THE EFFECT OF LAND USE ON NEST SITES SELECTED BY MISSISSIPPI KITES

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BY MISSISSIPPI KITES

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PREFACE

The purpose of this study was to determine the influence of surrounding land use on the selection of nesting habitat by Mississippi Kites. Study sites were selected and inspected for kite nests. Land use was quantified categorically in concentric zones and then subjected to univariate t-tests and multivariate analysis of variance to determine the difference of land use practices surrounding used and unused windbreaks.

Financial assistance was provided by the Frank M. Chapman Fund of the American Museum of Natural History; the Oklahoma Cooperative Wildlife Research Unit, School of Ecology, Fisheries, and Wildlife, Oklahoma State University; the Oklahoma Ornithological Society; and my mother, Nadine Holloway. Housing and facilities used during the course of this study were generously provided by Mr. and Mrs. Oren Brown, Dr. and Mrs. John Wiebelt, and the Kansas Fish and Game Commission.

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My mother, Nadine Holloway, deserves my most sincere thanks. She supported me during this study, assisted me in the field, and endured some hardships for my sake. From her I received an appreciation of God's creation.

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INTRODUCTION

The format and style of Chapter II in this thesis meets the manuscript specification for a scientific journal with international circulation. Chapter II was written in this manner to expedite submission to THE JOURNAL OF WILDLIFE MANAGEMENT and is complete without supportive information.

Approval for presenting the thesis is based upon the Graduate College's policy of accepting a thesis written in manuscript form and their approval of the major professor's request for a waiver for the standard format in a letter dated March 13, 1980.

CHAPTER II

THE EFFECT OF LAND USE ON NEST SITES SELECTED BY MISSISSIPPI KITES

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Abstract: Systematic searches for Mississippi Kite (*Ictinia misisippiensis*) nests were conducted in 89 windbreaks in Oklahoma and Kansas during the summers of 1977 and 1978. Surrounding land use was quantified categorically from aerial photographs. Univariate t-tests and multivariate analyses of variance were conducted to evaluate the difference of land use surrounding used and unused windbreaks. The surface area of 7 of the 272 land use variables differed significantly ($P < 0.10$) around used and unused sites for a given year, but the differences were not consistent between years. Since we expected 14 variables to be significant ($P < 0.05$) by chance, we conclude that Mississippi Kites select nesting habitats irrespective of surrounding land use patterns. Kites may select sites for nesting based upon structural parameters of the windbreaks only.

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Contemporary land use practices have dramatically altered breeding habitats of birds of prey (Cramp 1977). Land use has strongly influenced both the nesting activity (White 1975) and population levels (Olendorff and Stoddart (1974) of raptors.

The Mississippi Kite (Ictinia misisippiensis) is a locally common raptor of the southcentral plains of North America. In the plains of western Oklahoma and southwestern Kansas, Mississippi Kites readily nest in tree plantings designed as windbreaks. Within the limits of those locally available, kites selected a windbreak irrespective of its width, age, or tree species composition (Love and Knopf 1978). However, much of the potential nesting habitat within this region is not used by kites (Parker and Ogden 1979). In this paper, we address the relationship of surrounding land use practices to the use of a windbreak for nesting by kites.

STUDY AREA AND METHODS

The study was conducted in the grasslands and agricultural areas of southwestern Kansas and northwestern Oklahoma. Shortgrass prairie dominates the native grasslands, although mid-grass prairie occurs in some areas. Cultivation practices frequently included cereal grains (wheat and sorghum) and occasionally alfalfa. A general description of topography, soil association and vegetation is given in the Appendix. Plant nomenclature follows Waterfall (1966). Native woody vegetation is generally limited to narrow belts of riparian woodland dominated by cottonwood (Populus deltoides), and upland aggregations of shinnery oak (Quercus havardii). The windbreaks have been planted and contain mixtures of tree species, some native to the region and some introduced.

Windbreaks were similar in species composition and structural organization. Species commonly present were black locust (Robinia pseudo-acacia), eastern red cedar (Juniperus virginiana), elm (Ulmus sp.), green ash (Fraxinus pennsylvanica), osage orange (Maclura pomifera), and Russian mulberry (Morus alba). Rarely, catalapa (Catalapa sp.), cottonwood, pine (Pinus sp.), and walnut (Juglans sp.) were present. Conifers usually comprised the windward side of tree plantings. Deciduous trees occurred in rows of increasing height through the structure. Elm occurred on the lee side of most windbreaks.

