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BIRD POPULATIONS OF SEEDED GRASSLANDS IN THE ASPEN PARKLAND OF ALBERTA

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Abstract. The conversion of cropland to grasslands providing dense nesting cover is the main program being implemented by the North American Waterfowl Management Plan to restore duck populations in the Aspen Parkland of Alberta. We examined bird richness and abundance in six age classes (0–5 years) of "tame" dense nesting cover and in controls (cropland) in 1994. Our objectives were to describe temporal changes in bird communities as seeded grasslands matured, to relate these changes to structural changes in the grass cover, and to make recommendations on the timing of management of these restored habitats. Eighteen bird species were recorded in seeded grasslands and controls, but only Savannah Sparrows (*Passerculus sandwichensis*) were found in all age classes surveyed. Controls and dense nesting cover less than one year of age contained few breeding species (primarily Horned Larks [*Eremophila alpestris*] and Killdeer [*Charadrius vociferus*]) but were attractive to corvid and icterid species that used these areas for foraging. Older stands supported a variety of sparrows (Emberizinae) and, to a lesser extent, waterfowl (Anatidae), Sedge Wrens (*Cistothorus platensis*), and Northern Harriers (*Circus cyaneus*). Overall, bird species richness and abundance were lowest in controls, increased monotonically until three years after seeding, and declined thereafter. The Robel value and height of vegetation peaked at three and two years of age, respectively. Both vegetation measures were important determinants of bird richness, but abundance was related only to vegetation height.

Seeded grasslands require periodic management to remove lodged vegetation and rejuvenate growth. Although the type and timing of management that maximizes waterfowl production are not well established, we suggest that these habitats could be managed four to five years after establishment, when bird species richness and abundance are declining.

LAS POBLACIONES DE AVES EN PASTIZALES SEMBRADOS EN EL PRADO DE ASPEN DE ALBERTA

Sinopsis. Para restaurar las poblaciones de patos en el Prado de Aspen de Alberta se realiza actualmente el programa principal del Plan para el Control de Aves Acuáticas Norteamericanas, que es la conversión de terrenos sembrados a pastizales que ofrecen cobertura densa para anidaje. En 1994 estudiamos la riqueza y la abundancia de aves en seis clases de edad de cobertura densa no nativa para anidaje (0–5 años) y en controles (terrenos sembrados). Nuestros objetivos fueron describir los cambios temporales en las comunidades de las aves mientras maduraban los pastizales sembrados, relacionar estos cambios a los cambios estructurales en la cobertura de hierbas, y hacer recomendaciones para la coordinación del manejo de estos hábitats restaurados. Se registraron 18 especies de aves en los pastizales sembrados y en los controles, pero se encontraron solamente Gorriones Sabaneros (*Passerculus sandwichensis*) en todas las clases de edades estudiadas. Los controles y la cobertura densa para anidaje que tenía menos de un año de edad contenían pocas especies en reproducción (principalmente las Alondras Cornudas [*Eremophila alpestris*] y los Chorlitos Tildíos [*Charadrius vociferus*]) pero fueron atrayentes para las especies Corvidae e Icteridae que usaban estas áreas para forrajear. Los lugares con más años mantenían una variedad de gorriones (Emberizinae) y, en menor medida, aves acuáticas (Antidae), los Saltaparedes Sabaneros (*Cistothorus platensis*), y los Gavilanes Rastreros (*Circus cyaneus*). En total, la riqueza y la abundancia de las especies de aves fueron menores en los controles, aumentaron monotónicamente hasta tres años después del sembrado, y luego disminuyeron. El valor Robel y la altura de la vegetación alcanzaron su máximo grado a los tres y a los dos años de edad, respectivamente. Las dos mediciones de vegetación fueron factores determinantes en la riqueza de aves, pero la abundancia fue relacionada únicamente con la altura de la vegetación.

