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LE CONTE'S SPARROWS BREEDING IN CONSERVATION RESERVE PROGRAM FIELDS: PRECIPITATION AND PATTERNS OF POPULATION CHANGE

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Abstract. Breeding Le Conte's Sparrows (*Ammodramus leconteii*) were studied from 1990 to 1996 in perennial grasslands established on fields enrolled in the Conservation Reserve Program in the northern Great Plains. The status of Le Conte's Sparrow in these grasslands changed from that of an uncommon breeding species in 1990–1993 to that of one of the most abundant breeding species in 1994–1996. Numerical population lows and highs coincided with drought and amelioration of drought conditions, respectively. Our results emphasize the importance of rangewide conservation efforts and long-term observations of grassland birds.

PROCREACIÓN DEL GORRIÓN DE LE CONTE EN CAMPOS DEL PROGRAMA DE CONSERVACIÓN EN RESERVAS: PRECIPITACIONES Y ESQUEMAS DE CAMBIO DE LA POBLACIÓN

Sinopsis. Desde 1990 a 1996, los Gorriones de Le Conte (*Ammodramus leconteii*) se estudiaron durante su estación de reproducción en los pastizales perennes establecidos en terrenos del Programa de Conservación en Reservas en el norte de la Gran Llanura. La condición del Gorrión de Le Conte en estos pastizales cambió desde una especie poco común entre 1990 y 1993, a una de las especies más abundantes entre 1994 y 1996. Los números de población mínimos y máximos coincidieron con la sequía y el mejoramiento de las condiciones de sequía, respectivamente. Nuestros resultados ponen en relieve la importancia de las campañas conservacionistas del gorrión a gran escala y de las observaciones a largo plazo de las aves de pastizal.

Key Words: *Ammodramus leconteii*; climate; Conservation Reserve Program; drought; grassland; Great Plains; Le Conte's Sparrow; populations; precipitation.

The climate of the North American Great Plains is highly dynamic, with great year-to-year variability in precipitation and periodic, often extreme, wet and dry cycles (Bragg 1995). Drought is a major force of ecological disturbance on the Great Plains and has played a key role in directing the evolution of the grassland biota of this region (Knopf and Samson 1997). Although grassland birds may differ in their responses to environmental variations (Rotenberry and Wiens 1991), climatic variability and concomitant unpredictability of resources strongly influence populations of grassland birds across space and time (Wiens 1974, 1986; Cody 1985). Not surprisingly, breeding bird populations on the Great Plains are highly dynamic, exhibiting considerable annual variation in composition, abundance, and distribution (Johnson and Grier 1988, George et al. 1992, Zimmerman 1992, Igl and Johnson 1997).

Recently, interest in grassland birds has increased with the recognition that many species are declining both continentally (Droege and Sauer 1994) and globally (Goriup 1988). Identification of the specific factors associated with grassland bird declines in North America, however, remains largely enigmatic (Herkert 1997), and it is complicated by the considerable annual fluctuations in grassland bird distribution and abundance (Igl and Johnson 1997). Although there is evidence that land-use changes on the breeding grounds may have contributed to grassland bird declines (e.g., Igl and Johnson 1997), there also is an indication that long-term drought conditions may have influenced recent population changes of some breeding birds on the Great Plains (Droege and Sauer 1989, Peterjohn and Sauer 1993, Bethke and Nudds 1995, Igl and Johnson 1997).

Le Conte's Sparrow (*Ammodramus leconteii*) is a secretive grassland bird that breeds in central and southern Canada and the northcentral United States (Murray 1969). It winters primarily in the southern United States (Peterson 1980, 1990). Like populations of many grassland breeding birds in North America (Fretwell 1986, Igl and Johnson 1997), Le Conte's Sparrow populations exhibit numerical highs and lows depending on local moisture conditions (Peabody 1901, Stewart 1975, Knapton 1979, Zimmer 1979, Madden 1996). This observation, however, is based largely on anecdotal evidence or short-term observations. Long-term studies of Le Conte's Sparrow populations are limited. Le Conte's Sparrow is poorly represented on the North American Breeding Bird Survey (BBS) because of small sample sizes, poor coverage in the northern portion of its breeding range, and

