUBURBAN</b> - Not residential												
12	<b>RURAL</b> – Residential including out-buildings												
13	<b>RURAL</b> – Other buildings, e.g. commercial prop.												
14	<b>HARDTOP RIGHTS OF WAY</b>												
15	<b>UTILITY RIGHTS OF WAY</b>												
16	<b>AGRICULTURAL</b> - Cropland / pasture	<b>Not Mined</b>											
		<b>Reclaimed</b>											
17	<b>AGRICULTURAL</b> - Orchard, nursery, or Christmas trees	<b>Not Mined</b>											
		<b>Reclaimed</b>											
18	<b>AGRICULTURAL</b> - Other ag. Uses	<b>Not Mined</b>											
		<b>Reclaimed</b>											
19	<b>OPENLAND</b> - Nonpasture, herbaceous openland; mainly herbs & grasses, < 1/3 area in shrubs/ brush	<b>Not mined</b>											
		<b>Reclaimed</b>											
20	<b>OPENLAND TRANSITIONAL</b> - As above, but 1/3 to 2/3 of area covered with shrubs and brush	<b>Not Mined</b>											
		<b>Reclaimed</b>											
21	<b>FOREST TRANSITIONAL</b> Mainly > 2/3 of area in brush, some trees, mostly < 4" dbh*; a reverting field or second growth.	<b>Not Mined</b>											
		<b>Reclaimed</b>											
22	<b>FOREST 90%+ DECIDUOUS TREES</b> - Trees mainly over 4" dbh*												
23	<b>FOREST 90%+ EVERGREEN TREES</b> –Trees mainly over 4" dbh*												
24	<b>FOREST MIXED</b> - Neither deciduous nor evergreen trees comprise 90% of stand												

\* dbh = diameter at breast height



