3-2006

Fire History, Passerine Abundance, and Habitat on a North Dakota Drift Plain Prairie

Timothy J. Ludwick
University of Pittsburgh - Greensburg

Robert K. Murphy
University of Nebraska at Kearney, murphyrk@unk.edu

Fire History, Passerine Abundance, and Habitat on a North Dakota Drift Plain Prairie

TIMOTHY J. LUDWICK[1] and ROBERT K. MURPHY[2]

University of Pittsburgh at Greensburg, 1150 Mt. Pleasant-Greensburg Rd., Greensburg, PA 15601 (TJL)
U.S. Fish and Wildlife Service-Des Lacs National Wildlife Refuge Complex, 8315 Hwy 8, Kenmare, ND 58746 (RKM)

ABSTRACT -- Prescribed fire is among key tools for restoring and managing prairies in the northern Great Plains, yet there are no published reports of its impacts on grassland passerine birds on native prairie in the Drift Plain, a major physiographic subregion. We examined relationships between prescribed fire history and abundance and habitat of breeding passerines in Drift Plain prairie at Des Lacs National Wildlife National Refuge in northwestern North Dakota. In 2003, we used point counts (n = 79 75 m radius plots) to survey bird abundance on 16 management units that had been prescribe-burned one to three times each since 1992. General habitat composition and structure also were measured at each point count plot. We detected 14 passerine species, six of which were common (occurred on greater than 10 % of plots). Three endemic, historically common passerine species were rare or absent regardless of fire history. Abundances of common bird species were not influenced strongly by fire history, which contrasts with data from research on the adjacent Missouri Coteau physiographic subregion. Vegetation structure (litter depth and plant height-density) and occurrence of an exotic grass species, smooth brome (*Bromus inermis*), decreased with fire history. However, we detected no relationships between bird species abundances and these particular vegetation variables, perhaps because smooth brome continued to be a pervasive structural influence on all management units. Our findings indicate

[1]Current address: Texas A&M University-Kingsville, Caesar Kleberg Wildlife Research Institute, 700 University Blvd., Kingsville, TX 78363.
[2]Corresponding author. Current address: Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849. E-mail address: murphyrk@unk.edu

a need for better understanding of bird-fire relationships on remnant prairies in the vast Drift Plain.

Key words: *Bromus inermis*, grassland management, grassland passerines, North Dakota, northern mixed-grass prairie, prescribed fire.

Populations of most species of North American grassland passerine birds have declined significantly (Sauer et al. 2004), as have the quantity and quality of native grasslands (Samson and Knopf 1994, Samson et al. 2004). Appropriate management of remaining native grasslands that have been set aside for conservation purposes is critical for perpetuating these species, but resource personnel must know more about how grassland passerines respond to widely used management tools such as prescribed fire. There are only two published studies of the influence of prescribed fire history on occurrence or abundance of grassland passerines in northern mixed-grass prairie (Johnson 1997, Madden et al. 1999), and both were conducted in the rolling to hilly Missouri Coteau physiographic subregion, a moraine that crosses the northern Great Plains southeast to northwest (Bluemle 1991). The Drift Plain, an adjoining (north) physiographic subregion, has comparatively rich loam soils and level topography. We were uncertain whether the two subregions shared common links between bird abundance or habitat and fire history. Our objective was to assess the relationship between prescribed fire history and the abundance and habitat of grassland passerines on a Drift Plain prairie.

STUDY AREA and METHODS

Des Lacs National Wildlife Refuge (DLNWR) is a narrow (1 to 3 km wide), 42 km long riverine tract that encompasses 7913 ha of the Des Lacs River valley in northwestern North Dakota (48°48' N, 102°07' W). Within its boundaries are about 2250 ha of native prairie on the Drift Plain. Historically, this prairie is within the needlegrass-wheatgrass (*Stipa* spp.-*Agropyron* spp.) association (Coupland 1950). However, the contemporary Drift Plain vegetation at DLNWR is dominated by two exotic grass species, smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*), plus two native shrub species, western snowberry (*Symphoricarpos occidentalis*) and silverberry (*Elaeagnus commutata*) (Murphy and Grant 2005). Soils of the Drift Plain are level, well-drained loams. Precipitation averages 45 cm per year, with about 75 % occurring during April through September (U.S. Fish and Wildlife Service, Kenmare, North Dakota, unpublished data). Prescribed burns are conducted at DLNWR during spring (April and May) and late summer through mid-fall (August through October), mainly to reverse

invasion by woody and exotic plant species and improve nesting habitat for migratory birds.