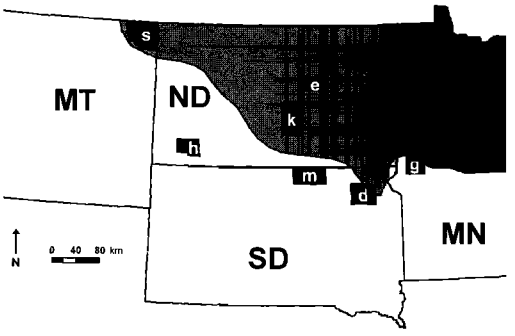

FIGURE 1. Breeding range (shaded area; Peterson 1980, 1990) of Le Conte's Sparrow in the area of our study in relation to the counties (solid areas) in which Le Conte's Sparrows were observed in CRP fields in the northern Great Plains. North Dakota: h = Hettinger County, e = Eddy County, k = Kidder County; Montana: s = Sheridan County; South Dakota: m = McPherson County, d = Day County; Minnesota: g = Grant County.

the species' furtive behavior (Sauer et al. 1995). Moreover, dramatic fluctuations in Le Conte's Sparrow abundance tend to obscure the species' long-term population trends on the BBS (Sauer et al. 1995).

In this paper we examine long-term population changes of Le Conte's Sparrows breeding in perennial grassland fields enrolled in the Conservation Reserve Program (CRP) on the northern Great Plains. We discuss patterns of population change of Le Conte's Sparrows associated with changes in precipitation and moisture conditions.

METHODS

The CRP of the 1985 Food Security Act removed millions of hectares of highly erodable and environmentally sensitive land from crop production and established perennial grassland for a 10-yr period (Young and Osborn 1990). We surveyed breeding birds from 1990 to 1996 in CRP grassland fields in nine counties in North Dakota, South Dakota, Minnesota, and Montana (Johnson and Schwartz 1993a, b). Le Conte's Sparrows were recorded in only seven of these counties. Herein we report data from those seven counties: Sheridan County, Montana; McPherson and Day Counties, South Dakota; Eddy, Hettinger, and Kidder Counties, North Dakota; and Grant County, Minnesota (Fig. 1). In these counties we surveyed 181 fields (3,565 ha) in 1990; 263 fields (4,843 ha) in 1991; 296 fields (5,468 ha) in 1992; 292 fields (5,360 ha) in 1993; 293 fields (5,369 ha) in 1994; 293 fields (5,369 ha) in 1995; and 290 fields (5,233 ha) in 1996. We selected fields with well-established vegetation because they offered more mature cover and thus a better perspective on long-term, rather than transient, effects. Once a field was selected, we surveyed it in subsequent years unless permission for further access was denied or the field was planted to small grains or row crops. We did not select any new CRP fields after 1993.

In the northern Great Plains, most CRP fields were left idle during their contract period, although in nearly every year some CRP fields in the northern Great Plains were released for emergency haying and grazing because of drought or flooding in the region. In this study, these disturbances occurred from 1993 through 1996, and in only a small number of fields each year. The highest percentage of disturbance was in 1996 when 15% of the CRP fields in our study were wholly or partially hayed or, in rare cases, grazed. Although the conditions for releasing CRP lands for emergency haying and grazing varied from year to year, in every year the perturbations occurred after the birds were surveyed (15 July or later).

We surveyed breeding birds using a minor modification of the strip transect procedures used by Stewart and Kantrud (1972) and Igl and Johnson (1997). This method allows a fairly rapid assessment of the breeding birds in a field. Fields were surveyed once each year by one or two observers on foot. Small (≤32 ha) fields usually were surveyed by a single observer; large fields typically were surveyed by two observers, each covering about half of the field. The number and configuration of transects varied depending on field size and shape. Care was taken to avoid double-counting birds. We tallied all breeding pairs, based on singing or calling males, females, observed pairs, or presence of an active nest. We avoided censusing birds in adverse weather conditions (precipitation or winds > 24 km/hr). Surveys began about dawn and continued until midafternoon. Although some surveys were conducted outside the time of most active bird vocalizations (early morning or late evening), Stewart and Kantrud (1972) concluded that singing and other activities of open-country birds were not appreciably affected by time of day during the peak of the breeding season (also see Vickery 1995). We conducted surveys from late May to early July each year, which coincided with the peak breeding season of Le Conte's Sparrow (Stewart and Kantrud 1972, Stewart 1975).

