Where the Bobolinks Roam: The Plight of North America's Grassland Birds

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Abstract. Grassland birds, in this study defined as species that are wholly or mostly dependent upon upland grasslands for their survival, have experienced the most pronounced declines of any other group of birds on the North American continent, and the declines appear to be continuing unabated. Widespread declines of farmland birds are also occurring in Great Britain and western Europe, largely due to the intensification of agricultural operations. Habitat loss has been the major driving force for declines of grassland birds up until the last 50 years when the intensification of mechanized agricultural operations, along with increased habitat fragmentation that is associated with larger "industrial" farm sizes, became strong factors. Other threats to grassland birds come from invasive species and planting of exotic grasses, urbanization, residential development, oil and gas extraction, wind power development, excessive predation/parasitism, fire suppression that results in succession to shrubland, ground water depletion, development of transportation corridors, use of pesticides, and rodent eradication programs. No single management approach or conservation solution will benefit the entire suite of grassland bird species across large geographic regions. Just stabilizing populations of grassland birds at their present levels presents a huge conservation challenge.

INTRODUCTION

Fuelled by concern about the loss of forested habitat in Latin America and the Caribbean, a tremendous amount of conservation attention and research has focused on neotropical migrant landbirds, particularly forest-dependent species (e.g. Hagan & Johnson 1992; Finch and Stangel 1993). It is now increasingly recognized that much more alarming population declines are taking place for grassland birds, the majority of which are short-distance, temperate migrants. Indeed, it can be argued that the conservation and research needs of the temperate migrant and grassland species groups are even more urgent than forest-dependent, neotropical migrants (Murphy 2003). (See Figures 1a and 1b.)

Grassland birds in North America have experienced the most pronounced declines of any group of birds on the continent, and the declines appear to be continuing unabated (Vickery *et al*. 1999; Blancher 2003; Murphy 2003; Sauer *et al.* 2005). Moreover, this is not just a North American phenomenon. Widespread declines of farmland birds are also occurring in Great Britain and western Europe, largely due to the intensification of agricultural operations (e.g. Fuller *et al.* 1995; Peterjohn 2003).

Native grassland habitats are the largest and most threatened ecosystems in North America (Blancher 2003; CEC and TNC 2005). While human-modified agricultural grassland habitats (pastures, hayfields, fallow land) replaced native prairies to some extent and somewhat buffered population declines of grassland birds (Vickery *et al.* 1999), they too are now undergoing significant decline.

HOW EXTENSIVE ARE THE DECLINES?

For the purposes of this article, grassland birds are defined as species that are wholly or mostly dependent upon upland grasslands for their survival. It does not include species that rely mostly on wet grassy marshes or open, scrubby grassland habitats for nesting (e.g. waterfowl, rails, Wilson's Snipe, American Kestrel, Loggerhead Shrike, Common Yellowthroat, Red-winged Blackbird, Field Sparrow, Nelson's Sharp-tailed Sparrow), though many of these species are also in decline (see Sauer *et al.* 2005).

Initiated in 1966, the North American Breeding Bird Survey (BBS) provides the best available information on the state of most grassland birds breeding in the U.S. and Canada (Peterjohn 2003). Of 37 species of grassland birds that appear to be reasonably well monitored by the BBS, 32 are demonstrating some form of decline, while only 5 are experiencing some form of increase (Sauer *et al.* 2005; Tables 1 and 2).

WHAT IS CAUSING THE DECLINES?

Vickery and Herkert (2001) noted that grassland bird declines have prompted a lot of recent research into the possible causes. Some things can be largely ruled out. For example, the declines are occurring regardless of migration strategy. The vast majority of grassland birds are short-distance, temperate migrants that generally winter no farther south than the southern U.S. and northern Mexico (Vickery *et al*. 1999; Blancher 2003). Several species (especially upland game birds) are non-migratory. Only three declining species (Swainson's Hawk, Dickcissel, and

Table 1. Summary of upland grassland bird population changes in North America, based upon Breeding Bird Survey results from 1966-2004 (Sauer *et al.* 2005).