Los pastizales sembrados requieren un manejo periódico para quitar la vegetación fija y para renovar el crecimiento. Aunque no se haya establecido apropiadamente el tipo de manejo y la coordinación del manejo que intensifique la producción de aves acuáticas, recomendamos el control de estos hábitats entre cuatro y cinco años después de su establecimiento, cuando la riqueza y la abundancia de especies de aves estén decreciendo.

Key Words: Alberta; Aspen Parkland; dense nesting cover; seeded grasslands.

Waterfowl populations have been in serious decline in North America since the early 1970s. The primary reasons for this decline appear to be a degradation of nesting habitat caused by wetlands drainage and intensive cultivation of upland nesting habitats. These factors are especially prominent on the Canadian prairies, where 50% of the continental population of dabbling ducks breed. In this region, almost 60% of wetland basins and 80% of wetland margins have been affected to some degree by agricultural practices (Turner et al. 1987), and more than 80% of uplands are intensively cultivated (Adams and Gentle 1978, Rounds 1982, Sugden and Beyersbergen 1984).

In 1986 the North American Waterfowl Management Plan (NAWMP) was implemented with the goal of restoring continental waterfowl populations to 1970s levels. NAWMP programs employ a wide variety of techniques to secure, restore, and enhance wetlands and adjacent upland habitats critical for nesting waterfowl. In the Aspen Parkland of Alberta, waterfowl production is limited primarily by the loss of upland nesting habitats to intensive agriculture (Alberta Prairie Habitat Joint Venture Technical Committee, unpubl. data). Accordingly, NAWMP programs in this area have focused on restoring permanent cover to upland sites in areas of high wetland density. The primary way of accomplishing this has been to establish permanent forages on land previously used for the production of annual crops. This forage is referred to as "dense nesting cover" (DNC) and is of two general types. Most cover seeded during early years of the NAWMP program in Alberta was composed of "tame" cultivars, dominated by alfalfa (*Medicago sativa*), brome grass (*Bromus* spp.), and introduced species of wheat grasses (*Agropyron* spp.). Increased availability of native grass seed has permitted a recent shift toward a "native" DNC mix that contains green needlegrass (*Stipa viridula*) and native wheat grasses. Collectively, DNC has been established on approximately 6,300 ha in the Aspen Parkland of Alberta and on more than 39,000 ha across the Canadian prairies.

DNC is planted as breeding habitat for waterfowl, but it is used by a wide variety of other wildlife species as well. Of particular interest are grassland songbirds, which have been declining at alarming rates over the past 25 yr (Peterjohn and Sauer 1993). Many of these species have colonized restored grasslands on the Canadian prairies (Dale 1993; Prescott et al. 1993, 1995; Hartley 1994; Jones 1994), suggesting that NAWMP programs are providing valuable habitat for these species in this area.

This study documents bird use of tame DNC established in the Aspen Parkland of Alberta over a 6-yr period. This duration is significant because it represents the approximate management interval of restored grasslands in this area; older grasslands must be rejuvenated to restore vigor (Duebbert et al. 1981). Our goals were to (1) document changes in the relative abundance and species composition of bird communities in tame DNC over time; (2) relate temporal changes in bird community structure to vegetational changes in seeded cover; and (3) make recommendations on the timing of rejuvenation of restored grasslands based on knowledge of temporal changes in bird community structure.

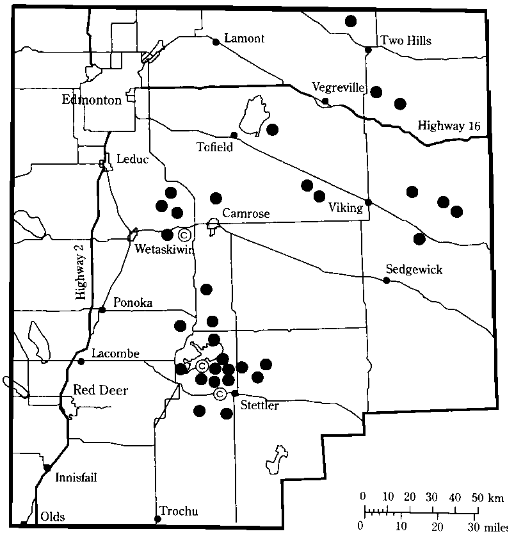

FIGURE 1. Location of DNC study plots (filled circles) and controls (open circles with "c") in the Aspen Parkland of Alberta.

