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Restoration and Winter Avian Use of Isolated Prairies in Eastern Texas

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Abstract - Numerous isolated prairies exist, or existed, on the West Gulf Coastal Plain east of the main distribution of the prairie ecosystem. Changing land-use patterns and suppression of wildfire have destroyed almost all of these small prairie occurrences. Intensified restoration and management of degraded prairie habitat on the Sam Houston National Forest in southeastern Texas have been ongoing since approximately 2004. As a result, encroaching woody vegetation has been substantially reduced, and a vegetation structure consistent with prairie habitat has been restored. Beginning in 2008, we conducted winter bird surveys on these prairies with the objective of quantifying avian use, especially by grassland sparrows of the genus *Ammodramus*. With the improvement in prairie structure, winter use of these sites by *Ammodramus* spp. was rapidly established, typically following the first post-restoration growing season. *Ammodramus henslowii* (Henslow's Sparrow), a species of conservation concern, responded particularly dramatically. These results demonstrate that aggressive restoration of prairie remnants on the West Gulf Coastal Plain can rapidly reestablish prairie habitat and facilitate re-colonization by at least some avian species characteristic of prairie habitats.

Introduction

Numerous isolated prairies occur, or once occurred, on the West Gulf Coastal Plain (WGCP) in eastern Texas, Louisiana, and southern Arkansas (Diggs et al. 2006, MacRoberts and MacRoberts 2004). In southeastern Texas, many small isolated prairies occur on the Sam Houston National Forest (SHNF) in Liberty, Montgomery, San Jacinto, and Walker counties (Carr 1993). These prairies are embedded within the pineywoods vegetation area on sites where a combination of edaphic conditions and a frequent fire regime historically inhibited establishment of woody vegetation (Diggs et al. 2006). Loss of isolated prairies on the WGCP has been extensive since the arrival of Europeans, primarily due to land-use changes, fire suppression, and silvicultural practices (MacRoberts and MacRoberts 2004). MacRoberts and MacRoberts (1997) estimated that the loss of isolated prairie communities is in excess of 99% in Louisiana alone, and there is no reason to infer a lower figure for eastern Texas. Many of the prairie occurrences on the SHNF became degraded due to the lack of consistent and focused management to preserve

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them. Fire suppression, agricultural impacts, grazing, and motorized vehicle activity also impacted the prairie sites (Carr 1993). Recognizing the widespread loss of prairie habitat and the degraded condition of isolated prairies on the SHNF, US Forest Service and Texas Parks and Wildlife Department personnel began a restoration project in 2004. Restoration consisted of mechanical removal of woody vegetation when necessary and initiation of a prescribed-fire regime specifically designed to reduce the prevalence of woody vegetation. On 5 of the prairie sites, restoration efforts included a limited reintroduction of herbaceous prairie species using sod and seed from nearby prairies. Restoration was successful in changing vegetation structure to more closely resemble historic prairie vegetation (Diamond and Smeins 1988). The eventual goal of restoration is for prescribed fire to become the only management treatment required to maintain prairie habitat.

Recognizing the improvement in prairie vegetation, we initiated winter bird surveys in 2008 to document the use of restored prairies by avian species, especially wintering sparrows in the genus *Ammodramus*. It is important to document restoration efforts on these prairies because the data will provide a basis for any future management and research that may occur on these important remnants of blackland prairies in eastern Texas. Our avian surveys were initiated in 2008, four years after prairie restoration, and after woody vegetation had largely been removed and herbaceous vegetation was well established on most prairies. Consequently, pretreatment avian and vegetation data are lacking. This situation precluded any formal study design or statistical evaluation of our results. However our survey results are important because they document the overall colonization pattern of these prairies by grassland sparrows following restoration.

Study Area and Methods

The study was conducted on the SHNF in southeastern Texas on prairies selected for restoration located in Walker and Montgomery counties. The prairies were small (0.4–10.0 ha) and embedded within a forested landscape dominated by mixed *Pinus* sp. (pine) and hardwood forest on the uplands, and bottomland hardwood forests along major drainages. The prairies are restricted to heavy clay vertisols of the Harris and Houston Black Series (Carr 1993, McClintock et al. 1972, 1979). Both series are components of the Miocene Fleming Formation consisting of calcareous marine sediments with high clay content (McClintock et al. 1972, 1979).