Systematic searches for kite nests were conducted in 89 windbreaks each year, 1977-1978. Of these, 22 windbreaks were used for nesting by kites for only one year during the 2-year study. An additional 9 windbreaks used by kites both years or neither year were randomly selected for land use analysis.

Land use practices surrounding windbreaks were classified into 10 categories principally defined by vegetation type. An additional 7 categories combined associated land use types. Table 1 summarizes the 17 land use types.

Land use practices were identified from aerial photographs which were verified in the field and quantified using a Numonics model 1224 digitizer. A series of concentric zones was centered on the middle and at each end of the windbreaks. The centers of the zones were arbitrarily selected to standardize the analysis since a given windbreak could provide either several nests or no nests. Land use was quantitatively stratified into zones of: from 0.0 to 0.25 km, 0.25 km to 0.50 km, 0.50 to 1.0 km, and 1.0 km to 2.0 km. Other zones examined in the analysis were from 0.0 to 0.50 km, 0.25 km to 1.0 km, 0.5 km to 2.0 km, and 0.0

Table 1. Land use categories used in this study.

Code	Land Use Category	Description
	CULTIVATION	
W	Wheat field	green, harvestable, stubble or mulched stage
C	Cropland	fields of sorghum and small grains other than wheat
IC	Irrigated cropland	fields of alfalfa, rarely wheat or cotton
FF	Fallow field	fields usually harvested the previous growing season, then plowed under, and not sown. If vegetation is present, it consists of weeds
CR	Dry farming	combined wheat field and cropland
WF	Wheat-fallow	combined wheat fields and fallow fields to achieve this category
AG	Total dry cultivation	wheat fields, cropland, and fallow fields were combined
AR	Total cultivation	wheat field, cropland, irrigated cultivation, and fallow were combined

Table 1. Continued

Code	Land Use Category	Description
	RANGELAND--used primarily for grazing	
SA	Sand sagebrush (*Artemisia filifolia*) rangeland	dominated by sand sagebrush
SH	Shinnery oak (*Quercus havardii*) rangeland	shorgrass prairie interspersions into shinnery oak
SY	Shinnery oak brushland	sand sagebrush interspersions into shinnery oak and shinnery oak rangeland
BR	Total brushland	included sand sagebrush rangeland and shinnery oak brushland
GR	Grassland	primarily shorgrass prairie and planted pasture
DG	Degenerating grassland	equal interspersions of sand sagebrush and shortgrass prairie, usually overgrazed and eroded
GS	Total grassland	included grassland and degenerating grassland
	MISCELLANEOUS	
WD	Woody vegetation	windbreaks, upland woodlands, and riparian woodlands

Table 1. Continued

Code	Land Use Category	Description
OT	Other land uses	including petroleum mining operations, golf courses and communities
PW	Permanent water	earthen dam impoundments, water standing in fields during summer months

to 2.0 km. Land use types were quantified within each series of concentric zones, then averaged for the windbreak. This averaging was necessary since some surrounding land use types (wheat, cropland, grassland, and degenerating grassland) were significantly different ($P < 0.05$) between locations in the windbreak.

The raw data in hectares were converted to the percentage of area of the appropriate zone. Each land use category in every zone was treated as a separate variable in the analysis and subjected to univariate t-tests. The difference between land use practices surrounding windbreaks selected by nesting kites and those land use practices surrounding windbreaks not chosen was evaluated by multivariate analysis of variance (MANOVA). Pillai's trace and Wilks' criterion (Marcus and Neff 1980) established significance for multivariate analysis.

RESULTS

We recorded 33 nest attempts in the 31 windbreaks in 1977, and 15 in 1978 (Table 2). In 1977, 22 windbreaks contained kite nests. In 1978, only 7 of those same windbreaks contained nests. Of the 9 randomly selected windbreaks, 6 were never used as nest sites and 3 were used by nesting kites both years.