Total number of upland grassland species	37
Proportion of species with positive trend estimates (proportion with significant positive trends)	13.5% (8.1%)
Proportion of species with negative trend estimates (proportion with significant negative trends)	86.5% (67.6%)

Table 2. Annual average percent population change of upland grassland birds in North America, based upon Breeding Bird Survey results for the period 1966-2004 (from Sauer *et al.* 2005).

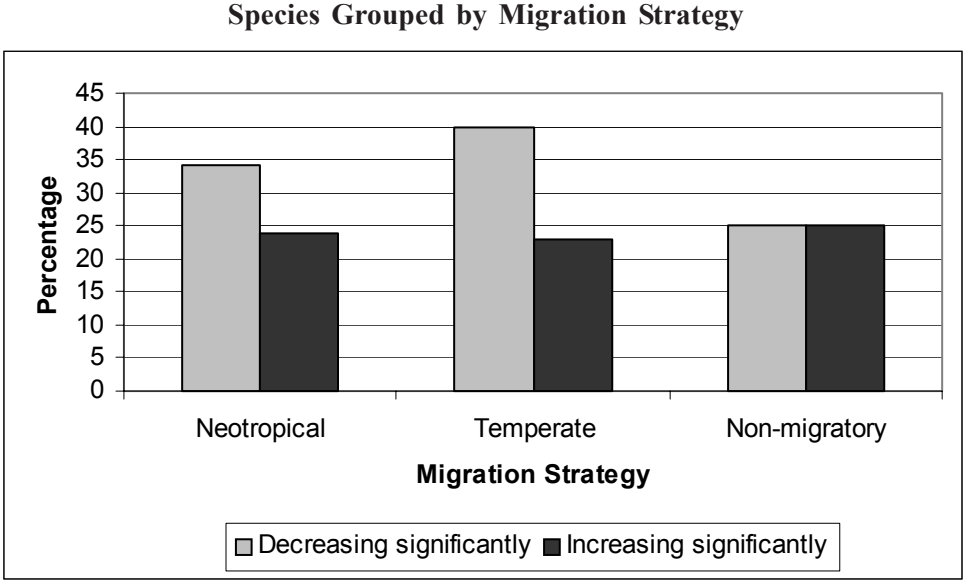
Species	Mean Annual Trend (%)	P Value1	Sample Size
DECLINING SPECIES			
Northern Harrier	-1.3	***	1043
Swainson's Hawk	-0.5	ns	706
Ring-necked Pheasant	-0.9	***	1351
Sharp-tailed Grouse	-0.7	ns	161
Greater Prairie-Chicken	-6.1	**	46
Northern Bobwhite	-3.0	***	1589
Killdeer	-0.5	***	3414
Mountain Plover	-2.7	**	43
Long-billed Curlew	-1.6	*	257
Marbled Godwit	-1.0	ns	222
Common Barn-Owl	-1.3	ns	39
Burrowing Owl	-2.3	ns	320
Short-eared Owl	-4.8	**	161
Horned Lark	-2.2	***	2026
Sprague's Pipit	-4.4	***	150
Cassin's Sparrow	-2.2	***	245
Clay-colored Sparrow	-1.2	***	508
Brewer's Sparrow	-2.8	***	491
Vesper Sparrow	-1.1	***	1683
Lark Sparrow	-2.5	***	1128
Lark Bunting	-1.4	***	376
Savannah Sparrow	-0.8	***	1688
Grasshopper Sparrow	-3.8	***	1596
Baird's Sparrow	-3.9	***	138
Henslow's Sparrow	-8.7	***	174
Le Conte's Sparrow	-0.5	ns	199
McCowan's Longspur	-2.8	ns	71
Chestnut-collared Longspur	-2.7	***	156
Dickcissel	-0.9	*	931
Bobolink	-1.7	***	1243
Eastern Meadowlark	-2.9	***	2125
Western Meadowlark	-0.9	***	1650
INCREASING SPECIES			
Ferruginous Hawk	+2.2	*	243
Gray Partridge	+0.1	ns	265
Sage Grouse	+1.0	ns	75
Upland Sandpiper	+0.7	*	637
Sedge Wren	+1.9	***	386

[1] ns = non-significant change (p>0.1); * = p<0.1; ** = p<0.05; *** =p<0.01

Bobolink) are neotropical migrants. Upland Sandpiper, the fourth neotropical migrant in the group, is increasing. It is clear that the declines of grassland birds are being driven primarily by factors originating from within Canada and the U.S.

