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Impact of prescribed burning on vegetation and bird abundance at Matagorda Island, Texas

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Abstract

We measured the impact of prescribed summer and winter burns on vegetation characteristics and spring abundance of birds in a *Spartina/Paspalum* grassland at Matagorda Island National Wildlife Refuge and State Natural Area, Texas, 1993–94. We burned 8 (4 summer burn, 4 winter burn), 122-ha plots. We estimated bird abundance by surveying once a week from March through May at 12–16 fixed-radius point count stations in each plot. We measured forb and grass foliar cover, litter depth, visual obstruction, and woody and residual stem density at each point count station 6–10 months after burning and 18–22 months after burning and found few differences in vegetation between summer and winter burns. Litter depth, visual obstruction, and woody stem density values were greater on control plots 6 to 10 months post-burn. By 18 to 22 months post-burn, only litter depth and visual obstruction remained higher on control plots than on either burn treatment. At 6 to 10 months after burning, wrens were more abundant on control plots and sparrows were more abundant on the burned plots. By 18 to 22 months post-burn, wren abundance had increased on the burned plots, but was still highest on control plots. Sparrow abundance remained highest on burned plots 18–22 months after burning. Precipitation was higher in 1993 than 1994; we believe blackbirds responded more to annual precipitation differences than to burning treatment. In this coastal island grassland, wren abundance was highest on unburned plots and sparrow abundance was highest on burned plots. We suggest that land managers could burn at > 2 year intervals in this grassland without negatively impacting most resident bird species.

Key Words: bird families, coastal barrier island, grassland, habitat, prescribed burning, Texas

Resúmen

Se midió el impacto de incendios intensionales en verano e invierno, sobre la vegetación y abundancia de aves durante la primavera en un pastizal de *Spartina/Paspalum* en el Area Natural Estatal y Refugio Nacional de Vida Silvestre Isla Matagorda, Texas, 1993–1994. Se quemaron 8 parcelas de 122 ha cada una (4 en verano y 4 en invierno). Estimamos la abundancia de aves mediante un muestreo semanal desde Marzo hasta Mayo utilizando12 a 16 puntos de conteo de radio fijo por parcela. Se midió covertura foliar de los pastos y matas, profundidad del mantillo, obstrucción visual y densidad de tallos leñosos y residuales, entre los 6 y 10 meses y los 18 y 22 meses después de las quemas en cada parcela, encontrándose pocas diferencias en la vegetación entre las quemas de verano e invierno. Los valores de profundidad del mantillo, obstrucción visual y densidad de tallos leñosos, fueron mayores en las parcelas controles luego de 6 a 10 meses de la quema. Luego de 18 a 22 meses, sólo la profundidad del mantillo y la obstrucción visual se mantuvieron altas en parcelas controles respecto de cualquier otro tratamiento. Durante los 6 a 10 meses después de las quemas, individuos de la familia Troglodytydae, fueron mas abundantes en las parcelas controles mientras que Emberizinae fue mas abundante en las parcelas quemadas. La abundancia de Troglodytydae se incrementó en las parcelas quemadas luego de 18 a 22 meses, manteniéndose alta en las parcelas controles mientras que la abundancia de Emberizinae, se mantuvo alta en los sitios quemados. El régimen deprecipitación fue más alto en 1993 que en 1994, nosotros creemos que individuos de la familia Icteridae respondieron más a las diferencias en la precipitación anual que a los tratamientos por quemas. En este pastizal costero de isla, la abundancia de Troglodytydae fue más alta en parcelas no quemadas mientras que la abundancia de Emberizinae fue más alta en parcelas quemadas. Sugerimos que los dueños de tierras en la reserva, podrían realizar quemas a intervalos mayores de 2 años en este pastizal sin generar un impacto negativo en la mayoría de las especies residentes.

The U.S. Fish and Wildlife Service's Breeding Bird Survey indicates that certain migratory bird species have declined (Robbins et al. 1989). These declines may be attributed to habitat loss on either wintering or breeding grounds (Gradwohl and Greenburg 1989), Robbins et al. 1989, Askins et al. 1990, Finch 1991). One frequently overlooked consideration that may contribute to the decline is the availability of suitable stop-over habitat where birds rest during migration (Hutto 1985, Moore et al. 1990).

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Large numbers of migrants use coastal habitats along the Gulf of Mexico during migration (Moore and Kerlinger 1987, Moore and Simons 1992). It is on these islands that species can replenish energy before continuing to their breeding grounds or build energy reserves for the long migration flight to the wintering grounds. The alteration or disturbance of in-transit habitat may detrimentally affect how these species meet the costs of migration (Ward 1987, Finch 1991, Moore and Simons 1992).