Cultivated Land Uses

Wheat fields were common in the study area. However, from 0.5 km outward the mean percentage of area comprising wheat was similar around both used and unused sites each year (Tables 3 and 4). In 1977, dry farmed cropland other than wheat was significantly ($P < 0.05$) more predominant around unused than used windbreaks in the 0.5 to 2.0 km and 0.0 to 2.0 km zones (Table 3). However, in 1978 the trend was reversed

Table 2. Nest attempts by windbreaks in 1977 and 1978.

Windbreaks Used by Kites Only 1 Year n = 22			Randomly Selected Windbreaks n = 9		
Windbreak Number	Nest Attempts 1977	Nest Attempts 1978	Windbreak Number	Nest Attempts 1977	Nest Attempts 1978
01	1	0	19	1	1
07	1	0	39	0	0
08	1	0	40	0	0
09	1	0	43	0	0
10	1	0	46	0	0
13	1	0	48	0	0
23	4	0	53	2	1
27	2	0	75	4	4
31	1	0	80	0	0
41	1	0			
42	1	0			
49	2	0			
50	2	0			

Table 2. Continued

Windbreaks Used by Kites Only 1 Year n = 22			Randomly Selected Windbreaks n = 9		
Windbreak Number	Nest Attempts 1977	Nest Attempts 1978	Windbreak Number	Nest Attempts 1977	Nest Attempts 1978
54	1	0			
56	2	0			
64	2	0			
66	0	1			
72	0	2			
73	0	1			
83	1	0			
86	0	5			
88	1	0			
Subtotal	26	9		7	6
TOTAL	33	15			

Table 3. Mean percentage of land use types surrounding used and unused windbreaks and P values for t-test comparisons for each of the designated zones for 1977.

Land Use Codes	0.0–0.25 km		0.25–0.50 km		0.50–1.0 km		1.0–2.0 km	
	Used/Unused	P	Used/Unused	P	Used/Unused	P	Used/Unused	P
W	24.9/32.3	0.41	26.7/30.7	0.62	26.6/25.8	0.91	25.4/24.0	0.85
C	7.8/18.9	0.65	8.3/13.1	0.37	7.7/ 8.5	0.78	5.9/ 9.4	0.02
IC	3.8/ 0.0	0.28	3.4/ 0.0	0.27	1.5/ 0.0	0.27	1.5/ 0.7	0.30
FF	1.8/ 2.3	0.83	1.9/ 2.5	0.82	1.4/ 0.9	0.69	0.5/ 0.1	0.34
CR	32.7/51.2	0.07	35.1/43.8	0.33	34.3/34.4	0.99	31.4/33.5	0.79
WF	26.8/34.6	0.39	33.2/28.6	0.59	28.1/26.7	0.86	26.0/24.2	0.80
AG	36.6/51.2	0.21	43.8/38.4	0.60	35.8/34.3	0.85	32.9/34.2	0.88
AR	38.5/53.5	0.19	40.4/46.3	0.57	37.3/35.3	0.81	33.5/34.3	0.92
SA	3.7/ 9.3	0.21	5.6/ 7.9	0.57	6.8/ 8.8	0.66	6.9/11.2	0.31
SY	1.2/ 0.0	0.51	1.8/ 1.6	0.95	1.7/ 5.1	0.41	2.9/ 4.4	0.70
BR	4.9/ 9.4	0.34	7.4/ 9.5	0.64	8.6/13.9	0.35	9.8/15.7	0.30
GR	29.0/18.6	0.21	28.6/19.1	0.19	30.0/24.2	0.32	28.9/21.9	0.24
DG	10.6/ 6.5	0.47	10.9/ 9.2	0.73	16.1/15.4	0.89	20.2/19.3	0.90
GS	39.6/25.1	0.13	29.5/28.3	0.17	46.1/39.6	0.34	49.1/41.3	0.31
WD	7.1/ 4.7	0.28	4.0/ 3.5	0.76	3.8/ 3.8	0.98	3.6/ 4.3	0.65
OT	6.0/ 0.3	0.39	2.4/ 1.3	0.62	1.6/ 2.3	0.67	1.9/ 1.6	0.85
PW	0.0/ 0.0		0.0/ 0.0*	0.39	0.0/ 0.0*	0.71	0.0/ 0.0*	0.78