Likewise, most grassland birds are diurnal migrants. Unlike nocturnal migrants, they are not exposed to unnaturally large mortality events associated with collision with tall structures (communications towers, sky scrapers, lighthouses).

North American grassland ecosystems have been under intense pressure from human disturbances since the 1800s. Massive amounts of native grassland have been lost, degraded, and fragmented as a result of conversion to intensive agricultural systems and overgrazing from livestock (e.g. Vickery *et al.* 1999). While there is little doubt that habitat loss was the major driving force underpinning declines of grassland birds up until at least the mid 1900s, more recent population declines may be more strongly related to the intensification of mechanized



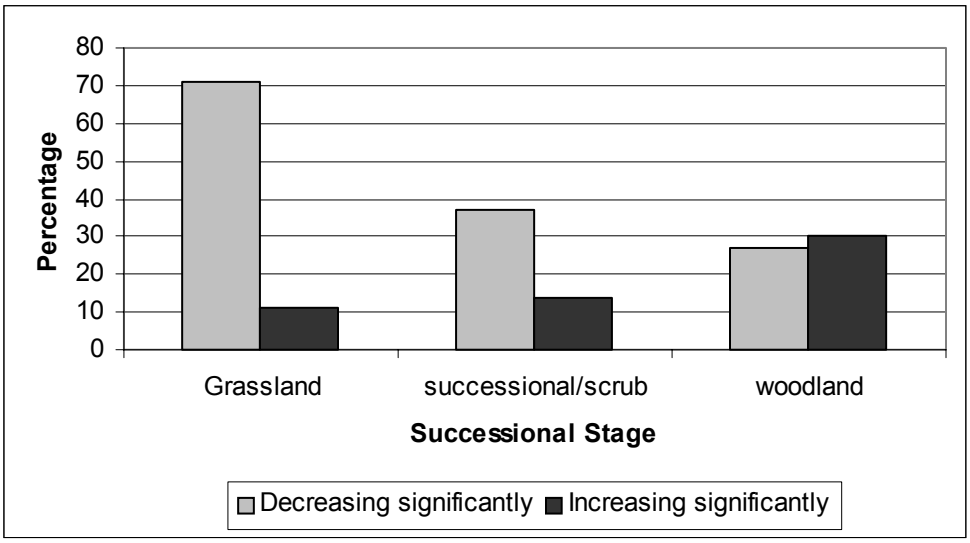


Figure 1. Proportion of species that show long-term, statistically-significant population trends in North America, based upon Breeding Bird Survey results from 1966-2004 (from Sauer *et al.* 2005).

agricultural operations, along with increased habitat fragmentation that is associated with larger "industrial" farm size (Murphy 2003; Peterjohn 2003). Anthropogenic grasslands also suffer from rapid natural succession on abandoned farmland, along with a variety of farm practices that directly reduce reproductive output and survivorship of grassland birds (e.g. hay-cutting and tilling operations). Other threats to grassland birds come from invasive species and planting of exotic grasses, urbanization, residential development, oil and gas extraction, wind power development, excessive predation/parasitism, fire suppression that results in succession to shrubland, ground water depletion, development of transportation corridors, use of pesticides, and rodent eradication programs (Vickery *et al.* 1999; Gauthier *et al.* 2003; CEC and TNC 2005). Major causes of the decline of grassland birds are summarized below.

1. Changes in Habitat Supply and Quality

Grassland birds are habitat specialists, requiring grasslands year round – during migration and on the breeding and wintering grounds. Such habitat specificity makes their populations vulnerable to habitat loss and degradation at each stage of their annual life cycle. Not surprisingly, the primary cause of declines of grassland birds is related to declines in habitat supply and quality, primarily due to the expansion and intensification of agriculture.