METHODS

Thirty-one treatment properties in the central Aspen Parkland of Alberta that were seeded with tame DNC between 1989 (stand age = 5 yr) and 1994 (0 yr) were selected for study (Fig. 1). Thirteen different plant species were used in tame DNC mixtures during this period, and five to seven species were present in any one mix (Table 1). The relative proportion of major seed types in these mixes was not constant over time. Recently restored properties tended to be seeded with a higher proportion of wheat grasses and a lower percentage of brome/fescue (*Festuca*) and legumes than properties seeded in the early years of the NAWMP program in this region (Fig. 2). Three properties subjected to conventional agricultural rotation (spring-seeded grain crops) were selected as controls (Fig. 1).

Bird censuses were conducted between 24 May and 17 June 1994 using fixed-radius point counts (Hutto et al. 1986). A 75-m radius was used for all counts, and count centers were at least 200 m apart to minimize the possibility of counting the same bird in adjacent circles (Prescott et al. 1993). Circles were also positioned so their perimeters were at least 30 m from wetland margins and property boundaries. The observer counted all individuals seen or heard in the count circle during a 3-min interval. Flying birds were excluded unless they were foraging in the air column within the bounds of the circle. All counts were conducted between 0600 and 1000 hours mountain daylight time under calm (winds < 19 km/hr), rainless conditions.

We measured vegetation height and density in each

TABLE 1. OVERALL COMPOSITION OF DNC MIXES USED TO RESTORE PERMANENT COVER ON STUDY PROPERTIES IN THE ASPEN PARKLAND OF ALBERTA

Species		Average % by mass
alfalfa	*Medicago sativa*	12.29 (0–25)
sweet clover	*Melilotus* sp.	0.45 (0–4)
crested wheat grass	*Agropyron cristatum*	4.17 (0–17)
intermediate wheat grass	*A. intermedium*	4.08 (0–23)
pubescent wheat grass	*A. trichophorum*	7.39 (0–22)
slender wheat grass	*A. trachycaulum*	3.05 (0–7)
western wheat grass	*A. smithii*	11.84 (0–29)
northern wheat grass	*A. dasystachyum*	3.34 (0–15)
streambank wheat grass	*A. riparium*	4.90 (0–9)
tall wheat grass	*A. elongatum*	24.04 (12–54)
smooth brome grass	*Bromus inermis*	7.73 (0–35)
meadow brome grass	*B. biebersteinii*	14.98 (0–32)
tall fescue	*Festuca arundinacea*	4.00 (0–17)

Note: Individual seed mixes contained 5–7 of these species; numbers in parentheses are range of percentages in individual seed mixtures.

count circle following the methodology of Robel et al. 1970. A wooden pole, marked in decimeter increments, was placed in a vertical position at each sample location. The observer viewed the pole from a distance of 4 m and a height of 1 m from each of four cardinal directions and recorded the lowest decimeter that was completely obstructed by vegetation (hereafter "ROBEL"). We also recorded the highest decimeter ("HIGHDM") that was intersected by vegetation. Each set of measurements was taken at four randomly chosen locations 10–30 m from the center of the point-count circle.

Analyses of variance were used to test for differences in species richness, relative abundance, and vegetation readings among treatment (six age classes) and control habitats (Sokal and Rohlf 1981). Following significant overall F tests, Dunnett's multiple comparison procedure was used to test for differences in mean values of dependent variables between year classes and the control (Dunnett 1955, Miller 1981). Spearman rank correlations (Conover 1980) and multiple regression analyses (Sokal and Rohlf 1981) were used to test for associations of ROBEL and HIGHDM values with species richness and relative abundance across year classes and controls. All analyses were conducted using PC-SAS/STAT (SAS Institute 1990).