Table 3. Continued

Land Use Codes	0.0-0.5 km Used/Unused	P	0.25-1.0 km Used/Unused	P	0.50-2.0 km Used/Unused	P	0.0-2.0 km Used/Unused	P
W	26.3/31.1	0.55	26.6/26.8	0.98	25.7/24.4	0.86	25.8/24.8	0.90
C	8.2/14.5	0.24	7.8/ 9.4	0.62	6.3/ 9.3	0.05	6.4/ 9.6	0.04
IC	3.5/ 0.0	0.27	1.9/ 0.0	0.26	1.5/ 0.5	0.20	1.6/ 0.5	0.17
FF	1.9/ 2.4	0.82	1.6/ 1.2	0.83	0.7/ 0.3	0.43	0.8/ 0.4	0.55
CR	34.5/45.6	0.23	34.5/36.3	0.81	31.9/33.7	0.83	32.1/34.4	0.76
WF	28.2/33.5	0.52	28.2/28.1	0.98	26.4/24.7	0.81	26.5/25.2	0.85
AG	37.9/45.6	0.46	36.4/36.3	0.99	33.5/34.2	0.93	33.8/34.9	0.89
AR	39.9/48.1	0.44	37.9/37.5	0.96	34.3/34.5	0.97	34.6/35.4	0.92
SA	5.1/ 8.3	0.44	6.6/ 8.6	0.63	6.9/10.7	0.36	6.8/10.6	0.36
SY	1.6/ 1.2	0.87	1.7/ 4.4	0.48	2.7/ 4.6	0.63	2.6/ 4.4	0.65
BR	6.8/ 9.5	0.55	8.3/13.0	0.37	9.6/15.3	0.30	9.4/15.0	0.30
GR	28.7/19.0	0.19	29.7/23.2	0.25	29.2/22.4	0.23	29.1/22.2	0.21
DG	10.8/ 8.5	0.65	15.0/14.1	0.86	19.4/18.6	0.89	18.8/17.9	0.88
GS	39.5/27.5	0.16	44.8/37.3	0.28	48.5/41.0	0.29	48.0/40.1	0.27
WD	4.8/ 3.8	0.59	3.8/ 3.7	0.94	4.2/ 3.7	0.73	3.7/ 4.1	0.79
OT	2.4/ 1.0	0.54	1.8/ 2.1	0.84	1.8/ 1.7	0.98	1.9/ 1.7	0.90
PW	0.0/ 0.0*	0.36	0.0/ 0.0*	0.91	0.0/ 0.0*	0.74	0.0/ 0.0*	0.77

*Values beyond second place attributing to P value.

Table 4. Mean percentage of land use types surrounding used and unused windbreaks and P values for t-tests comparisons for each of the designated zones for 1978.

Land Use Codes	0.0-0.25 km Used/Unused	P	0.25-0.50 km Used/Unused	P	0.50-1.0 km Used/Unused	P	1.0-2.0 km Used/Unused	P
W	29.4/29.1	0.98	28.5/30.6	0.83	26.3/28.5	0.81	21.1/26.9	0.47
C	12.6/10.7	0.79	11.2/ 9.2	0.74	8.5/ 7.5	0.75	6.9/ 6.4	0.77
IC	0.0/ 3.4	0.40	0.0/ 3.0	0.39	0.0/ 1.4	0.39	0.0/ 1.6	0.07
FF	0.0/ 1.0	0.60	0.5/ 0.0	0.60	0.0/ 0.0*	0.60	0.0/ 0.0	
CR	42.0/39.8	0.85	39.7/39.8	1.00	34.8/35.8	0.91	28.0/33.8	0.52
WF	29.4/30.1	0.95	28.5/31.2	0.79	26.3/28.4	0.81	21.1/26.9	0.47
AG	42.0/43.2	0.92	39.7/42.8	0.79	34.8/37.2	0.80	28.0/35.0	0.42
AR	42.0/44.2	0.86	39.7/43.3	0.76	34.8/37.2	0.79	28.0/35.0	0.42
SA	1.8/ 6.6	0.35	2.5/ 7.4	0.27	4.8/ 8.2	0.50	7.5/ 8.6	0.82
SY	0.0/ 1.0	0.59	0.1/ 2.2	0.51	0.9/ 3.4	0.50	2.4/ 3.7	0.78
BR	1.8/ 7.6	0.27	2.7/ 9.6	0.17	5.8/11.6	0.36	9.9/12.2	0.72
GR	25.5/25.7	0.99	28.3/24.7	0.66	31.5/27.2	0.51	30.8/25.5	0.43
DG	14.3/ 7.4	0.25	15.1/ 8.7	0.23	17.2/15.4	0.74	23.7/ 8.8	0.50
GS	39.8/33.1	0.53	43.4/33.5	0.27	48.8/42.5	0.42	54.6/44.3	0.23
WD	7.7/ 5.9	0.46	3.6/ 3.9	0.90	3.4/ 3.9	0.84	3.2/ 4.0	0.60
OT	0.4/ 2.3	0.54	18.4/ 2.1	0.29	3.3/ 1.4	0.26	2.3/ 1.6	0.73
PW	0.0/ 0.0		0.0/ 0.0*	0.50	0.0/ 0.0*	0.39	0.0/ 0.0*	0.74