We likely missed some breeding Le Conte's Sparrows in our single annual survey of CRP fields (see Järvinen and Lokki 1978). We used the same technique each year, however, so any bias, other than differences in observers, should be consistent. Stewart and Kantrud (1972) felt justified in estimating bird populations in open habitats using single counts because many species have behavioral adaptations (e.g., elevated perches, flight songs, synchronous displays) that tend to increase their detectability compared with birds inhabiting wooded areas (also see Cody 1985).

For each county we obtained data for long-term (1961–1990) average precipitation (May of previous year to April of current year) and annual deviations from the average, 1989–1996, taken at the nearest national weather station (National Oceanic and Atmospheric Administration [NOAA] 1987–1996). To describe moisture conditions in the study area, we obtained regional data for the Palmer Drought Severity Index (PDSI) for May of each year (NOAA 1997). The PDSI incorporates information on both moisture and temperature and expresses the severity of a wet (positive values) or dry (negative values) period by incor-

TABLE 1. NUMBER OF BREEDING PAIRS OF LE CONTE'S SPARROWS OBSERVED IN CONSERVATION RESERVE PROGRAM FIELDS IN THE NORTHERN GREAT PLAINS, 1990–1996

County	Number of breeding pairs						
	1990	1991	1992	1993	1994	1995	1996
Sheridan, MT	0	0	8	0	52	76	99
Eddy, ND	0	1	0	0	206	694	529
Kidder, ND	0	0	0	1	26	148	184
Hettinger, ND	0	0	0	0	0	0	7
McPherson, SD	0	0	0	0	0	47	106
Day, SD	0	0	0	0	2	101	190
Grant, MN	0	0	0	2	4	74	25
Totals	0	1	8	3	290	1,140	1,140

porating past and present conditions. Specifically, PDSI values of 0 to −0.5 indicate normal moisture conditions, −0.5 to −1.0 incipient drought, −1.0 to −2.0 mild drought, −2.0 to −3.0 moderate drought, −3.0 to −4.0 severe drought, and less than −4.0 extreme drought. Similar terms are associated with positive values and wet spells.

RESULTS

Between 1990 and 1996 we recorded 111 species of birds using CRP grassland fields in the northern Great Plains during the breeding season (L. Igl and D. Johnson, unpubl. data). The number of Le Conte's Sparrows in CRP fields was relatively low in 1990–1993 compared with 1994–1996; fewer than 1% of all breeding pairs were observed in the first 4 of the 7 yr (Table 1). Le Conte's Sparrows were not observed in any CRP field that we surveyed in 1990, the first year of this study. Between 1994 and 1996, Le Conte's Sparrow was one of the most abundant species in CRP fields in the northern Great Plains (Igl and Johnson 1995; L. Igl and D. Johnson, unpubl. data).

Most of the Le Conte's Sparrow's breeding range occurs north of our study area (Stewart 1975; Peterson 1980, 1990; AOU 1983; Janssen 1987; South Dakota Ornithologists' Union [SDOU] 1991; Montana Bird Distribution Committee [MBDC] 1996). Also, Le Conte's Sparrow abundance was not uniform across the region of the study (Table 1, Figs. 1 and 2). The species was most common in 1994–1996 in Eddy and Kidder Counties, North Dakota (Fig. 1), in the interior (albeit southern) portion of the species' breeding range. Le Conte's Sparrows were least abundant in the other five counties, which occur on the southern edge of (Day County, South Dakota; Grant County, Minnesota; and Sheridan County, Montana) or outside (Hettinger County, North Dakota, and McPherson County, South Dakota) the species' known breeding range (Stewart 1975; Peterson 1980, 1990; AOU 1983; Janssen 1987; SDOU 1991; MBDC 1996).