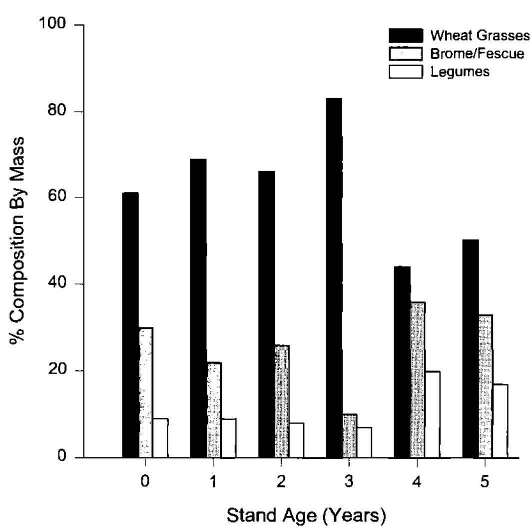

FIGURE 2. Mean composition (percent by mass in seed mix) of major vegetation types in DNC mixes used on study areas in the Aspen Parkland of Alberta.

RESULTS

Bird censuses were conducted in 162 count circles (137 treatment, 25 control) in 1994. Sample sizes were greater than 21 point counts for every control and age class except 5-yr-old stands (N = 5). A total of 18 bird species were observed in seeded grasslands and control fields during the study (Tables 2 and 3).

Bird species composition changed over time as grasslands matured (Tables 2 and 3). Controls and DNC less than 1 yr of age tended to contain species that were not found in older age classes. Although Killdeer (*Charadrius vociferus*) and Horned Larks (*Eremophila alpestris*) were undoubtedly breeding in the upland areas, corvid and icterid species probably used these uplands only for feeding. Savannah Sparrows (*Passerculus sandwichensis*) were found in all age classes but were most frequently encountered, and most abundant, in 1- to 3-yr-old stands. Clay-colored Sparrows (*Spizella pallida*), Le Conte's Sparrows (*Ammodramus leconteii*), and Nelson's Sharp-tailed Sparrows (*A. nelsoni*) were rare or absent in grasslands less than 2 yr of age; these species were more frequently encountered as stand age increased, although a decline in average abundance was observed in the oldest age class. Gadwall (*Anas strepera*), Northern Harriers (*Circus cyaneus*), Common Snipe (*Gallinago gallinago*), and Sedge Wrens (*Cistothorus pla-

TABLE 2. Frequency of occurrence (percent of points) of bird species in treatment and control plots in the Aspen Parkland of Alberta, 1994

		Stand age (years)					
Species	Control (N = 25)	0 (N = 23)	1 (N = 27)	2 (N = 21)	3 (N = 30)	4 (N = 31)	5 (N = 5)
Mallard *Anas platyrhynchos*		8.7				3.2	
Blue-winged Teal *A. discors*				4.8			
Gadwall *A. strepera*					3.3	3.2	
Northern Harrier *Circus cyaneus*					10.0		
Killdeer *Charadrius vociferus*	8.0						
Marbled Godwit *Limosa fedoa*			3.7				
Common Snipe *Gallinago gallinago*						3.2	
Horned Lark *Eremophila alpestris*	4.0	17.4					
Black-billed Magpie *Pica pica*	4.0						
American Crow *Corvus brachyrhynchos*	4.0	4.3					
Sedge Wren *Cistothorus platensis*					6.7	3.2	
Clay-colored Sparrow *Spizella pallida*				52.4	66.7	77.4	80.0
Vesper Sparrow *Pooecetes gramineus*		4.3			3.3	3.2	
Savannah Sparrow *Passerculus sandwichensis*	65.6	65.2	92.6	95.2	86.7	64.5	20.0
Le Conte's Sparrow *Ammodramus leconteii*		4.3		95.2	96.7	87.1	80.0
Nelson's Sharp-tailed Sparrow *A. nelsoni*			7.4	4.8	10.0	9.7	
Red-winged Blackbird *Agelaius phoeniceus*	16.0	17.4	14.8		3.3		
Yellow-headed Blackbird *Xanthocephalus xanthocephalus*	4.0						

tensis) also showed a preference for mature cover, although the frequency of occurrence and mean abundance of these species were relatively low.