Table 4. Continued

Land Use Codes	0.0-0.50 km Used/Unused	P	0.25-1.0 km Used/Unused	P	0.50-2.0 km Used/Unused	P	0.0-2.0 km Used/Unused	P
W	28.7/30.2	0.88	26.7/28.8	0.81	22.1/27.2	0.52	22.5/27.4	0.53
C	11.5/ 9.6	0.75	0.1/ 7.8	0.73	7.3/ 6.6	0.71	7.5/ 6.8	0.69
IC	0.0/ 3.1	0.39	0.0/ 1.7	0.38	0.0/ 1.6	0.06	0.0/ 1.7	0.07
FF	0.0/ 0.7	0.60	0.0/ 0.1	0.60	0.0/ 0.0*	0.60	0.0/ 0.0*	0.60
CR	40.3/39.8	0.96	35.8/36.6	0.92	29.4/33.9	0.58	30.1/34.2	0.61
WF	28.7/30.9	0.83	26.7/28.9	0.80	22.1/27.2	0.52	22.5/27.5	0.53
AG	40.3/42.9	0.83	35.8/38.3	0.79	29.4/35.4	0.47	30.1/35.9	0.49
AR	40.3/43.5	0.78	35.8/38.4	0.78	29.4/35.4	0.47	30.1/35.9	0.48
SA	2.4/ 7.2	0.28	4.4/ 8.1	0.43	7.0/ 8.5	0.74	6.7/ 8.4	0.70
SY	0.1/ 1.9	0.52	0.8/ 3.1	0.58	2.1/ 3.6	0.74	2.0/ 3.5	0.73
BR	2.5/ 9.1	0.18	5.2/11.2	0.30	9.1/12.1	0.63	8.7/11.9	0.60
GR	27.6/25.0	0.75	30.9/26.7	0.52	31.0/25.8	0.41	30.7/25.8	0.42
DG	14.9/ 8.4	0.23	16.8/14.0	0.61	22.4/18.1	0.52	22.0/17.5	0.49
GS	42.5/33.4	0.33	47.7/40.7	0.36	53.4/43.9	0.27	52.7/43.3	0.28
WD	4.7/ 4.4	0.91	3.5/ 3.9	0.85	3.2/ 4.0	0.64	3.3/ 4.0	0.68
OT	1.5/ 2.1	0.80	3.0/ 1.5	0.39	2.5/ 1.6	0.62	2.4/ 1.6	0.65
PW	0.0/ 0.0*	0.48	0.0/ 0.0*	0.32	0.0/ 0.0*	0.64	0.0/ 0.0*	0.62

*Values beyond second place attributing to P value

($\underline{P}$ < 0.05) with more dry farmed cropland around used windbreaks than unused windbreaks (Table 4). Irrigated cropland was infrequent in the study area. In 1977, kites apparently preferred irrigated cropland since unused windbreaks had virtually none of this land use in the vicinity. In 1978, however, the area of irrigated cropland surrounding unused windbreaks was higher in the zones of 1.0-2.0 km ($\underline{P}$ = 0.07), 0.5-2.0 km ($\underline{P}$ = 0.06), and 0.0-2.0 km ($\underline{P}$ = 0.07). Irrigated cropland was not found within 2.0 km of used windbreaks in 1978 (Table 4). A small percentage of land use practices surrounding windbreaks were fallow fields. This category was found within 2.0 km of 6 windbreaks in 1977, but within 2.0 km of only 1 windbreak in 1978. In 1977, dry farmed cropland was significantly ($\underline{P}$ < 0.10) more abundant around unused (51.2%) than used (32.7%) windbreaks in the zone from 0.0-0.25 km zone (Table 3). However, this trend was not observed in 1978.