Our study included some of the driest and wettest years on record in the northern Great Plains (NOAA 1987–1996, 1997). Between 1987 and mid-1993, drought conditions occurred over much of the study area (Table 2, Fig. 2). Numerical increases of Le Conte's Sparrows began in 1994, coincident with dramatic increases in precipitation (Tables 1 and 2, Fig. 2). Changes in Le Conte's Sparrow densities generally paralleled changes in moisture conditions for the two counties in the interior of the species' breeding range (Fig. 2). Le Conte's Sparrows, however, exhibited a time lag or delayed numerical response to improved moisture conditions in all counties, especially those on the edge of or outside the species' typical breeding range (Fig. 2). In the extralimital counties (McPherson County, South Dakota, and Hettinger County, North Dakota), colonization of CRP fields coincided with dramatic increases in abundance in the interior of the species' breeding range (Tables 1 and 2, Fig. 2). Le Conte's Sparrows were absent from CRP fields in McPherson County until 1995 and in Hettinger County until 1996.

DISCUSSION

Between 1990 and 1996 we recorded four species of *Ammodramus* sparrows in the grassland habitats established by the CRP in the northern Great Plains: Baird's Sparrow (*A. bairdii*), Grasshopper Sparrow (*A. savannarum*), Nelson's Sharp-tailed Sparrow (*A. nelsoni*), and Le Conte's Sparrow (Johnson and Schwartz 1993a, b). Le Conte's Sparrow is among the most poorly known of these sympatric *Ammodramus* sparrows (Ehrlich et al. 1988). This likely reflects the species' secretive behavior, weak insect-like song, cryptic appearance, and sporadic distribution and abundance (Walkinshaw 1968, Murray 1969), as well as a general misconception about its habitat affinities (Robbins 1969, 1991). Le Conte's Sparrows also tend to be most vocal in the evening or at night (Murray 1969), a period when few observers visit the