Overall, count circles contained 1.94 ± 0.08 (SE) species and 3.93 ± 0.18 individuals. The number of species ($F = 24.7$; df = 6, 155; $P < 0.0001$) and relative abundance of individuals ($F = 21.3$; df = 6, 155; $P < 0.0001$) differed across treatment and control properties. Dunnett's test indicated that the numbers of species observed in 2- to 4-yr-old stands were significantly higher than in controls ($P < 0.05$), with the largest difference between controls and treatment means occurring in 3-yr-old stands. Avian abundance in DNC was significantly higher than in controls for all but the 0-yr stand (Dunnett's test, $P < 0.05$), with the largest difference between treatment and control means occurring in 3-yr-old cover (Fig. 3). Overall, species richness and relative abundance were lowest in controls, increased monotonically with age of DNC until 3 yr of age, and then declined (Fig. 3).

ROBEL ($F = 561.7$; df = 6, 2569; $P < 0.0001$) and HIGHDM ($F = 744.2$; df = 6, 2569; $P < 0.0001$) values varied significantly across treatment and control habitats. All treatment years had significantly higher mean values than controls for both vegetation measures (Dunnett's tests, $P < 0.05$), with the greatest difference between treatment and controls occurring in 2-yr-old stands for ROBEL values and in 3-yr-old stands for HIGHDM values (Fig. 3).

There was a high correlation between ROBEL and HIGHDM values ($N = 161$, $r = 0.82$, $P < 0.0001$) and significant associations of bird spe-

TABLE 3. MEAN (± SE) ABUNDANCE OF BIRD SPECIES IN TREATMENT AND CONTROL PLOTS IN THE ASPEN PARKLAND OF ALBERTA, 1994

		Stand age (years)					
Species	Control (N = 25)	0 (N = 23)	1 (N = 27)	2 (N = 21)	3 (N = 30)	4 (N = 31)	5 (N = 5)
Mallard		0.13 ± 0.10				0.03 ± 0.03	
Blue-winged Teal				0.05 ± 0.05			
Gadwall					0.03 ± 0.03	0.03 ± 0.03	
Northern Harrier					0.13 ± 0.08		
Killdeer	0.08 ± 0.06						
Marbled Godwit			0.04 ± 0.04				
Common Snipe						0.03 ± 0.03	
Horned Lark	0.04 ± 0.04	0.18 ± 0.08					
Black-billed Magpie	0.08 ± 0.08						
American Crow	0.04 ± 0.04	0.09 ± 0.09					
Sedge Wren					0.17 ± 0.19	0.13 ± 0.13	
Clay-colored Sparrow				0.62 ± 0.15	1.00 ± 0.16	1.52 ± 0.21	0.40 ± 0.19
Vesper Sparrow		0.04 ± 0.04	0.04 ± 0.04		0.03 ± 0.03	0.03 ± 0.03	
Savannah Sparrow	0.92 ± 0.18	1.48 ± 0.31	2.96 ± 0.40	2.52 ± 0.33	2.20 ± 0.28	1.74 ± 0.27	0.08 ± 0.08
Le Conte's Sparrow		0.04 ± 0.04		1.52 ± 0.18	1.77 ± 0.20	1.84 ± 0.20	0.44 ± 0.21
Nelson's Sharp-tailed Sparrow			0.07 ± 0.05	0.05 ± 0.05	0.17 ± 0.11	0.10 ± 0.05	
Red-winged Blackbird	0.28 ± 0.15	0.17 ± 0.08	0.26 ± 0.14		0.03 ± 0.03		
Yellow-headed Blackbird	0.16 ± 0.16						