The isolated prairies of southeastern Texas have received virtually no ecological or floristic attention (Brown et al. 2002), but the limited information available suggests that they are transitional between the extensive blackland prairie to the northwest and the coastal prairie to the south (Brown et al. 2002; Diamond and Smeins 1984, 1988; MacRoberts and MacRoberts 2004; Nesom and Brown 1998; Smeins and Diamond 1983). These prairies also have floristic affinities with isolated prairies throughout the WGCP and eastward into Mississippi and Alabama (MacRoberts and MacRoberts 2004). The calcareous soils underlying these prairies support numerous species absent from the surrounding forested habitats, including many herbaceous plants (Carr 1993) and gastropods (Hubricht 1985).

Prairies of the SHNF have been degraded over the last century by agriculture, silviculture, fire suppression, grazing, off-road vehicle use, and other causes. Agricultural impacts ceased with the establishment of the national forest in the 1930s. In recent years, silvicultural impacts, grazing, and off-road vehicle use in SHNF have essentially eliminated sites that retain native prairie characteristics (Carr 1993). Prescribed fire was widespread on the SHNF prior to restoration efforts, but it was used primarily as a forest management tool; effects on prairie sites were incidental. Thus, the effectiveness of prescribed fires on these prairies was limited by the season, intensity, and differences in fuel characteristics between forest stands and the prairie habitats within the burn areas.

Prescribed burning of areas that include the study prairies has been a regular component of management on the SHNF for decades, as has occasional removal of woody vegetation from the prairies using chainsaws. A more intensive management protocol was initiated in 2004 with the specific objective of restoring the degraded prairies. Restoration initially consisted of woody vegetation removal using mulching machines, chainsaws, and mowing, as required to eliminate encroachment by woody species. Mulched material was left in place, and intact woody material was either burned, removed, or left in place depending on the amount present. Limited reintroduction of herbaceous prairie species was attempted using seed harvested in nearby areas (4 sites) and transplanting of sod (1 site). This effort was independent of our avian surveys, and no data are available on the details of this effort. Following the initial removal of woody vegetation, prescribed fire was applied when fuel conditions were suitable and management resources were available.

Little information was available on the floristics and vegetation structure of the prairies prior to initiation of restoration (Carr 1993; E. Keith, Raven Ecological Services, Huntsville, TX, pers. comm.). We collected limited additional data on selected prairies (% herbaceous cover, % woody cover) coincident with our avian surveys in 2010 and 2011. Differences in data collection methods and the paucity of pre-treatment data precluded analysis of these data.

We conducted winter avian surveys once per year between 19 January and 29 March from 2008 to 2011. In 2008, we surveyed only 5 prairies. We surveyed 16 prairies in 2009, and 23 in 2010 and 2011 as we continued to identify more prairie sites and our survey resources increased. Two to nine observers conducted the surveys depending on prairie size and year. Individual observers were spaced approximately 3 m apart and walked slowly through the prairies in a line (Bechtoldt and Stouffer 2005). Width of prairie and number of observers frequently required more than one pass to cover the entire prairie. We recorded all birds detected, and birds that could not be identified when initially flushed—primarily *Ammodramus* sparrows—were flushed repeatedly until identified or lost. Observers surveyed entire prairies in this manner, and minimized double counting by carefully observing the location where flushed birds landed. We were confident that double counting was avoided because individual prairies were small and the grassland bird species were present at relatively low abundance.

Results

We initiated prairie restoration efforts in 2004 and intensified our efforts in 2007. By 2008, we included a total of 23 prairies in restoration and survey efforts. Table 1 lists the prairies and their initial condition, based on visual assessment, prior to the initiation of intensified management. Table 2 documents the history of woody plant removal treatments and prescribed fire on the 23 prairies from 2004 to 2011. Multiple mechanical treatments were frequently necessary to reduce woody vegetation to levels compatible with development of prairie vegetation structure, i.e., the development of dense herbaceous vegetation. Mechanical treatments are currently being phased out. We could not measure pre-restoration woody vegetation because restoration was well underway prior to initiation of the avian surveys. However, 1–3 mechanical treatments appear to have been sufficient to eliminate woody vegetation, or at least reduce it to a level that could be effectively managed with fire.