Other combinations of cultivated land uses revealed no significant differences between used and unused sites (Tables 3 and 4). All cultivated land uses were pooled and examined collectively to determine their ability to separate used from unused windbreaks. The $\underline{P}$ values for 1977 and 1978 show that total cultivation was ineffective in distinguishing used and unused windbreaks.

Rangeland Classes

It seems nesting kites will tend to avoid brushland. This trend was noted for both years in both of the brushland land use types, sand sagebrush and shinnery oak. In contrast, kites selected windbreaks with a higher mean percentage of surrounding grassland and degenerating grassland. The grassland categories accounted for approximately half of the area surrounding the used windbreaks both years. However, neither differences between the grasslands nor brushlands were significant between used and unused sites.

Other Land Use Classes

Land uses such as golf courses, human residences, communities, woodlands, and petroleum drilling operations showed no patterns of abundance around used or unused windbreaks in 1977. In 1978 from 0.25 km outward, nonsignificantly higher percentage of other land uses occurred near used windbreaks (Table 4). The inner zone had a higher percentage surrounding unused windbreaks than used windbreaks. Permanent water was seldom encountered within 2.0 km of windbreaks. No permanent water occurred within 0.25 km of windbreaks.

Multivariate Analyses

Over 200 combinations of variables were subjected to multivariate analysis of variance to evaluate the difference between land use patterns surrounding used and unused windbreaks for each zone or combination of zones (Table 5). To utilize multivariate techniques, the number of variables must be less than the number of observations. One hundred thirty-six variables were generated each year from the 17 land use categories in each of the 8 zones. Similar land uses were pooled and adjacent zones were combined to reduce the number of variables from 136 to 30. Variables with similar means for used and unused sites were eliminated from the multivariate analysis. These variables included grassland, degenerating grassland and other land uses in the outer zones (1977), and wheat fields (1978).

Tables 6 and 7 present the land use categories and the zones which were significantly ($\underline{P} < 0.10$) different surrounding used and unused windbreaks for 1977 and 1978. Four of the 5 MANOVAs included a

Table 5. Codes for zones surrounding windbreaks included in the analysis.

Code	Zone Analyzed
1	0.0 -0.25 km
2	0.25-0.50 km
3	0.50-1.0 km
4	1.0 -2.0 km
12	0.0 -0.50 km
23	0.25-1.0 km
34	0.50-2.0 km
1234	0.0 -2.0 km

Table 6. Statistics establishing significance in multivariate analysis of variance between used and unused sites for 1977, by land use codes and zones.

Land Use Codes	Wilks' Criterion; Pillai's Trace			
	P = 0.0315	0.0659	0.0864	0.0954
		Zones		
W		12-3-4		
C	1-23-4	12-3-4		
IC	1-23-4	12-3-4	1-23-4	
FF		12-3-4	1-23-4	
CR			1-23-4	
WF				
AG				
AR				
SA	1-23-4	12-3-4		1-2-34
SH	1-23-4	12-3-4		
BR			1-23-4	1-2-34
GR	1-23	12		
DG	1	12		
GS			1-23-4	1-2-34
WD	1-23-4	12-3-4	1-23-4	1-2-34
OT	1-23	12	1-23-4	1-2-34
PW	23-4	12-3-4	23-4	2-34

Table 7. Statistics establishing significance in multivariate analysis of variance between used and unused sites for 1978, by land use codes and zones.

Land Use Codes	Wilks' Criterion; Pillai's Trace $\underline{P}$ = 0.0639
	Zones
W	1-2-34
C	1-2-34
IC	1-2-34
FF	
CR	
WF	
AG	
AR	
SA	1-2-34
SH	1-2-34
BR	
GR	1-2
DG	1
GS	
WD	1-2-34
OT	1-21
PW	2-34

variable which was significant when tested independently. This significance in itself will cause the Wilks' criterion and Pillai's trace to be significant.