As much as 52% of the total land area of the contiguous 48 states and 11% of Canada is now farmed (Rodenhouse *et al.* 1993). In central North America, tall grass prairie has

been reduced to 1%, while mixed-grass and short-grass prairie have been reduced to 20-30% of their former extents (Gauthier *et al.* 2003). Together, these losses exceed those of any other major ecosystem on the continent. Grassland losses have not been restricted to the vast central prairies. For example, over 99.5% of native prairie and savannah habitat has been destroyed in southern Ontario (Bakowsky and Riley 1994).

Even at small regional scales, monitoring the amount of native and anthropogenic grassland is not very precise, because it is imperfectly reported in agricultural statistics and because the various types of grassland are not well-classified by remote imagery. The amount of grassland habitat in eastern North America is inversely related to the amount of regional forest cover (Norment 2002), but this is only a coarse relationship, since non-forested agricultural lands do not necessarily proportionally reflect the amount of grassland. For example, the total amount of agricultural land under cultivation in Canada increased by 14% during the period 1951 to 2001, entirely due to a large (45%) increase in the extent of cropland (Statistics Canada 2005). Conversely, the amount of summer fallow (cultivated grassland) declined by 48% during the same period.

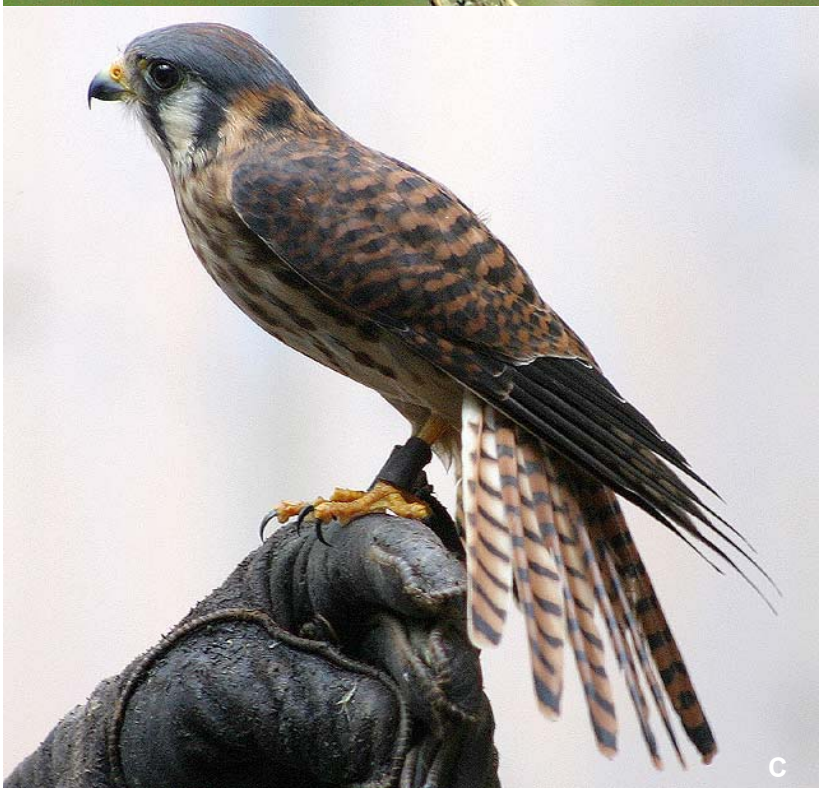
In terms of habitat quality, cropland diversity in North America has decreased since the 1930s, as small fields, which formerly produced a variety of crops (including pasture, hay, and small grains) have given way to large monocultures that have relatively little benefit to grassland birds (Best 1986; Rodenhouse *et al.* 1993). Even the composition of hayfields has changed. For example, Bollinger and Gavin (1992) attributed Bobolink declines not only to a large decline in the overall acreage of hayfields, but to a dramatic shift away from timothy and timothy/clover mixtures (favoured by Bobolinks) to alfalfa (much less favoured).