Initial conditions on the prairies were highly variable. Most had moderate (50–75%) to heavy (75–100%) canopy cover by woody vegetation, primarily *Pinus taeda* L. (Loblolly Pine), *Juniperus virginiana* L. (Eastern Redcedar), *Crataegus* spp. (hawthorns), *Quercus* spp. (oaks), *Sideroxylon lanuginosum* Michaux (Gum Bumelia), *Celtis laevigata* Willdenow (Sugarberry), *Ilex vomitoria* Sol (Yaupon), and *Cornus drummondii* von Meyer (Roughleaf Dogwood). Numerous additional

Table 1. Prairie condition (percent woody encroachment) prior to initiation of restoration activities. Prairie designations are US Forest Service compartment and stand numbers and east–west or north–south portions of stands.

Prairie	% woody encroachment	Comments
2-1 E	58	>15-m pine encroachment
2-1 W	58	>15-m pine, w/ hardwood, and brush encroachment
2-2 E	1	Minimal encroachment
2-2 W	1	Minimal encroachment
2-9	35	3–5-m brush on periphery, center portion open
4-7 E	10	Minimal encroachment
4-7 W	10	Minimal encroachment
5-8	66	>15-m pines and brush on eastern portion and periphery
23-8	43	12-m pines and brush on western portion
33-8	78	10-m pines and brush on eastern 2/3 of site
58-14	?	12-m pines in central portion and scattered *Juniperus*
60-10	23	>15-m scattered pines and 1–2-m brush
60-12	32	>15-m pines and 2-m brush on periphery
60-20	34	2–5-m pines and brush on periphery
60-21	38	2–4-m brush on periphery w/ minimal herbaceous vegetation
60-22	61	2–5-m brush on western side and periphery
60-23	40	2–4-m brush mostly on eastern portion and periphery
60-38 N	44	>15-m pines and 4–7-m brush throughout
60-38 S	44	Minimal encroachment
61-18	62	>15-m pines and 2–5-m brush on northern portion
62-10	33	>15-m pines and ? brush
62-13	99	4–5-m woody encroachment, minimal herbaceous vegetation
63-18	99	>15-m pine, 10-m *Juniperus*, and 5-m brush, minimal herbaceous vegetation

species were present as minor components. Due to the dense shade created by the woody plant canopy, herbaceous species cover was minimal. Portions of several prairies were still relatively free of woody vegetation and supported a diverse herbaceous flora based on visual assessments. However, based on the extent of vertisol soils that presumably once supported prairie vegetation, we characterized all prairies as being encroached upon by woody vegetation, at least around the margins.

The abundance of woody vegetation rapidly declined on encroached sites when we initiated mechanical treatments (mulching, mowing, and chainsaw felling). Following the removal of woody vegetation, herbaceous vegetation developed rapidly on all sites except limited areas characterized by the most challenging edaphic conditions including areas of active erosion and poor soils. Stand 21, Compartment 60 is one of the sites where we observed a rapid response by herbaceous species following woody plant removal. Figure 1 depicts the site's condition prior to restoration in 2007; Figure 2 depicts the same site in 2011 following 2 mechanical treatments and 2 prescribed fires.

Numerous plant species characteristic of these isolated prairies (Brown et al. 2002, Carr 1993, MacRoberts and MacRoberts 2004) are currently present post-restoration including *Schizachyrium scoparium* (Michaux) Nash (Little

Table 2. Area of 23 prairies on the Sam Houston National Forest and management activities carried out by year, 2004–2011. Prairie = US Forest Service compartment and stand number, C = chainsaw felling of woody vegetation, P = prescribed burn, Mu = mechanical removal of woody vegetation using a mulching machine, and Mo = mowed.