Land use patterns in various zones around nesting habitat does not appear to influence selection by nesting Mississippi Kites. A smaller number of significant ($\underline{P} < 0.10$) land use categories occurred in designated zones than would be expected randomly. No significant patterns in the results were consistent between years.

DISCUSSION

Evaluation of differences between used and unused nesting sites must include parameters affecting the selection process. Our ability to identify the structural features of the habitat selected by the birds is limited to our previous knowledge of the species and its requirements.

Mississippi Kites have nested in an area one year, and the next year the area may be completely devoid of nesting kites. Parker (1974a) believed that a decrease in the number of nests in a given windbreak was usually independent of discernable change in the windbreak. This observation, coupled with a growing awareness of the effect of land use on wildlife populations, warranted this investigation on Mississippi Kite nest habitat selection.

Canada goose (Branta canadensis) nesting habitats were quantitatively investigated utilizing multivariate techniques to compare the habitat surrounding used and unused nest sites (Kaminski and Prince 1977). A significant difference in parameters measured at used and used sites was found. This method was adopted to measure quantitatively the land use categories surrounding windbreaks used by nesting kites versus similar unused sites. For Mississippi Kites, a windbreak might have multiple nests, a single nest, or no nests. To resolve this variation, surrounding land use was quantified into zones from 3 separate points in the windbreak, then averaged. The 3 points were the center and each end of the windbreak.

Of the 272 variables tested to evaluate the magnitude of difference between used and unused sites in 1977 and 1978, 7 were found to be significant ($\underline{P} < 0.10$). Only cultivated land uses were significantly different between used and unused windbreaks; cropland in 1977, and irrigated cropland in 1978. This suggests a relationship between cultivation and the selection of nesting habitat by kites; however, no consistent patterns between years were observed. The significant differences ($\underline{P} < 0.10$, see RESULTS section) between used and unused sites suggested a tendency of nesting kites to avoid cropland. However, the mean percentage of these land use types in 1978 does not substantiate this, with higher percentages of wheat and cropland surrounding used sites than unused sites.

Although significant differences in cultivated land uses were realized, the inconsistency of significance indicated that these land uses were ineffective in distinguishing used from unused nest sites. Cultivation did not strongly influence site selection by nesting kites in our analysis.

The structural organization of grassland and brushland gives insight into the kites' directional response to these land use categories. Verner (1975) noted that birds often respond to the general structure of vegetation rather than to the plant species comprising it. Nesting kites tended to avoid nesting near shinnery oak and sand sagebrush rangeland. The density of this vegetation is responsible for this response. The visibility of prey is likely reduced in shinnery oak pastures and to a lesser degree in sand sagebrush rangeland. Shortgrass prairie provides easier foraging for kites because the density and patchiness of vegetation is less than in brushland situations. Degenerating grassland (sand sagebrush interspersions into prairie) has a higher prey visibility than brushland. Prey visibility is likely a factor for kites' selection of a nest, although no significant differences ($\underline{P} < 0.10$) of the area of degenerating grassland surrounding used and used sites were found either year.

Parker (1974b) stated that kites are not as limited with regard to prey as generalized reports indicate (Brown and Amadon 1968). Mississippi Kites are opportunistic with regard to their diet and will forage several kilometers from their nest (Parker, pers. comm.). Prey availability does not appear to serve as a primary factor in nest site selection by kites, but its effect is not negligible. Hilden (1965) maintained that food supply is not important in habitat selection by most species. Since many birds are generalists, other environmental factors will take precedence over availability of food when selecting a habitat. The relationship of the prey base to the land use practices is a delicate one and needs examining thoroughly. Relating land use types to nest site selection may be indirectly relating the food supply to nesting habitat selection. The prey base is likely correlated with vegetation types; thus surrounding land use practices could serve as an indirect measure of the prey base. Further evaluation of the relationship between land use, prey base and nest site selection is warranted.

The multivariate analysis provided little insight into nesting habitat selection by Mississippi Kites. The significant results were not consistent for the 2 years, which suggests that surrounding land use is not an environmental parameter to which kites respond.