We surveyed breeding bird abundance and habitat on Drift Plain prairie in 16 habitat management units ($\bar{x}$ = 85.8 ha) that had been prescribe-burned at least once since 1992 (Appendix A). The units had not been grazed by livestock for at least 5 years prior to our study. To summarize fire history on each unit, we used a "fire index" that incorporated both the number of fires and number of years since last fire into a single metric (sensu Madden et al. 1999):

Fire index = number of fires / number of years since last fire

Fire index values of our plots ranged from 0.2 (little fire experience: only one fire, 5 years previous) to 3.0 (moderate fire experience: three burns, the last only 1 year previous; Appendix A). The number of burns since 1992 ranged from one to three. The number of years since the last fire ranged from one to five. We ignored immediate, postfire effects; all habitat units had had at least one growing season since the last fire.

We used 8 min point counts (Hutto et al. 1986) to survey breeding birds on 75 m radius plots. Plots were located randomly, at least 100 m apart ($\bar{x}$ = 4.9 plots/unit; Appendix A), and contained no woodland and less than 20 % wetland cover, similar to the 1994 plot selection criteria used by Madden et al. (1999). At each plot, each singing male or breeding pair was mapped where it was first detected. Paired birds exhibited behaviors such as threat calls or food carrying. Species such as swallows (Hirundinidae) and the American goldfinch (*Carduelis tristis*), which used the prairie for feeding but not nesting, were disregarded. We conducted two counts on each plot during 0530 to 0830 CDT, between 29 May and 22 June 2003. Before the counts, we spent a week in the field together to ensure our methods were consistent. We conducted counts on mornings when weather did not impede detection of birds (i.e., no rain and wind less than 15 km/h). For each species in each plot, we considered abundance to be the maximum number of indicated pairs between the two visits. For each management unit under study, abundance of a given species was the mean abundance among plots within the unit.

We measured vegetation structure and composition on each plot. Structure was measured as soon as passerines had arrived and had begun to select breeding territories (late May). Composition was measured when plant species were identified most accurately (mid-summer; Grant et al. 2004b). Eight measures of vegetation height-density (visual obstruction readings; Robel et al. 1970) were collected along each of two randomly located, 50 m transects within each plot. The mean of these was computed for the plot (n = 16 measures/plot). We also recorded litter depth along these transects at 12.5 m intervals (n = 10 measures/plot) by measuring the height of any horizontal, dead vegetation that formed a mat extending continuously from the ground (Madden et al. 1999). We measured

vegetation composition along the same random transects. Every 0.5 m interval along each transect represented a "belt" that was assigned a dominant plant species or species group category, and the percentage frequency of each category was calculated for the plot (Grant et al. 2004b).

Bird species detected at greater than 10 % of all plots were considered common and were used in our analysis (sensu Madden et al. 1999). We plotted the data and used simple linear regression to examine relationships between the fire index and bird species abundance, or vegetation composition or structure. We also used regression analysis to evaluate relationships between bird species abundances and vegetation variables that were significant ($P < 0.05$) in the regression analysis.

RESULTS

We detected 14 passerine species on the Drift Plain prairie at DLNWR (Table 1; species' scientific names are included in the table). The breeding bird community was characterized by three species: clay-colored sparrow, Savannah sparrow, and bobolink. Le Conte's sparrow, grasshopper sparrow, and western meadowlark also were common, but far less so. Brown-headed cowbird was marginally common and thus was excluded from subsequent analyses. Passerine species endemic to northern mixed-grass prairie, Baird's sparrow, chestnut-collared longspur (*Calcarius ornatus*), and Sprague's pipit (*Anthus spragueii*), were rare or absent. We found no strong relationships (i.e., $P < 0.05$) between abundances of the common species and fire history as characterized by the fire index (Fig. 1). Clay-colored sparrow and bobolink abundances were related weakly to fire history, however (negatively and positively, respectively).