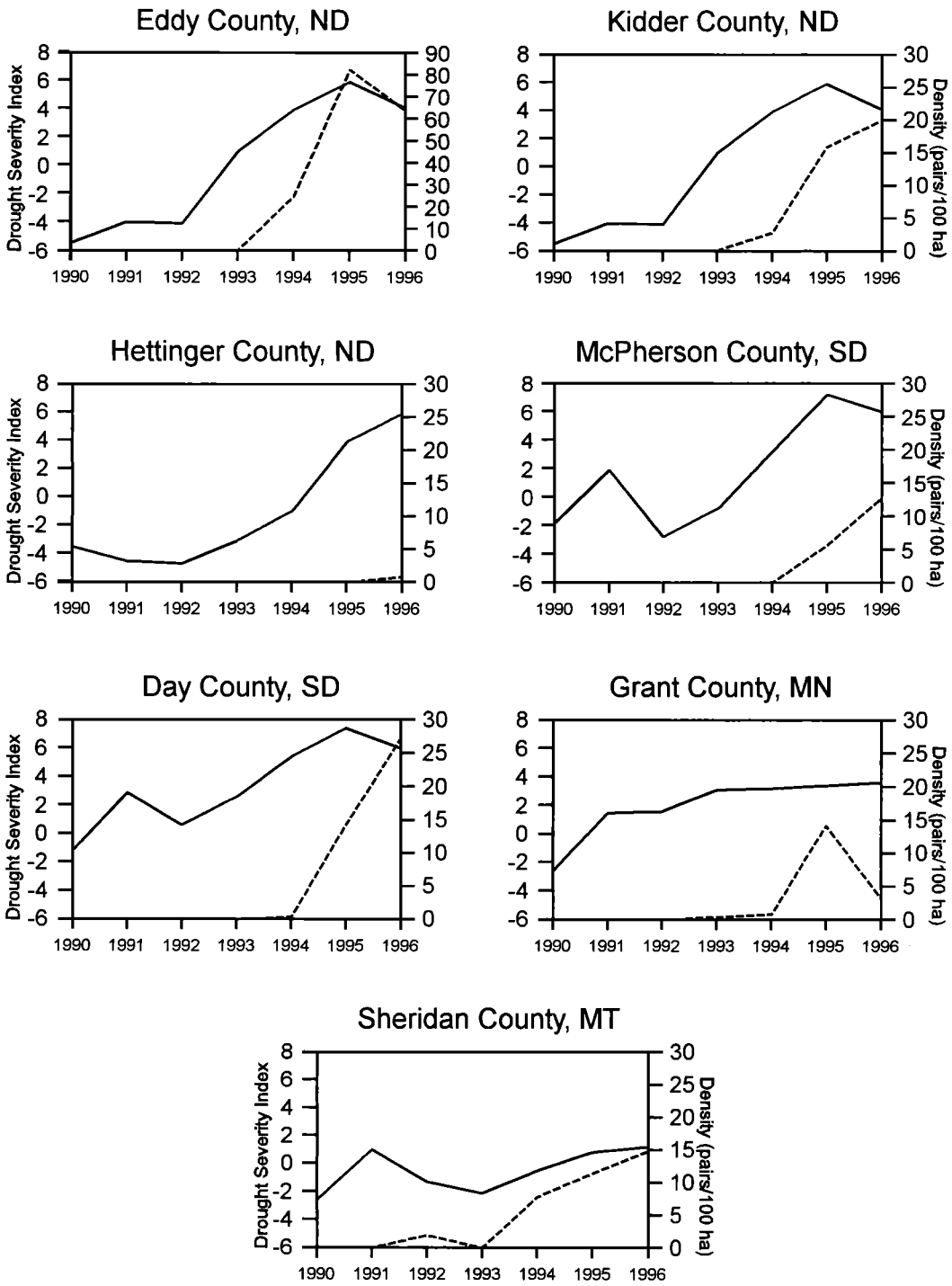

FIGURE 2. Palmer Drought Severity Index (solid lines) and breeding densities (dashed lines) of Le Conte's Sparrows in CRP fields in seven counties in the northern Great Plains, 1990–1996.

TABLE 2. LONG-TERM (1961–1990) AVERAGE PRECIPITATION IN CENTIMETERS (MAY OF PREVIOUS YEAR TO APRIL OF CURRENT YEAR) AND ANNUAL DEVIATIONS FROM THE AVERAGE PRECIPITATION, 1989–1996, TAKEN AT THE NATIONAL WEATHER STATION NEAREST EACH STUDY AREA

County	Long-term average	Deviation from the long-term average						
		1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96
Sheridan, MT	32.39	−8.36	+1.57	+10.26	−6.38	+24.92	+2.03	+0.15
Eddy, ND	45.72	+0.58	−2.11	+3.71	−8.33	+22.81	+9.00	+9.45
Kidder, ND	41.10	−13.87	+6.35	+1.83	−7.67	+19.66	+15.42	+11.40
Hettinger, ND	41.88	−13.43	−11.68	−9.34	−13.86	+20.25	+0.64	+4.04
McPherson, SD	40.18	−10.41	+12.57	−9.02	+18.03	+39.29	+15.22	+19.38
Day, SD	53.49	+3.91	+1.40	+11.94	−6.30	+30.10	+12.27	+2.26
Grant, MN	64.72	−3.40	−3.38	+5.61	−1.37	+0.25	−4.50	−3.46

species' preferred breeding habitats (Sauer et al. 1995).

During the breeding season, Le Conte's Sparrows generally prefer moister grassland habitats than Baird's or Grasshopper sparrows and drier habitats than Nelson's Sharp-tailed Sparrows (AOU 1983). Although Le Conte's Sparrows tend to avoid areas with permanent standing water, their affinity for tall, dense vegetation in wet meadows and wetland edges has frequently been noted (Davis 1952, Murray 1969, Stewart 1975, Graber and Graber 1976, SDOU 1991). This has resulted in the species being known more as a wetland or wet-meadow species than as a grassland species (Johnsgard 1979, Maxwell et al. 1988).