We assessed prescribed burning as a management tool on Matagorda Island National Wildlife Refuge and State Natural Area, Texas. Our objectives were to evaluate the impact of summer and winter burns on vegetative characteristics and bird abundance.

Materials and Methods

Study Area

Matagorda Island is a 22,943 ha coastal barrier island along the mid-coast of Texas in Calhoun county (Blankenship et al. 1990). It is 1 of 5 large barrier islands adjacent to the Texas coast and is located about 14.5 km southwest of Port O'Connor and 81 km southeast of Victoria. The island is 60.8 km long and varies in width between 1.2 to 7.2 km.

The climate is maritime and largely controlled by the Gulf of Mexico and associated warm, moist air masses (Mowery and Bower 1978, Blankenship et al. 1990). Peak rainfall periods are May, June, August, and September with an annual precipitation of 98 cm. Temperatures are fairly constant throughout the year with an average annual temperature of 21°C.

Major physiographic areas include the beach-dune complex, barrier flats, salt marsh, and wind-tidal flats (Blankenship et al. 1990). These areas are flat to gently rolling with the exception of the sand dunes. Barrier flats are dominated by grassland habitat typical of coastal barrier islands in Texas (Blankenship et al. 1990). Grass species include primarily gulf cordgrass (*Spartina spartinae* (Trin.) Merr. authority for soil type names), marshhay cordgrass (*Spartina patens* (Ait.) Muhl.), and gulf dune paspalum (*Paspalum monostachyum* Vasey). Baccharis (*Baccharis* sp. Vasey), a shrub indigenous to barrier islands, occurs in scattered clumps.

Sampling Design

We located 6 plots each year, approximately 122-ha each, on the mid-portion of Matagorda Island in the barrier flats and established a matrix of 12–16 survey point count stations, 300 m between each station, in each plot. In 2 irregularly shaped plots, we reduced the number of count survey stations to 12 and 15. We randomly assigned 2 burn treatments to 2 plots each year. We conducted our first summer burns on 27–28 August 1992 and our second summer on 24–25 August 1993. We burned our first winter burns on 6 and 14 January 1993 and the second burns on 4–5 January 1994. Four plots served as controls. All burns were conducted with half a headfire and half a backfire technique on each plot (C. M. Britton and S. D. Brown, Tex. Tech Univ., pers. commun.).

We used a fixed-radius point count method to estimate bird abundance (no./40 ha) from 1 March to 30 May 1993 and 1994 (Verner 1985, Verner and Ritter 1985) and recorded all birds heard or sighted over a 5-minute period and within 50 m at each point count station. We repeated all surveys 12 times on each plot in both years with about 7 days between surveys on individual plots. In 1993, we estimated bird abundance on 2 summer burn plots, 2 winter burn plots, and 2 control plots. We defined this sampling period as 6–10 months post-burn. In 1994, we surveyed birds on 2 'new' (1993–1994) winter and summer burns and 2 additional control plots. The 'new' plots provided another sample from 6–10 months post-burn. In addition, in 1994, we resurveyed the 2 control and 4 treatment plots burned in 1992–93; these surveys provided samples 18 to 22 months post-burn.

At each point count station, we measured vegetation along a 50-m tape extended in the 4 cardinal directions. We estimated forb and grass foliar cover with an ocular sighting tube (Yahner 1986) and measured litter depth to the nearest centimeter at 5-m intervals along each 50-m line. We used a Robel pole (Robel et al. 1970) at a 1-m sighting height and distance to estimate visual obstruction (i.e., lowest height that vegetation obstructed 100% of the pole) at 10-m intervals along each line. To estimate density, we counted all woody and residual (i.e., dead woody and sunflower stalks) stems contained in a 50-m radius at point count stations. We obtained annual precipitation data from the U.S. Fish and Wildlife Service's headquarters on Matagorda Island.

Statistical Methods

We used 2 analyses to test for differences ($P < 0.10$) in bird abundance and characteristics of the vegetation among treatments. We used a randomized block two-way analysis of variance to test for the influence of year and burn treatment on vegetation variables and bird abundance 6–10 months after burning. To test for differences between vegetation variables and bird abundance on plots that we sampled at both the 6–10 months and 18–22 months interval, we used a randomized block repeated measures two-way analysis of variance (SAS. 1989). We used Tukey's HSD mean separation tests when we found significant main effects and interactions. We investigated trends in diversity (Shannon and Weaver1949) at the species and family/subfamily taxonomic level using one-way analysis of variance. We estimated abundance for families/subfamilies of birds when we had at least 5 observation/plot/survey during the 12 survey periods.