The mean frequency of occurrence of transect belts dominated by smooth brome decreased with increasing degrees of fire influence (Fig. 2). Vegetation dominated by a mix of native graminoids and forbs typically included Kentucky bluegrass or smooth brome as subdominant plant species. This mix of native dominated vegetation might have increased as smooth brome dominated vegetation declined with increasing fire influence, but the trend was not significant (Fig. 2). Vegetation composed exclusively of native graminoids or of a mix of native graminoids and forbs occurred rarely, regardless of fire history (range, 0 to 12.4 % mean occurrence among units; versus fire history, $R^2 = 0.01$, $P = 0.83$). We detected no relationship between fire history and occurrences of vegetation dominated by native low shrub or Kentucky bluegrass (Fig. 2).

Litter depth and vegetation height-density decreased with increasing fire influence (Fig. 2). There was little variation in vegetation structure, especially in plant height-density, within units with the most fire experience (based on SE's for units with fire index values ≥ 2; Fig. 2).

Table 1. Occurrence of passerine bird species detected during point count surveys on 16 prescribe-burned, mixed-grass prairie management units at Des Lacs National Wildlife Refuge, northwestern North Dakota, 2003.

Species	% occurrence[a]
Eastern kingbird (*Tyrannus tyrannus*)	1.2
Sedge wren (*Cistothorus platensis*)	4.9
Clay-colored sparrow (*Spizella pallida*)	60.4
Vesper sparrow (*Pooecetes gramineus*)	2.4
Savannah sparrow (*Passerculus sandwichensis*)	80.2
Grasshopper sparrow (*Ammodramus savannarum*)	14.8
Baird's sparrow (*A. bairdii*)	1.2
Le Conte's sparrow (*A. leconteii*)	14.8
Nelson's sharp-tailed sparrow (*A. nelsoni*)	2.4
Bobolink (*Dolichonyx oryzivorus*)	87.6
Red-winged blackbird (*Agelaius phoeniceus*)	2.4
Western meadowlark (*Sturnella neglecta*)	11.1
Brown-headed cowbird (*Molothrus ater*)	9.8
Brewer's blackbird (*Euphagus cyanocephalus*)	4.9

[a]Percentage of plots where detected.

We examined relationships between bird abundance and vegetation variables that demonstrated strong relationships with fire history. We detected no relationships between abundance of any common bird species and litter depth or vegetation height-density (all $P > 0.15$). We also observed no relationships between species abundances and the occurrence of smooth brome (all $P > 0.20$).

DISCUSSION

Clay-colored sparrow, Savannah sparrow, Le Conte's sparrow, grasshopper sparrow, bobolink, and western meadowlark were common breeding passerines on prescribe-burned Drift Plain prairie at DLNWR, and brown-headed cowbird was marginally common. Using similar methods, Madden et al. (1999) found these