Area Sensitivity and Sensitivity to Fragmentation*:* Over half of the species in Table 2 are sensitive to the size of grassland habitats (Bollinger and Gavin 1992; Herkert *et al.* 1993; Vickery *et al.* 1994; Bollinger 1995; Johnson and Igl 2001; Bakker *et al.* 2002; Bollinger and Gavin 2004). Because area sensitivity varies among species along a continuum, and is apt to vary regionally, the "optimal" size of a grassland cannot be determined. Even so, small grasslands less than 10 ha (especially if they are linear) are of little benefit to grassland species of conservation concern. Vickery *et al.* (1994) suggested that grasslands need to be at least 100 ha in size in order to support a diverse grassland bird community, while Herkert *et al.* (2003) recommended that protection and restoration efforts were best placed on grasslands that are at least 1000 ha. Grasslands greater than 100 ha are increasingly difficult to find, especially in the east.

The degree of area-sensitivity is likely modified by landscape attributes related to the number, size, and interspersion of habitat patches (e.g. Bakker *et al.* 2002). In part due to high rates of nest predation, grassland birds respond negatively to such fragmentation effects (e.g. Herkert *et al.* 1993; Herkert *et al.* 2003; Bollinger and Gavin 2004; Renfrew *et al.* 2005).

A, Grassland (© John Davidson, Ottawa, Canada); B, Killdeer (© John Davidson); C, Common Barn-Owl (© John Davidson).

Hayfield Age: Bollinger (1995) found that breeding bird composition changes with age of hayfield. For Bobolinks,



hayfields that are at least 8 years old are preferred (Bollinger and Gavin 1992). Because of a shift towards much shorter rotational times, older hayfields are now much less common features in the agricultural landscape than they once were.

Natural Succession: Marginal farmlands that are abandoned become habitat for grassland birds for a decade or so, but then quickly succeed into shrubland and secondary forest. This has been a major factor in the recent decline of grassland birds in the east. For example, in Québec, massive abandonment of farmland on poor soils resulted in an initial pulse of old field habitat after World War II, but most of it subsequently reverted to second-growth forest (Desponts 1996). Natural succession is also a common problem in native prairie systems because of fire suppression.

Overgrazing of Rangeland: Bock *et al.* (1993) noted that several species of grassland birds respond negatively to intensive cattle grazing (e.g. Northern Harrier, Short-eared Owl, Cassin's Sparrow, Savannah Sparrow, Baird's Sparrow, and Henslow's Sparrow). Vast expanses of rangeland include about 1.5 million ha of National Grasslands in the U.S. that are managed primarily for livestock production.

2. Productivity and Survivorship Issues Associated with Ground Nesting

An important trait shared by grassland-dependent birds is that nearly all of them nest on the ground. Only 4 of 37 species listed in Table 2 (e.g. Swainson's Hawk) nest above ground. An examination of population trends of forest-dwelling species that also nest on the ground shows that they too exhibit declining trends (Table 3). Indeed, as a group, species that nest on or close to the ground show much greater declines than species that nest in tall shrubs and trees (see Figure 2).

Ground nesting habits make nests, incubating females, and fledglings particularly vulnerable to mammalian predation (e.g. Johnson and Temple 1990; Rodenhouse et al. 1993; Pietz and Granfors 2000; Renfrew and Ribic 2003; Renfrew et al. 2005). Johnson and Temple (1990) noted that there has been a general increase in populations of mammalian nest predators (notably raccoon and red fox).

Likewise, ground nesting birds are also highly susceptible to destruction by farm machinery. Agricultural practices that destroy nests, fledglings, and incubating females in fields include primary tillage, disking, cultivation, rotary hoeing, chemical applications, and the progression towards earlier and more frequent mowing of hay crops (Hurley and Franks 1976; Best 1986; Warner and Etter 1989; Frawley and Best 1991; Bollinger and Gavin 1992; Rodenhouse *et al. 1993;* Bollinger 1995; Dale *et al.* 1997).

For the reasons given above, breeding productivity is particularly low in intensively managed hayfields and

A, Savannah Sparrow (© Ann Cook, Winnipeg Beach, Canada, http://www.birdsofmanitoba.com); B, Bobolink (© John Davidson); C, American Kestral (female) (© John Davidson).

Table 3. Average annual population trends of forest and shrubland species that nest on the ground. Only species having statistically significant trends are listed.