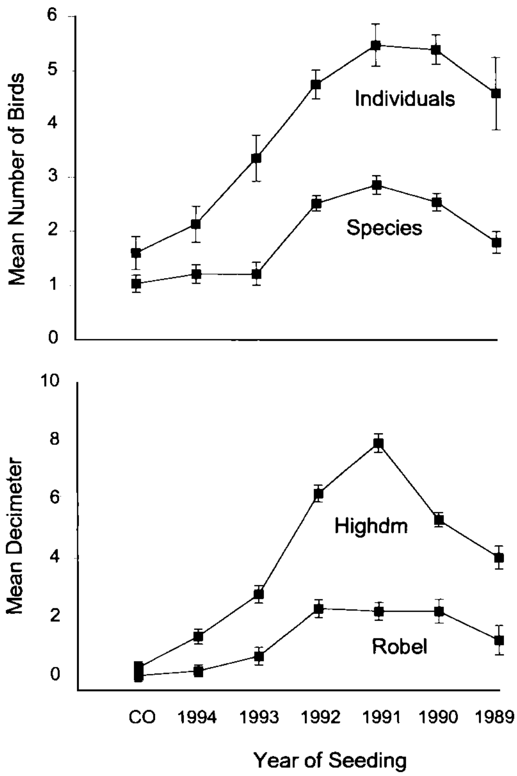

FIGURE 3. Changes in bird species richness and abundance (top) and vegetation profile (bottom) across age classes of DNC and controls in the Aspen Parkland of Alberta. Plotted values are mean ± SE.

cies richness and abundance with average ROBEL and HIGHDM values across count circles (all $r > 0.60$, all $P < 0.0001$). To determine the relative importance of vegetation measures to bird communities in DNC, multiple linear regressions of ROBEL and HIGHDM on bird species richness and abundance were performed. Both HIGHDM (partial $F = 5.1$; df = 1, 158; $P < 0.03$) and ROBEL (partial $F = 15.1$; df = 1, 158; $P < 0.0001$) values were important determinants of species richness in count circles, but relative abundance was influenced only by HIGHDM values (partial $F = 26.5$; df = 1, 158; $P < 0.0001$) after the effects of ROBEL were removed.

DISCUSSION

The structure of seeded grasslands in the Aspen Parkland of Alberta changes substantially over a 6-yr period. Grass height and visual obstruction increase rapidly during the first 2–3 yr, peak, and then decline in older stands. This general pattern has been found in other studies. Higgins et al. (1984) reported that the height and density of seeded cover increased monotonically during a 4-yr study in North Dakota. Blankespoor (1980) noted a decrease in growth during the fifth year of establishment, although this trend could be attributed partly to local drought and grazing pressure. Higgins and Barker (1982) studied DNC up to 9 yr of age and found that growth declined after a maximum that occurred 3–5 yr after seeding; the authors noted that annual trends in height and density of vegetation were due not only to growth but to successional changes in species composition (see also Blankespoor 1980) and to "lodging" of decadent vegetation in older stands. Although we did not measure compositional changes in the upland cover, matting of vegetation was clearly evident in DNC stands older than 4 yr (pers. obs.). We acknowledge that some of the observed "changes" in vegetation structure over time may be due to annual differences in seed mixes. For example, HIGHDM values in 3- to 5-yr-old stands (Fig. 3) paralleled the amounts of wheat grass in associated seed mixtures (Fig. 2). ROBEL values, however, exhibited a different pattern. They remained high in 4-yr-old stands but then declined in the oldest age class. Furthermore, the high percentage of brome/fescue and legume in older seed mixes should have meant higher ROBEL values in 4- and 5-yr-old stands. The decline in ROBEL values in the oldest age class therefore appears to be independent of the composition of the seed mix, suggesting a major role of stand decadence in the annual trends in vegetation structure we observed.