It is less well known that moist habitats are not necessary for Le Conte's Sparrows during the breeding season (Walkinshaw 1937, Robbins 1969, Cooper 1984). Although Mengel (1970) did not consider Le Conte's Sparrow to be an endemic or secondary grassland bird, he grouped it with other marsh-inhabiting species (e.g., Nelson's Sharp-tailed Sparrow) that have secondary preferences for moist or dry grasslands. This flexibility in habitat selection presumably is not of recent origin (e.g., in response to changes in agriculture) and likely reflects the similarity in grassland-like vegetation structure that is characteristic of both wetlands and grasslands in the species' breeding range. Nonetheless, changes in land use after European settlement probably have influenced the distribution of suitable habitats for this species (Lowther 1996).

In addition to breeding in native prairie, Le Conte's Sparrows regularly breed in other upland grass areas, including pasture, hayland, and retired cropland (Stewart 1975, AOU 1983, Cooper 1984, Renken and Dinsmore 1987, Robbins 1991, Hartley 1994, Igl and Johnson 1995, Madden 1996, Prescott and Murphy 1996). The grassland habitats established by the CRP are similar to the upland habitats used by Le Conte's Sparrows elsewhere in their breeding range. Although vegetation composition varied considerably among fields and counties (Johnson and Schwartz 1993b, Igl and Johnson 1995), most CRP land in this study was planted to a mixture of grasses (mostly cool season) and legumes. In Saskatchewan, Hartley (1994) reported that Le Conte's Sparrow was the second most abundant species in native prairie and the most abundant species in grasslands dominated by grass-legume mixtures and managed for waterfowl production. In Alberta, Prescott and Murphy (1996) reported that Le Conte's Sparrows were more common in pastures dominated by exotic grasses and legumes than in native pastures. In North Dakota, Renken and Dinsmore (1987) found Le Conte's Sparrows in grasslands dominated by grass-legume mixtures and managed for waterfowl production, but in contrast to Hartley (1994) and Prescott and Murphy (1996), they did not find this species in native mixed-grass prairie. Also in North Dakota, Madden (1996) noted the species' affinity for areas dominated by broad-leaved exotic grasses over native prairie.

In semiarid environments such as the northern Great Plains, extreme wet or dry conditions may cause increases, decreases, or no changes in bird populations (e.g., George et al. 1992). Our results indicate that the dramatic population increases of Le Conte's Sparrows during the breeding season coincided with the occurrence of wet conditions (or the amelioration of drought conditions) in the northern Great Plains. This finding was consistent with the anecdotal, but somewhat vague, reports of Peabody (1901), Stewart (1975), Knapton (1979), and Zimmer (1979), each suggesting that Le Conte's Sparrows were more abundant or common during wet years than dry years. Madden (1996) also reported dramatic increases in Le Conte's Sparrow abundance in North Dakota between 1993 and 1994, and she attributed these increases to improved moisture conditions in the region. Le

Conte's Sparrows also appear to respond to wet conditions during migration and on their wintering grounds (Grzybowski 1980, Lowther 1996). Although climatic variability may have been a factor leading to these dramatic fluctuations in Le Conte's Sparrow distribution and abundance, our data shed little light on the mechanisms underlying these patterns of population change. Nonetheless, these large population fluctuations suggest strong selection for coping with unpredictable resources in a variable environment.

In general, most birds do not respond directly to a climatic condition such as a prolonged wet or dry period; instead their response is indirect and tempered by the direct effects of climate on primary and secondary production (Wiens 1986, Rotenberry et al. 1995). The suitability of grassland habitats for birds is strongly influenced by floristic composition and vegetation structure (Cody 1985) as well as food resource availability (Wiens 1986, George et al. 1992). Although we did not collect data on annual changes in vegetation structure or food resource availability in the CRP grassland fields, it is reasonable to assume that the extreme variations in moisture availability influenced primary and secondary resources in these grasslands (Wiens 1986, George et al. 1992). Unlike habitats dominated by woody perennials, grasslands are dominated by mostly herbaceous vegetation (grasses, annuals, and some perennials), which responds relatively quickly to climate changes (Wiens 1986). A species' response to a climatic condition, however, may not be immediate. Primary and secondary resources may change through time in response to environmental variation. Additional time lags occur in the conversion of these changes in resources into variations in grassland bird abundance (Wiens 1986).