Species	Mean Annual Trend (%)	P Value1	Sample Size (No. of routes)
DECLINING SPECIES			
Ruffed Grouse	-2.4	***	573
Common Nighthawk	-1.5	***	1644
Whip-poor-will	-2.3	***	482
Chuck-wills-widow	-1.7	***	583
Veery	-1.4	***	1072
Brown Thrasher	-1.2	***	2283
Kentucky Warbler	-1.0	***	740
Mourning Warbler	-1.2	***	575
Wilson's Warbler	-1.6	***	545
Eastern Towhee	-1.7	***	1670
Canyon Towhee	-1.6	**	110
White-crowned Sparrow	-1.3	*	320
White-throated Sparrow	-0.7	***	731
Dark-eyed Junco	-1.5	***	1150
Field Sparrow	-3.0	***	1769
INCREASING SPECIES			
Ovenbird	+0.5	***	1456

* = p<0.1; ** = p<0.05; *** =p<0.01

rowcrops, and it is suggested that such habitats probably represent population "sinks" (Bollinger and Gavin 1992; Rodenhouse *et al.* 1993).

3. CHANGES IN FOOD SUPPLY

It is quite possible that food supply and/or food quality is a limiting factor. Most species of grassland landbirds are dependent on insects during the breeding season. Agricultural practices often reduce invertebrate abundance and diversity (reviewed by Rodenhouse et al. 1993). In addition, some species (e.g. Burrowing Owl and Northern Harrier) are small mammal specialists. Ongoing attempts to eradicate small mammals have likely impacted the food supply of raptors (Gauthier *et al.* 2003). Eradication programs have been surprisingly successful. For example, the prairie dog now occupies only about 2% of its original range (Vickery *et al.* 1999).

4. THE IMPACT OF TOXINS

Forsyth (1991) and Rodenhouse *et al.* (1993) believed that pesticides have widespread impacts, though incompletely understood and documented, on a large number of grassland bird species. Bird populations can be impacted directly through increased mortality, as well as indirectly through decreased reproductive success and decreased food availability. Widespread use of insecticides has resulted in numerous avian die-offs (e.g. Gard *et al.* 1993; Mineau 1993). While all grassland birds are likely affected by

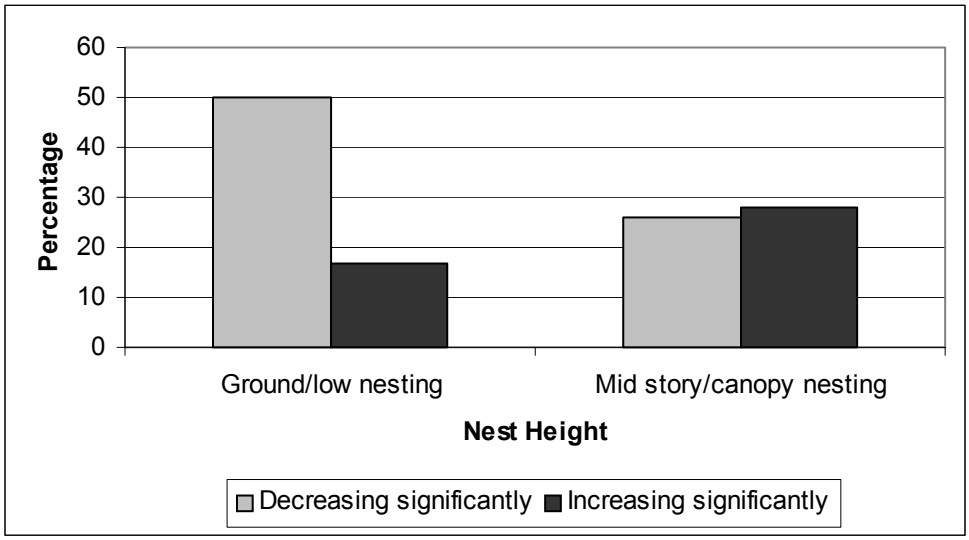


Figure 2. Proportion of species that show long-term, statistically-significant population trends in North America, based upon Breeding Bird Survey results from 1966-2004. Species are grouped by nest height.