		Management activities by year							
Prairie	Area (ha)	2004	2005	2006	2007	2008	2009	2010	2011
2-1 E	7.3	C, P	P		P	P			P
2-1 W	3.5	C, P	P		P	P			P
2-2 E	3.6		P		C, P	P			
2-2 W	4.7		P		C, P				
2-9	1.0					P			P
4-7 E	2.3				P				
4-7 W	3.0				P				
5-8	2.8				C, P	P		P	
23-8	1.5					Mu, P		C	
33-8	2.0								
58-14	1.3								
60-10	10.0	C, P		P	Mu, P	P	Mo		
60-12	2.6	C, P		P	Mu	P	Mo		
60-20	1.0	P			Mu	P	Mo		
60-21	1.9				Mu, P	P	Mo		
60-22	0.4				Mu		P		
60-23	0.7				Mu		Mo, P		
60-38 N	1.0				Mu				
60-38 S	1.6				Mu				
61-18	1.9					Mu	P		
62-10	3.1	C, P		P	P	Mo	Mo		
62-13	1.5	P		P	Mu				
63-18	3.1					Mu, P		C	P

Figure 1. Prairie in Compartment 60, Stand 21 on the Sam Houston National Forest, TX, prior to restoration (2007).

Figure 2. Prairie in Compartment 60, Stand 21 on the Sam Houston National Forest, TX, after restoration (2011).

Bluestem), *Andropogon gerardii* Vitman (Big Bluestem), *Bouteloua rigidiseta* (Steudl) Hitchcock (Texas Grama), *Eustoma grandiflorum* (Rafinesque) Shinners (Prairie Gentian), *Carex microdonta* Torrey & Hooker (Littletooth Sedge), *Polytaenia nuttallii* de Candolle (Prairie Parsley), *Arnoglossum plantagineum* Rafinesque (Prairie Plantain), and *Echinacea purpurea* (L.) Moench (Purple Coneflower). The presence of these species indicates that a significant portion of the flora survived the period of fire suppression and grazing as remnant communities, isolated plants within the encroached habitats, or in the seed bank, though some may have been established through transfer of soil or seed from nearby prairie sites as part of the restoration effort, or by natural dispersal. Non-native species are relatively uncommon. However, *Bothriochloa ischaemum* (L.) Keng (King Ranch Bluestem) is a pernicious invader present on most of the prairies we surveyed, and abundant on several of them. Specific data are not available; however casual observations indicate that King Ranch Bluestem has increased with disturbance associated with restoration, and forest service personnel are initiating control measures.

We detected a total of 1626 birds of 31 species on 23 prairies. These included a suite of species characteristic of forest habitats. We frequently detected an additional 4 species—*Spizella passerine* Bechstein (Chipping Sparrow), *Spizella pusilla* Wilson (Field Sparrow), *Melospiza lincolnii* Audubon (Lincoln's Sparrow), and *Passerculus sandwichensis* Gmelin (Savannah Sparrow)—characteristic of grassland and edge habitats. These species tended to occur in fairly large flocks, and their numbers varied substantially among prairies and years. Forest birds and those that inhabit grassland and edge habitats accounted for 1215 (74.7%) of the total detections. These species did not exhibit any consistent numerical trend across years, likely due to their lack of strict dependence on improving prairie habitat, and the highly variable data for the 4 species that often occurred in large flocks. Our surveys failed to detect any members of a suite of several species that we consider typical of grassland habitats in the region, including *Circus cyaneus* L. (Northern Harrier), *Eremophilus alpestris* L. (Horned Lark), *Anthus spragueii* Audubon (Sprague's Pipit), and *Cistothorus platensis* Latham (Sedge Wren). In addition, we detected *Sturnella magna* L. (Eastern Meadowlark) only once.

Three species of sparrows in the genus *Ammodramus* accounted for 411 of the total detections (25.3%), of which 283 were identified to species. *Ammodramus henslowii* Audubon (Henslow's Sparrow) was the predominant species (214 individuals; 75.6%), followed by *A. lecontii* Audubon (Le Conte's Sparrow; 67 individuals; 23.7%), and *A. savannarum* Gmelin (Grasshopper Sparrow; 2 individuals; 0.7%). Unidentified *Ammodramus* spp. totaled 128 individuals. Table 3 presents data for *Ammodramus* sparrows stratified by groups of prairies surveyed for 4 ($n = 5$) and 3 ($n = 11$) years. The total number of individuals of *Ammodramus* sparrows increased substantially across years in concert with the overall reduction in woody vegetation and an increase in herbaceous vegetation during those same years. Increases were substantial: an order of magnitude for the prairies surveyed for 4 years, and a 27% increase for prairies surveyed for 3 years.