Data from this study indicate that Le Conte's Sparrows are capable of locating available habitat opportunistically. Dramatic changes of this nature in distribution and abundance have been documented for other grassland and wetland species that breed in the Great Plains and winter elsewhere (e.g., George et al. 1992, Zimmerman 1992). Johnson and Grier (1988) found that grassland-nesting ducks migrating north to their breeding grounds tend to fill breeding habitat in the southern portion of their breeding ranges first. During dry years, however, several species of ducks arriving on the breeding grounds respond by over-flying southern portions of their breeding range, apparently in search of more suitable habitat in the northern portion of the range (Johnson and Grier 1988). Similarly, Baird's Sparrows are more common in northern portions of their breeding range when areas in the southern portions of the range are experiencing drought conditions, and they are less common in the north when areas in the south are experiencing wet conditions (Kantrud and Faanes 1979). Roth (1979) and others (Oberholser and Kinkaid 1974, Robbins and Van Velzen 1974, Fretwell 1986) also alluded to this pattern for Dickcissels (*Spiza americana*), which nest in the extreme southern portion of their range during wet years, when herbaceous vegetation is lush, but continue north during dry years when conditions are poor for nesting. Roth (1979) suggested that this behavior represents past selection to compensate for unpredictable weather and vegetation conditions.

Although the concept of climate-driven shifts in grassland bird populations is pervasive in the literature, our understanding of these population fluctuations and their conservation implications is poor. Skagen and Knopf (1994) suggested that species that use disjunct patches of changing habitat in an irregular fashion may be the most difficult species to protect in the Great Plains. The large fluctuations in the abundance and distribution of Le Conte's Sparrows emphasize the importance of large-scale conservation efforts such as the CRP for grassland birds. Although the CRP is primarily an agricultural commodities program, many grassland birds have benefited from the network of perennial grasslands established by this program throughout the Great Plains (Johnson and Schwartz 1993a, b; Kantrud 1993; Reynolds et al. 1994; Johnson and Igl 1995; Patterson and Best 1996). The dramatic increase in Le Conte's Sparrow abundance in CRP fields since 1994, however, suggests that these perennial grasslands in the southern portion of the species' breeding range may be an important breeding habitat for this species only under moist conditions (Igl and Johnson 1995). Thus, conservation of grassland birds poses a special challenge that requires an assessment of a species' habitat needs in different portions of its breeding range under various conditions. Managers and policy makers should recognize that negative impacts (e.g., loss and fragmentation of grassland habitat) in a portion of the Great Plains could affect grassland birds that use that area only under certain conditions. Unfortunately, some conservation and land set-aside programs, such as the CRP, terminate at international or political borders, whereas breeding ranges and annual shifts in grassland bird populations may involve two or more countries (Johnson and Grier 1988).

In the early years of this study, it was readily apparent that the densities of breeding birds in a county reflected the uneven geographical distributions of a particular species (Johnson and Schwartz 1993b). Data from more recent years

also indicate the value of long-term over short-term approaches to studies of grassland breeding birds. In this study, Le Conte's Sparrows were absent or rare in some years and abundant in others. Wiens (1974) noted similar changes in Grasshopper Sparrow populations in Texas; Grasshopper Sparrows were rare or absent during a severe and widespread drought but abundant the year after the drought. Because grassland bird populations fluctuate naturally and dramatically, short-term studies may provide a misleading picture of a changing population captured at one point in time (Wiens 1986). Additionally, a species' response to climatic variation may not be immediate; it may take 1 yr or more for a numerical response to occur. Thus, the probability of observing patterns of population change associated with changes in climate increases with longer term observations.

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