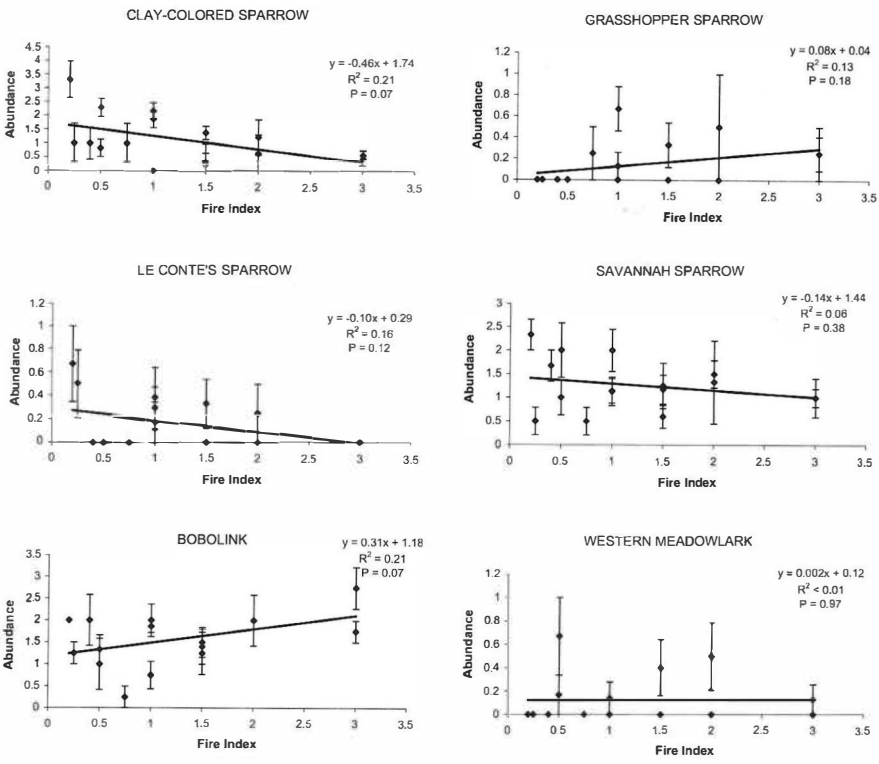

Figure 1. Relationships between prescribed fire history and abundances of common grassland bird species in Drift Plain prairie at Des Lacs National Wildlife Refuge, North Dakota, 2003, based on linear regression (n = 16 management units sampled). Fire history for a given management unit is expressed as an index based on the number of fires/number of years since last fire (Madden et al. 1999). Bird abundance is the mean number of indicated pairs per 75 m radius survey plot, as determined by 8 min point counts (Hutto et al. 1986). Vertical bars represent ± 1 SE around the mean for each management unit.

species common on hilly, fire treated prairie on the Missouri Coteau, 35 km west of DLNWR, along with Baird's sparrow and Sprague's pipit, two endemic species that historically were abundant in the region (Coues 1878). We found Baird's sparrow rare and Sprague's pipit absent on our study sites. Chestnut-collared longspur, another endemic species described as historically abundant in the region (Coues 1878), was not detected in our study or in a previous, broader survey of the same area (Murphy and Sondreal 2003), and was rare on fire treated areas of the Missouri

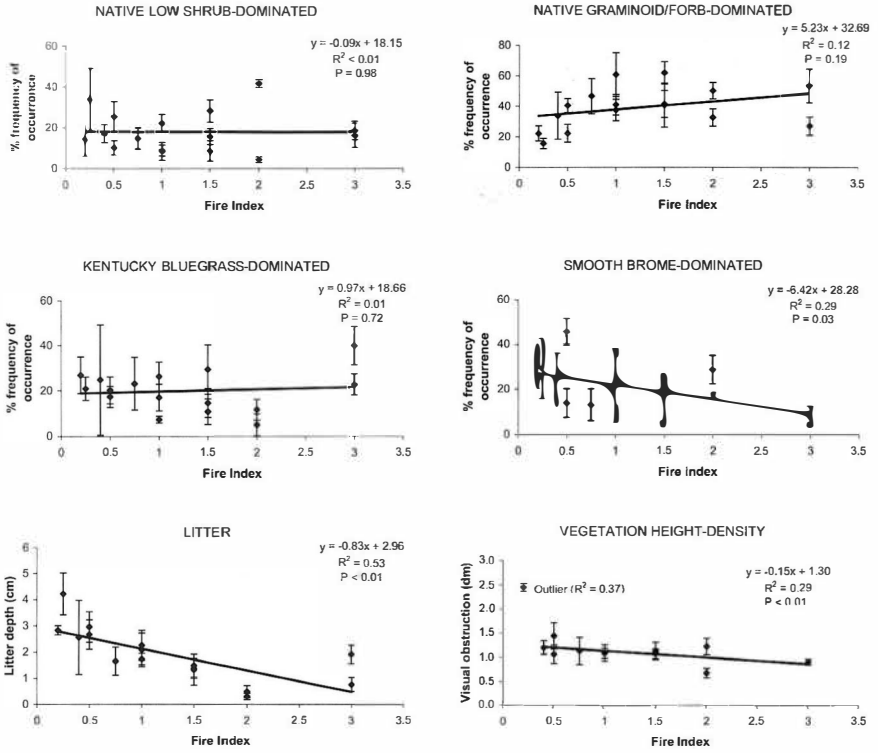

Figure 2. Relationships between prescribed fire history and the general composition and structure of vegetation in Drift Plain prairie at Des Lacs National Wildlife Refuge, based on linear regression (n = 16 management units sampled, except visual obstruction readings were not collected from three units). Fire history for a given management unit is expressed as an index based on the number of fires/number of years since last fire (Madden et al. 1999). Vertical bars represent ± 1 SE around the mean for each management unit.

Coteau (Johnson 1997, Madden et al. 1999). This species prefers relatively short, heavily grazed prairie (Kantrud 1981).