The number of individuals of *Ammodramus* sparrows detected on specific prairies across years was informative. At least 4 prairies (60-21, 60-38, 61-18, and 62-13) had very severe encroachment by woody vegetation prior to mechanical treatments (Table 1). Woody vegetation was 3–5 m in height with an essentially closed canopy, producing dense shade that had almost completely eliminated herbaceous vegetation. Although bird surveys were not conducted prior to mechanical removal of woody vegetation, the habitat was unsuitable for *Ammodramus* sparrows due to the abundance of remaining woody vegetation and the paucity of herbaceous vegetation in the moderately and heavily encroached prairies. Presumably, they were absent or present in very low numbers. However, 1–3 growing seasons after removal of woody plants, extensive grass cover was established, and the numbers of *Ammodramus* sparrows began to increase substantially (Table 3).

Prescribed fires and unauthorized grazing also had an impact on use by *Ammodramus* sparrows. Prairie 2-2 (20.9 ha) had limited woody encroachment, which was removed by chainsaw in 2007. Prairie structure remained intact during the 2008 survey, and we detected 9 *Ammodramus* sparrows. In 2009, prescribed burning was conducted prior to the avian survey, and we detected only 1 Henslow's Sparrow in a small patch of residual grass on the periphery of the prairie. In 2010, cattle had grazed the site, resulting in a reduction of vegetation height to <15 cm, and observers detected no *Ammodramus* sparrows. In 2011, herbaceous cover had reestablished in the absence of burning and grazing, and we detected 30 *Ammodramus* sparrows. Prairie 2-9, a small 1-ha site, was grazed in 2010, and observers detected no *Ammodramus* sparrows. In the absence of grazing, we detected 2 *Ammodramus* sparrows in 2009 and 1 in 2011.

Discussion

Although the lack of pre-treatment data and divergent sampling techniques precluded statistical analysis of vegetation, several tentative conclusions are evident. Following management, prairie sites that were heavily encroached by woody vegetation were rapidly converted to communities dominated by herbaceous species with a minimal or non-existent woody component. More importantly, many herbaceous species present in historic and surviving remnants of blackland prairies and in remnant patches within the current sites at the beginning of restoration activities are now present on the restored sites. It is important to conduct detailed surveys to document the current floristic makeup of these prairies.

Ongoing management will be required to maintain current progress and continue the restoration of these prairies. In the absence of ecologically significant wildfire,

Table 3. Number of *Ammodramus* sparrows detected on 5 prairies surveyed for 4 years and 11 prairies surveyed for 3 years, Sam Houston National Forest, TX (2007–2011).

# prairies	2008	2009	2010	2011
5	9	17	52	96
11	-	61	68	83

prescribed fire will be necessary to prevent encroachment of woody vegetation. Anecdotal observations of the current conditions suggest that prescribed fire will be sufficient to maintain restored conditions once they are achieved. Some remaining woody vegetation will require additional mechanical control and a few additional prairie sites remain that are suitable for future restoration.

Due to the increased abundance of herbaceous vegetation and the fuel they produce, prescribed fires remove all, or nearly all, woody vegetation and debris. Future prescribed burns later in the growing season are under consideration both to control invasive King Ranch Bluestem and to better match the presumed natural fire regime. Erosional features >1 m deep are present at some sites. In the absence of grazing, these washouts are becoming vegetated and the soil stabilized. If this trend continues, specific measures to control erosion will not be required. However, a number of plant species are dependent on areas of bare soil associated with these erosional features (J. Singhurst, Texas Parks and Wildlife Department, Austin, TX, pers. comm.) suggesting that some of these areas should be maintained.