Results

Six to 10 months post-burn

Vegetation

Burning changed vegetation characteristics by decreasing litter, visual obstruction, and woody stem densities (Table 1). Litter depth decreased from 1993 to 1994, but was greater on unburned plots in both years. Precipitation was higher in 1993 (110 cm) than 1994 (52 cm).

Birds

We recorded 6827 birds of 136 species and 36 families/subfamilies in 1993 and 6624 birds in of 135 species and 40 families in 1994. Because abundance of individual bird species was low and we found no difference in diversity at the species ($P>0.95$) or the family ($P > 0.94$) level, we grouped birds into families or subfamilies (Samson 1979, Short 1983) for analyses of abundance. We present estimates of spring bird abundance for 10 resident families/subfamilies: Anatidae (waterfowl), Ardeidae (herons, egrets),

Table 1. Vegetation characteristics measured at point count stations (n = 24–32) on the barrier flats 6 to 10 months after burning, Matagorda Island National Wildlife Refuge and State Natural Area, Texas, July 1993 and 1994.

Vegetation Variables	1993 Control	1993 Summer	1993 Winter	1994 Control	1994 Summer	1994 Winter
Forb Cover (%)	18.9(6.1)[a]	23.9(4.9)	30.5(5.3)	27.3(2.8)	32.0(7.1)	36.1(8.8)
Grass Cover (%)	57.6(1.2)	58.6(8.4)	49.7(2.3)	40.3(7.2)	36.3(8.1)	28.8(13.4)
Litter Depth (cm)	9.9(0.6)[b]A	0.0(0.0)B	0.0	6.6(0.4)A	0.0(0.0)B	0.0(0.0)B
Visual Obstruction	17.3(2.2)[c]	11.0(0.2)	10.0(0.8)	11.0(0.9)	2.6(0.4)	3.1(0.3)
Residual Stems (no./ha)						
<1 m	0.0[d](0.0)	1.6(0.9)	0.3(0.2)	0.0(0.0)	6.2(3.7)	1.2(0.1)
1–2 m	5.9(3.1)	7.2(6.5)	7.0(6.9)	17.0(3.1)	18.5(14.3)	8.4(3.5)
Woody Stems (no./ha)						
<1 m	4.7(3.6)[e]B	1.4(1.4)A	2.1(1.9)A	4.0(0.9)A	0.0(0.0)B	0.3(0.3)C0.3(0.3)C
1–2 m	21.0(8.3)A	4.8(4.3)B	2.5(1.7)B	38.3(20.9)A	0.5(0.5)B	0.1(0.1)B

[a]Mean (standard error)
[b]Within years, variables followed by the same letter were not different (P>0.05).
[c]Height of vegetation at 100% obstruction.
[d]Dead herbaceous and sunflower stalks.
[e]All woody stems, except sunflower stalks

Rallidae (rails), Scolopacidae (shorebirds), Caprimulgidae (nightjars), Hirundinidae(swallows), Troglodytidae (wrens), Icteridae (blackbirds), Fringillidae (grosbeaks, buntings), and Emberizinae (sparrows). We found few differences in bird abundance among treatments (Table 2). Wrens (P = 0.03) were most abundant on control plots and sparrows (P = 0.08) were most abundant on the burned plots. Blackbirds (P = 0.04) were more abundant in the year of higher precipitation (1993).

6–10 month vs. 18–22 month post-burn

Vegetation

By 18–22 months after burning, we found the treatment effect was not detectable for most vegetation characteristics we measured (Table 3). Within treatments, we found grass cover decreased on all but winter burns, visual obstruction decreased on all treatments, and residual stem density increased on all treatments.

Birds

Wren (P = 0.01) abundance remained highest on control plots than either of the burn treatments, but had increased over levels found 6–10 months post-burn. Sparrow (P = 0.01) abundance remained highest on both burn treatments 18–22 months after burning (Table 4).

Discussion and Conclusions

There were few differences in vegetation variables between burned and unburned areas when we measured at 6–10 months post-burn and 18–22 months post-burn. Drawe and Kattner (1978) reported that burning in September on Padre Island, Texas, produced greater forb response, but burning in February depressed grass and forb production the first growing season after treatment. In contrast to the work on Padre Island, we found grass and forb foliar cover did not differ among our treatments in either the 6–10 or the 18–22 month sampling period. In our work, litter depth remained unchanged from the first to the second post-burn period. We suspect that litter may take longer than 2 seasons after a fire to accumulate. Our results agree with Wright and Bailey (1982) who reported litter accumulated after 2 to 3 years following a fire and generally returned to normal on grasslands within 5 years after burning depending on annual precipitation.