We observed no strong relationships between fire history and the abundances of common bird species. On the nearby Missouri Coteau, abundances of Sprague's pipit, grasshopper sparrow, Le Conte's sparrow, Baird's sparrow, bobolink, and western meadowlark related strongly and positively to fire history, and clay-colored sparrow abundance exhibited a strong, negative relationship

(Madden et al. 1999). The weak relationship between clay-colored sparrow abundance and the fire index in our study was surprising. This species prefers brushy habitat, which typically is reduced by repeated fire (Johnson 1997, Madden et al. 1999). There is additional evidence that the breeding bird community on the Drift Plain at DLNWR has changed little despite recent widespread application of prescribed fire. Composition of the bird community was measured in 1994 (Murphy and Sondreal 2003), before burning was extensive. Bird species composition was similar then except that the western meadowlark was uncommon in 1994. Le Conte's sparrow also was uncommon in 1994, but probably because this species tends to be scarce during below average precipitation cycles (Igl and Johnson 1999) and the 1994 survey followed a series of unusually dry years (Murphy and Sondreal 2003).

The mean frequency of vegetation dominated by smooth brome decreased with increasing degrees of fire influence on DLNWR, but we detected no relationships between fire history and occurrences of other broad vegetation types. In contrast, "broad leaved exotic grass," mainly smooth brome, increased with fire on the Missouri Coteau, and most other vegetation components were influenced significantly by fire history (e.g., shrub cover decreased; Madden et al. 1999). Roughly two-thirds of the contemporary Drift Plain prairie at DLNWR is covered by vegetation that includes exotic grasses, especially smooth brome, as a dominant or subdominant plant component (Murphy and Grant 2005). Exotic grasses occur less frequently on the nearby Missouri Coteau, and prairies there are invaded chiefly by Kentucky bluegrass (Madden 1996, Grant et al. 2004b). These differences between the two study areas have implications for grassland birds. Smooth brome has a relatively tall, dense physiognomy that might attract Le Conte's sparrow, grasshopper sparrow, and bobolink at DLNWR but deter other species such as Sprague's pipit, that prefer shorter cover dominated by fine leaved graminoids (Wilson and Belcher 1989, Madden et al. 2000, Grant et al. 2004a). Smooth brome probably had extensively invaded the Drift Plain prairie at DLNWR by the 1990's (Murphy and Grant 2005), before prescribed fire was used widely on the area. Compared to the Missouri Coteau, the Drift Plain prairie at DLNWR appeared to be more vulnerable to smooth brome invasion due to its close proximity to edges (i.e., narrow land base adjacent to annually tilled cropland), greater soil moisture and A-horizon development, and recent history (1930's through 1980's) of infrequent defoliation, especially by livestock grazing (Murphy and Grant 2005).

Vegetation structure, particularly litter and plant height and density, affect the composition of grassland bird communities elsewhere in northern mixed-grass prairies (Dale 1983, Madden et al. 2000, Grant et al. 2004a). Although litter depth and vegetation height-density decreased with increasing fire influence at DLNWR, we detected no relationship between abundance of any bird species and these structural attributes. We are uncertain why grassland birds on DLNWR did not

appear to respond to changes in vegetation structure as they do elsewhere. Smooth brome maintained a major structural influence in all plots regardless of fire history and this influence might have masked effects of changes in litter depth and height-density. We also observed little variation in vegetation structure within management units that had experienced the most fire. Combinations of fire and other defoliation tools, such as livestock grazing, might change the structural heterogeneity of this Drift Plain prairie and make the habitat more attractive to a broader mix of grassland passerine species, including endemic species.

Our data were derived from only one season of sampling but represent more than a decade of fire effects on vegetation that composes habitat for grassland birds. As such, our study suggested that relationships between prescribed fire history and abundance and habitat of grassland birds on remnant Drift Plain prairies might indeed differ from those on prairies in other subregions of the northern Great Plains and should be more fully explored.

ACKNOWLEDGMENTS

Our study was conducted as a senior thesis project by TJL and was supported mainly by the Joint Fire Science Program, which includes six agencies of the U.S. Department of the Interior and U.S. Department of Agriculture. We thank T. Grant, L. Igl, E. Madden, K. Smith, and two anonymous reviewers for helpful comments that improved the manuscript.

LITERATURE CITED

Bluemle, J. P. 1991. The face of North Dakota. North Dakota Geological Survey, Educational Series 21.