Grazing by domestic stock is officially prohibited on these prairie sites; however, unauthorized grazing still occurs, occasionally resulting in reduction of the grass height to approximately 10 cm. These heavily grazed sites do not provide suitable habitat for the *Ammodramus* sparrows. Grazing also has the potential to reactivate erosion and introduce additional non-native species. Carr (1993) suggested that stabilization of eroded portions of these prairies was unlikely as long as grazing continues, strengthening the case for setting the elimination of grazing as a management goal. Additionally, soil disturbance by feral hogs and off-road vehicles occurs intermittently. Management efforts should be made to minimize these and any other sources of soil disturbance.

Barring the return of fire-suppression, the threat from exotic invasive plant species is undoubtedly the major threat to the continued existence of these prairie communities. King Ranch Bluestem, a native of central Asia, is rapidly spreading in the region (Gabbard and Fowler 2007). It is currently present in most of the SHNF prairies and has the potential to drastically change the vegetation structure with potentially serious impacts on floristics, grassland bird communities, and other taxonomic groups. Some success in the control of King Ranch Bluestem through the use of hot, growing-season fires, especially immediately prior to seed dispersal, has been reported (Ruckman 2009, Simmons et al. 2008, but see Davis 2011). Prairie vegetation in the SHNF should be closely monitored to ascertain the distribution and amount of King Ranch Bluestem and determine if control measures are warranted.

The abundance of wintering grassland sparrows, primarily Henslow's Sparrow, is notable. Henslow's Sparrow is of significant conservation concern (Burhans 2002), and little is known concerning its wintering ecology. Several studies have detailed the relationship of wintering Henslow's Sparrows with fire (Carrie et al. 2002, Johnson et al. 2009, Tucker and Robinson 2003), suggesting that Henslow's Sparrows preferentially use ephemeral habitats within 1–2 years post-burn. This is consistent with the rapid arrival of wintering birds following

prairie restoration in this study. The high density of *Ammodramus* sparrows is also noteworthy. The 61.8 ha of prairie habitat surveyed in 2010 and 2011 supported 137 and 187 *Ammodramus* sparrows, respectively. Henslow's Sparrows, were most numerous, but substantial numbers of Le Conte's Sparrows and an occasional Grasshopper Sparrow were also present. Not all prairie habitat was suitable for sparrows in any given year. To our knowledge, such a high density of wintering Henslow's Sparrows has not been previously reported on the WGCP. Christmas Bird Count data for the WGCP only report low numbers, and our reported densities are higher than those reported by Carrie et al. (2002) in Louisiana. The density of Henslow's Sparrows suggests that the prairies we studied may provide quality wintering habitat for this species.

We presume that the extremely small size of these prairie inclusions is the reason that our surveys failed to detect some species characteristic of regional prairie habitats. Many of the grassland species that were absent at our survey sites have been shown to exhibit aspects of area sensitivity (Herkert 1994, Johnson and Igl 2001). However, most studies were of breeding birds, were conducted in landscapes more heavily dominated by grasslands, and seldom included fragments as small as those considered in this study. Consequently, results are not directly applicable, but do suggest that area sensitivity is a factor.

Despite the regrettable lack of pretreatment data, we suggest that two very general conclusions are indicated by the data available. First, effective restoration of prairie vegetation is straightforward using mechanical treatments and prescribed fire. Furthermore, restoration, including re-establishment of typical prairie plant species, is rapid. Prairie conditions including low abundance or elimination of woody vegetation, are established within 1–3 years after the start of restoration efforts. Our study suggests that these restored conditions can be maintained with prescribed fire as the only management tool, even on what had previously been extremely fire-suppressed sites. Second, wintering sparrows in the genus *Ammodramus* colonize the sites rapidly, following the first growing season post-restoration in some cases. Within 1–2 years, high densities of Henslow's Sparrows can be present. These two general observations highlight both the feasibility and importance of restoration and future management of these remnants of the blackland prairie ecosystem on the Sam Houston National Forest.

The Blackland prairie community type of the WGCP is one of the most endangered biotic communities of North America (MacRoberts and MacRoberts 2004, Zollner et al. 2003). Very few examples remain that are both protected and in good condition. The >60 ha represented by the isolated prairies on the SHNF are a significant contribution to the preservation of this once widespread community (Carr 1993, MacRoberts and MacRoberts 2004). Land managers should make continued management of these prairie remnants a high priority.

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