Changes in the structure of seeded cover between years are accompanied by changes in the resident bird community. In the Aspen Parkland of Alberta, bird species richness and abundance peaked 3 yr after establishment, and count circles with the greatest vegetation cover, regardless of year class, supported the most species and individuals. Species that breed in short-grass or bare-ground habitats (Horned Lark, Killdeer) are displaced when permanent cover is planted (Owens and Myres 1973, Dale 1993, Johnson and Schwartz 1993), as are icterids and corvids that use these habitats for foraging. Because neither Horned Larks nor Killdeer are declining on a regional or continental basis (Robbins et al. 1986, Peterjohn and Sauer 1993), the conversion to permanent cover should not seriously affect breeding populations of these species. Well-established (>2 yr) DNC in Alberta, and in other areas of the northern Great Plains, is dominated by Le Conte's, Clay-colored, and Savannah sparrows (Duebbert 1981, Renken and Dinsmore 1987, Dale 1993, Hartley 1994, Prescott et al. 1995) and attracts Northern Harriers, Sedge Wrens, and Nelson's Sharp-tailed Sparrows.

Most of these species have stable populations on a continental scale. Clay-colored Sparrows have been declining over the last 25 yr (Peterjohn and Sauer 1993), however, so seeded grasslands might be providing valuable habitat for this species. The same is true of Sedge Wrens. Although this species is currently increasing on a continental scale (Peterjohn and Sauer 1993), sharp declines were noted in all regions, including the Canadian prairies, between 1966 and 1979 (Robbins et al. 1986). This species is at the edge of its range in our study area and was only encountered in three count circles. Sedge Wrens are common inhabitants of seeded cover elsewhere in the prairie region (Higgins et al. 1984, Renken and Dinsmore 1987, Dale 1993, Hartley 1994), however, and the establishment of tame DNC in the parkland of Alberta may provide habitat for the establishment of Sedge Wren colonies in previously unoccupied areas.

In general, the conversion of cropland to permanent cover results in a replacement of several common and stable species with other species of similar attributes. It is notable that Western Meadowlarks (*Sturnella neglecta*), Sprague's Pipits (*Anthus spragueii*), and to a lesser extent, Baird's Sparrows (*Ammodramus bairdii*), which are endemic to grasslands in the Aspen Parkland of Alberta (Semenchuk 1992, Prescott et al. 1995) and which have experienced long-term declines in numbers (Robbins et al. 1986, Peterjohn and Sauer 1993, Sauer et al. 1997), were not encountered during our study. Thus, tame DNC does not provide habitat for some declining grassland songbirds. Even so, restored grasslands may be valuable because nest success is higher in perennial cover than in the cropland it replaces (Dale 1993, Hartley 1994). Future study will determine if the recent shift to more "native" DNC mixes in the Aspen Parkland will provide habitat for species that require undisturbed native prairie.

Previous studies have suggested that seeded grasslands may be productive as waterfowl habitat for a period of 8–10 yr (Duebbert et al. 1981, Higgins and Barker 1982). We did not specifically census waterfowl, and it is difficult to objectively determine how long these habitats would remain "productive" breeding areas for these species. Kirsch et al. (1978), however, reported that the density and success of duck nests are related to the height and density of the surrounding vegetation. The relationship we observed between vegetation structure and bird species richness and abundance therefore suggests that DNC management for waterfowl and for avifauna in general is complementary. Accordingly, habitat managers may consider mowing, burning, or grazing (Duebbert 1981, Higgins and Barker 1982) to rejuvenate seeded grasslands that are losing vertical structure. We suggest that 4–5 yr be the minimum age at which such management occurs. However, stand decadence is known to be influenced by plant composition, climatic conditions, and soil type, so rejuvenation schedules should be determined on a field-by-field basis (Higgins and Barker 1982).

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