A, Dark-eyed Junco, a ground-nester (© John Davidson); B, White-throated Sparrow (© Ann Cook); C, Ruffed Grouse (© Ann Cook).

toxins, some species suffer more than others. For example, until very recently, very large numbers of Swainson's Hawks in Argentina were being poisoned inadvertently by farmers who were using a highly toxic pesticide to control grasshoppers (Goldstein *et al.* 1996). Likewise, Dickcissel populations have been impacted by deliberate, large-scale eradication campaigns conducted by rice and sorghum farmers on their wintering grounds in Venezuela (Basili and Temple 1999).

5. Impacts from Hunting

Hunting does not appear to be a major factor responsible for recent declines of grassland birds, although unrestricted hunting of upland game species undoubtedly played a role before the introduction of modern bag limits. Nevertheless, hunting could still be an important added stressor on regional populations of some species like Northern Bobwhite (Brennan 1991).

THE CONSERVATION CHALLENGE

East versus West:

Through the 1800s and early 1900s, massive acreages of native grasslands in central North America were converted into agricultural systems, and grassland birds declined accordingly. During the same period, clearing of the eastern deciduous forest for agriculture and building materials resulted in the creation of large areas of pastureland and hay fields. In the East, these landscape changes in turn resulted in increased populations and/or range extensions of several species of grassland birds, including Bobolink, Horned Lark, Eastern Meadowlark, Grasshopper Sparrow, Savannah Sparrow, and Dickcissel (e.g. Hurley and Franks 1976), perhaps fuelled by displacement of birds from the West. For a while at least, population declines of several grassland bird species in the West were buffered to some extent by concomitant increases in the East.

As modern farming methods intensified in the mid 1900s, grassland birds in both the West and the East were increasingly challenged. Meanwhile, large acreages of marginal farmland in the East began to be retired from agricultural production. Much of the abandoned lands became old grassy fields, but then quickly reverted to secondary-growth forest.

Because grassland species in the East initially benefited from removal of the forests, it could be argued that their populations are now more-or-less simply returning to their former natural levels and that they merit relatively little conservation attention. Norment (2002) cautioned that maintaining or enhancing grasslands in the East will face large, long-term costs associated with keeping natural succession in check, and that such programs may divert scarce resources from other, potentially more important, conservation efforts in the region. Nevertheless, owing to the on-going severity of population declines in the West, it must be acknowledged that eastern populations of grassland birds are important to the maintenance of continental populations.

Current Conservation Programs:

Although the great bulk of native grasslands in central North America (about 85%) occurs within the U.S., most of the protected native grasslands currently occur in Canada (about 15% versus <2% in the U.S. and Mexico; see Table 4). Overall, only about 3% of native/natural grasslands in

A, Marbled Godwit (© Ethan Meleg, www.ethanmeleg.com); B, Savannah Sparrow (© Ethan Meleg, www.ethanmeleg.com); C, Upland Sandpiper (© Ethan Meleg, www.ethanmeleg.com); D, Veery (© Ethan Meleg, www.ethanmeleg.com); E, Wilson's Warbler (© Ethan Meleg, www.ethanmeleg.com); F, Burrowing Owl (© Ethan Meleg, www.ethanmeleg.com).

central North America are currently in protected areas.