Table 2. Spring abundance (no./40 ha) of resident birds on 2 control (C), summer burn (S), and winter burn (W) plots surveyed 6 to 10 months post-burn, Matagorda Island National Wildlife Refuge and State Natural Area, Texas, 1 March to 31 May 1993 and 1994.

	Bird Abundance								
	1993			1994					
Families/	Plot[a]			Plot			P[b]		
subfamilies	C	S	W	C	S	W	T	Y	I
	(no./40ha)								
Anatidae	18.6	6.0	9.9	4.4	4.5	0.3	0.67	0.09	0.85
Ardeidae	0.9	3.3	0.0	0.2	9.9	1.4	0.53	0.44	0.61
Rallidae	1.6	1.5	0.1	0.0	0.0	0.0	0.44	0.13	0.44
Scolopacidae	2.2	1.3	3.5	1.0	1.9	0.9	0.70	0.39	0.09
Caprimulgidae	0.2	0.0	0.2	0.0	0.4	0.2	0.50	0.50	0.50
Hirundinidae	0.5	0.0	1.8	1.6	2.1	3.4	0.61	0.42	0.97
Troglodytidae	28.2	3.1	0.9	20.7	1.8	0.7	0.03	0.44	0.60
Icteridae	23.3	52.9	34.4	22.8	42.9	28.3	0.15	0.04	0.74
Fringillidae	0.3	0.1	0.5	1.9	1.1	0.3	0.67	0.16	0.54
Emberizinae	2.9	18.9	11.0	8.4	30.1	15.7	0.08	0.11	0.50

[a]n = 12–16 survey points per plot, 12 visits per plot.
[b]T = treatment effect, Y = time after burn effect, I = interaction effect.

Table 3. Vegetation characteristics measured at point count stations (n = 24–32) at 6 to 10 and 18 to 22 months post-burn, Matagorda Island National Wildlife Refuge and State Natural Area, Texas, July 1993 and 1994.B

Vegetation Variables	6–10 months post-burn			18–22 months post-burn		
	Control	Summer	Winter	Control	Summer	Winter
Forb Cover (%)	18.9(6.1)[a]A	23.9(4.9)A	30.5(5.3)	26.7(6.4)	25.6(3.1)A	26.4(3.3)A
Grass Cover (%)	57.6(1.2)A	58.6(8.4)A	49.7(2.3)	42.5(0.6)B	53.7(9.9)B	54.7(3.8)B
Litter Depth (cm)	9.9(0.6)A	0.(0.0)B	0.(0.0)B	5.5(0.3)B	1.0(0.4)A	0.3(0.3)A
Visual Obstruction	17.3(2.2)[b]A	11.0(0.2)A	10.0(0.8)	11.0(1.2)B	5.4(0.7)B	3.9(0.6)B
Residual Stems (#/ha)						
<1 m	0.0(0.0)[c]A	1.6(0.9)A	0.3(0.2)A	0.4(0.4)A	14.7(14.6)	
1–2 m	5.9(3.1)A	7.2(6.5)A	7.0(6.9)B	19.4(9.6)	17.3(14.6)	71.2(1.3)B
Woody Stems (#/ha)						
<1 m	4.7(3.6)[d]A	1.4(1.4)A	2.1(1.9)A	3.7(3.6)A	6.0(6.0)A	
1–2 m	21.0(8.3)A	4.8(4.3)A	2.5(1.7)A	40.0(3.4)B	3.3(2.9)A	1.9(1.9)A

[a]Means (standard error). Variables followed by the same letter were not different (P > 0.05) in a comparison within treatments between 6–10 and 18–22 months after burning.
[b]Height of vegetation at 100% obstruction.
[c]Dead herbaceous stems and sunflower stalks.
[d]All woody stems, except sunflower stalks.

We believe the trends in vegetation variables on individual treatments in the second post-burn season may be explained by annual weather patterns. Rainfall plays a major role in the structure of grasslands (Wright and Bailey 1982). Weather conditions differed between years in our study: 1993 was an average year, 1994 was a dry year. On control plots, we found that grass cover, litter depth, and visual obstruction were higher in 1993 than in 1994. These variables followed the same trends on burned areas by the second post-burn sampling.

Weather (e.g., rainfall) is also thought to influence breeding grassland bird density (Smith 1982, Cody 1985, George et al. 1992). Zimmerman (1992) noted that burning in drought years in tallgrass prairie may influence breeding birds more strongly than in average years. He suggested that this could be due to lower above ground biomass and structural simplicity on burned areas in drought years. Because weather conditions differed between years in our study, we expected lower bird abundance in the dry year, 1994. However, we detected differences in abundance between years in only 10% of the families. We speculate that precipitation levels in 1994 must have not been severe enough to impact bird abundance.