Coues, E. 1878. Field notes on birds observed in Dakota and Montana along the forty-ninth parallel during the seasons of 1873 and 1874. U.S. Geologic and Geographic Survey Territorial Bulletin 4:545-661.

Coupland, R. T. 1950. Ecology of mixed grass prairie in Canada. Ecological Monographs 20:271-315.

Dale, B. C. 1983. Habitat relationships of passerine birds at Last Mountain Lake, Saskatchewan. M.S. Thesis, University of Regina, Saskatchewan.

Grant, T. A., E. M. Madden, and G. B. Berkey. 2004a. Tree and shrub invasion in northern mixed-grass prairie: implications for breeding grassland birds. Wildlife Society Bulletin 32:807-818.

Grant, T. A, E. M. Madden, R. K. Murphy, M. P. Nenneman, and K. A. Smith. 2004b. Monitoring native prairie vegetation: the belt transect method. Ecological Restoration 22:106-111.

Hutto, R. L., S. M. Pletschet, and P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 118:593-602.

Igl, L. D., and D. H. Johnson. 1999. Le Conte's sparrows breeding in Conservation Reserve Program fields: precipitation and patterns of population change. Studies in Avian Biology 19:178-186.

Johnson, D. H. 1997. Effects of fire on bird populations in mixed-grass prairie. Pp. 181-206 *in* Ecology and conservation of Great Plains vertebrates (F. L. Knopf and F. B. Samson, editors). Springer, New York, New York.

Kantrud, H. A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Canadian Field-Naturalist 95:404-417.

Madden, E. M. 1996. Passerine communities and bird-habitat relationships on prescribe-burned mixed-grass prairie in North Dakota. M.S. Thesis, Montana State University, Bozeman.

Madden, E. M., A. J. Hansen, and R. K. Murphy. 1999. Influence of prescribed fire history on habitat and abundance of passerine birds in northern mixed-grass prairie. Canadian Field-Naturalist 113:627-640.

Madden, E. M., R. K. Murphy, A. J. Hansen, and L. Murray. 2000. Models for guiding management of prairie bird habitat in northwestern North Dakota. American Midland Naturalist 144:377-392.

Murphy, R. K., and T. A. Grant. 2005. Land management history and floristics in mixed-grass prairie, North Dakota, USA. Natural Areas Journal 25:351-358.

Murphy, R. K., and M. L. Sondreal. 2003. Breeding bird abundance and habitat along the Des Lacs River valley, North Dakota. Blue Jay 61:82-94.

Robel, R. J., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management 23:295-297.

Samson, F., and F. Knopf. 1994. Prairie conservation in North America. BioScience 44:418-421.

Samson, F. B., F. L. Knopf, and W. R. Ostlie. 2004. Great Plains ecosystems: past, present, and future. Wildlife Society Bulletin 32:6-15.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, results and analysis 1966 - 2003. Version 2004.1. U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland.

Wilson, S. D., and J. W. Belcher. 1989. Plant and bird communities of native prairie and introduced Eurasian vegetation in Manitoba, Canada. Conservation Biology 3:39-44.

Appendix A. Characteristics of habitat management units sampled for passerine birds and vegetation on Drift Plain prairie at Des Lacs National Wildlife Refuge, northwestern North Dakota, 2003.

			Prescribed fire history		
Unit	Size (ha)	Number of point count plots	Number of burns[a]	YSF[b]	Fire index[c]
2	49	3	1	5	0.20
37	68	4	1	4	0.25
40	65	3	2	5	0.40
8	125	6	1	2	0.50
5	36	3	2	4	0.50
38S	75	4	3	4	0.75
7	125	7	1	1	1.00
36	109	8	2	2	1.00
3	85	7	2	2	1.00
10	150	6	3	2	1.50
38N	75	5	3	2	1.50
39	74	4	3	2	1.50
41	64	3	2	1	2.00
31	84	4	2	1	2.00
6	124	8	3	1	3.00
35	65	4	3	1	3.00

[a]Number of prescribed fires conducted, spring 1992 through spring 2002.
[b]YSF = number of years since the last prescribed fire was conducted.
[c]Fire index = number of fires / number of years since last fire (Madden et al. 1999).

Received: 15 November 2004 *Accepted: 10 April 2006*

Associate Editor for Ornithology: Gregory A. Smith