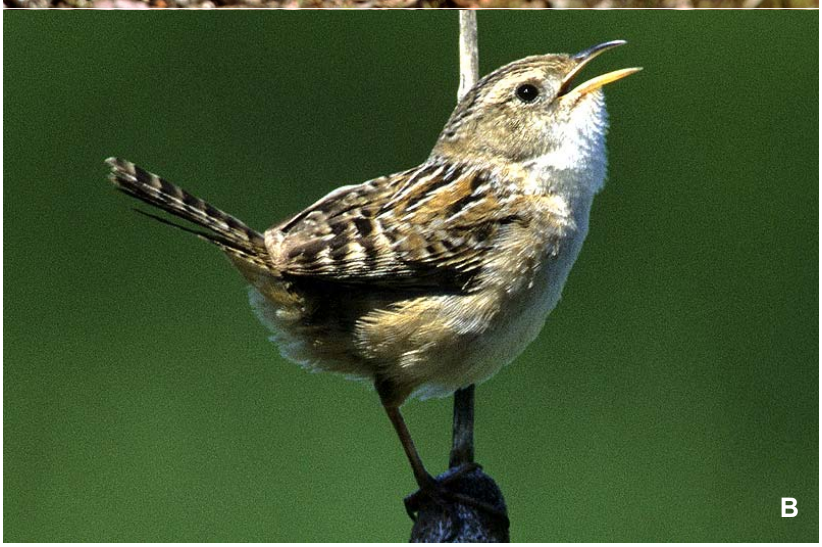
As part of the Strategic Plan for North American Cooperation in the Conservation of Biodiversity, a new continental initiative recently led to the identification of 55 grassland priority conservation areas within North America's central grasslands (CEC and TNC 2005). Together, these sites comprise 26,686,000 ha (about 32% of the total area of native grasslands within the biome).

In addition to various pieces of legislation and a network of protected areas, large-scale conservation initiatives that benefit grassland birds include the North American Waterfowl Management Plan and various Joint

Table 4. Protection status of native/natural grasslands in central North America (adapted from CEC and TNC 2005).

Country	Area of Native Grasslands (ha)	% of Native Grasslands in Protected Areas (ha)
Canada	8,655,400	14.95% (1,293,823)
United States	69,620,600	1.61% (1,120,892)
Mexico	3,844,300	1.80% (69,197)
Total	**82,120,300**	**3.03% (2,483,912)**

Ventures, the Permanent Cover Program and Community Pasture Program of Canada's Prairie Farm Rehabilitation Administration, and the U.S. government's Conservation Reserve Program (CRP) (see Gauthier *et al.* 2003). Millions of ha of CRP grasslands have been planted in the U.S. since 1985 (Bock *et al.* 1993), and 92% of CRP land is enrolled as perennial grassland (Rodenhouse *et al.* 1993). Meanwhile, the Commission for Environmental Cooperation is attempting to foster tri-national conservation actions through a continental grasslands strategy (Gauthier *et al.* 2003). Despite these efforts, grassland birds are continuing to decline.



A, Common Nighthawk (© Ethan Meleg, www.ethanmeleg.com); B, Sedge Wren (© Ethan Meleg, www.ethanmeleg.com).

The Future:

As noted by Peterjohn (2003), simply "reverting to less-intensive agricultural operations across North America is not realistic." Because of the geographic scale of the problem, conservation of grassland birds in North America is going to rely upon efforts made at every level, from local and regional initiatives to cooperative international efforts. Vickery *et al.* (1999) felt that conservation planning at the regional level was most important. Indeed, the Partners In Flight regional bird conservation plans appear to form an excellent framework for grasslands conservation across multiple levels.

No single management approach or conservation solution will benefit the entire suite of grassland bird species across large geographic regions. Some species will benefit from some management actions, while others will respond negatively. Nevertheless, many quite specific guidelines for grasslands management have been recommended by numerous authors. Some useful examples are as follows:

- Large patches of habitat should be created or maintained;
- Hay should be cropped every 2-3 years to prevent encroachment of shrubs and trees;
- Hay cutting should occur after the middle of July (and preferably in August) to avoid nest mortality;
- Crop residue should be retained on the soil surface in order to help sustain invertebrate populations and provide cover for birds;
- To the extent possible, integrated pest management rather than chemical treatments should be used to manage pest weeds and insects; and
- The number and types of field operations that destroy nests and birds should be minimized.

Finally, despite the surge in research being conducted on grassland birds, there are still many information gaps, especially with regard to their wintering ecology and winter habitat requirements. More study is certainly useful, but this is no reason to delay implementing conservation measures on the breeding grounds.

Just stabilizing populations of grassland birds at their present levels presents a huge conservation challenge.

Ultimately, it depends on the attitudes and engagement of governments, non-government agencies, and private landowners alike. We will never again see millions of bison roaming the prairies, but there is a growing interest in grasslands conservation and management among landowners and land managers, who are collectively beginning to sing the refrain "*Oh, give me a home, where the Bobolink roam."*

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