We could not generalize across bird families about response to prescribed burning. Generally, wrens were most abundant on unburned, control plots. Burning removes the accumulated dead plant material and creates a more open habitat; wrens may prefer dense vegetation. Although, wrens were seldom seen on burned plots 6–10 mo. after burning, they increased significantly in the second post-burn season. The difference may have been due to the low visual obstruction on burned plots in the first post-burn season. By the second post-burn season, wrens abundance increased on burned areas where vegetation resembled control plots. Herkert (1994) noted that Sedge Wrens (*Cistothorus platensis*) were never encountered on transects in recently burned grassland in the first year post-burn, but were sighted again after 2 or more post-burn seasons.

Sparrows tended to frequent burn areas when we surveyed 6–10 months as well as 18–22 months after the burns. Recently burned areas were more open and presented more bare ground than controls. Herkert (1994) also showed that sparrows (e.g., Grasshopper Sparrow [*Ammodramus savannarum*], Savannah Sparrow [*Passerculus sandwichensis*]) were more common on recently burned areas and then decreased in numbers following

Table 4. Spring abundance (no/40 ha) of resident birds on 2 control (C), summer burn (S), and winter burn (W) plots surveyed 6 to 10 months and 18–22 month after burning at Matagorda Island National Wildlife Refuge and State Natural Area, Texas, 1 March to 31 May 1993 and 1994.

Families/ subfamilies	Bird Abundance: 6–10 months, Plot[a]			18–22 months, Plot			P[b]		
	C	S	W	C	S	W	T	Y	I
	(no./40ha)								
Anatidae	18.6	6.0	9.8	6.6	1.9	0.4	0.37	0.15	0.79
Ardeidae	0.9	3.3	0.0	1.4	0.4	0.0	0.41	0.46	0.43
Rallidae	1.6	1.5	0.1	0.4	0.2	0.1	0.24	0.11	0.40
Scolopacidae	2.2	1.3	3.5	2.5	0.3	0.6	0.25	0.14	0.22
Caprimulgidae	0.2	2.0	0.2	0.0	0.2	0.6	0.52	0.51	0.83
Hirundinidae	0.5	0.1	1.8	0.0	0.0	0.1	0.49	0.30	0.55
Troglodytidae	28.2	3.1	0.9	21.7	14.8	15.1	0.01	0.08	0.04
Icteridae	23.3	52.9	34.4	23.0	28.5	26.8	0.08	0.07	0.18
Fringillidae	0.3	0.1	0.5	1.3	2.9	3.8	0.76	0.20	0.80
Emberizinae	2.9	18.9	11.0	6.5	15.6	16.7	0.01	0.25	0.16

[a]n = 12–16 survey points per plot, 12 visits per plot.
[b]T = treatment effect, Y = time after burn effect, I = interaction effect.

the second post-burn season. These species generally prefer low to medium height vegetation on their breeding grounds and our burn treatments may have provided sparrows with the appropriate vegetative structure for their foraging activities (Wiens 1969).

Our bird survey results should be interpreted cautiously because statistical power in our research was variable, ranging from 0.10 to 0.90 depending on family (Lipsey 1990). We found that the highest effect sizes came from resident bird families on Matagorda Island and lower effect sizes from migratory bird families. Other researchers (Moore and Kerlinger 1987, Moore et al. 1990, Moore and Simons 1992) reported large variation in bird numbers for bird species in migration. Moore et al.'s (1990) description of marsh/meadow habitat on Horn Island, Mississippi,was similar to the barrier flats on Matagorda Island. They noted that migratory bird species used marsh/meadow habitat less than others on Horn Island. Although we did not look at other habitats, migrant bird families seemed infrequent on the barrier flats of Matagorda Island and this infrequency may account for the low effect sizes. In our experience, migrant bird use of Matagorda Island can vary on an hourly basis; this makes powerful sampling very difficult to achieve.

Vegetation on Matagorda Island seems highly resilient to prescribed fire. This resiliency may be the result of a long growing season. Since vegetation attributes return quickly to pre-burn conditions, the impact of burning on bird abundance was weak by the second post-burn season and may decline further after 2 or more growing seasons. Wren abundance was negatively impacted by burning and sparrows were more abundant on burned areas. For groups of birds other than wrens, we suggest that prescribed burning be applied about once every 2 or more years since vegetation and bird abundance on the barrier flats returned to near pre-burn conditions by 18–22 months post-burn.

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