All the windbreaks in this study are approximately the same age and structure, providing similar nesting habitat for kites. Of the 31 windbreaks in this study, 29 were chosen as nest sites by kites at least one year, and 22 were not used by nesting kites the other year. Since land use types and structure and composition of windbreaks (Love and Knopf 1978) do not strongly influence nesting habitat selection by kites, an intricate detail of the windbreak itself may serve as a proximate factor in the selection process. Parker (1974a) believed that other nesting kites may serve as the proximate stimulus for nesting kites. It is not uncommon for windbreaks to support multiple kite nests. However, these birds are more successful nesting singly (Parker 1974a).

Parker (1974a) stated that kites demonstrate nest site tenacity. In windbreaks, tenacity to a local area was more frequent than the re-use of an actual nest. Nest site tenacity remains to be conclusively documented, although it is strongly suspected in Mississippi Kites and is supportive evidence that land use has little effect on nesting habitat selection.

Bald eagles are thought to select nest sites in preferred habitats on the basis of a particular nest tree and not the actual composition of the habitat (McEwan and Hirth 1979). This suggests that birds will select specific nest trees in a given habitat type. A suitable nest tree could serve as an important proximate factor for bald eagle nest site selection.

An environmental feature which kites are selecting could be the arrangement and placement of snags (dead or dying trees) in the windbreaks. Balda (1975) noted the significance of this structural factor had been overlooked by biologists. Snags provide kites with unobstructed sites for copulation, nesting, watching, and feeding. Oftentimes one adult will perch on a snag near its mate which is attending the eggs and/or young. During nest building and incubation, the adults spend a large portion of each day watching and resting on snags. Windbreaks were qualitatively inspected for snags and were found to be a requirement for nesting kites. Snags were found in unused windbreaks also; however, an absence of snags would preclude rejection of the windbreak by the nesting kite. The importance of snags to windbreak nesting kites may be assessed by habitat manipulation by introducing snags into unused windbreaks.

The presence of great horned owls (Bubo virginianus) may actually provide a negative reinforcement to nesting kites. Parker (1974a) stated that great horned owls are a primary predator on nestling kites. An owl pellet was found containing a kite leg and foot in the study area. When inspecting windbreaks for kite nests, oftentimes owls were observed and no kite nests were found. Other windbreaks supported a nest of great horned owls and one of kites which were at opposite ends of the windbreak. Since owls nest earlier in the spring, I believe that great horned owls utilizing windbreaks will deter kites from selecting that windbreak for nesting.

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APPENDIXES

GENERAL DESCRIPTION OF STUDY AREA

Topography of the study area includes broad, nearly level uplands typical of the High Plains in Meade County, Kansas and Beaver County, Oklahoma (USDA 1977, USDA 1962). erosional uplands, valleys, and sand dunes in Beaver and Harper Counties (USDA 1962, USDA 1960), and rolling hills interspersed with flat tracts and rough broken areas in Ellis, Roger Mills, and Custer Counties (USDA 1966, USDA 1967, USDA 1978).

Permian red beds underlie loamy soils of the Harney-Spearville and Mansic-Campus-Otereo associations in central Meade County (USDA 1977), and Ulysses-Richfield association in eastern Beaver County (USDA 1962), the St. Paul-Manter-Dalhart and Mansic-Richfield associations in northern and western Ellis County (USDA 1966), and Vernon-Quinlan and Woodward-Quinlan associations in eastern Roger Mills County (USDA 1963), and the Woodward-Quinlan association in western Custer County. Sandy soil types include the Pratt-Trivoli association in southern Meade county (USDA 1977), the Pratt association in northern Beavery County (USDA 1962), the Nobscot-Brownfield, Pratt-Carwile, Berthoud-Enterprise associations in southern Ellis County (USDA 1966), and the Miles-Springer and Nobscot-Brownfield associations in western Roger Mills County (USDA 1963).

The major vegetative habitats of wildlife in Oklahoma were described by Duck and Fletcher (1944). The shortgrass prairie prevailing in Meade, Clark, Beaver, Harper and northern Ellis Counties is interrupted by sand sagebrush grassland and mixed grass plains along the Cimarron and North Canadian Rivers. Floodplain woodland is associated with the river courses and first terraces. Shinnery oak grassland occurs in southeastern Ellis and western Roger Mills Counties and is flanked on the east by mixed grass plains in eastern Roger Mills and western Custer Counties.

Species abundant throughout the study area include blue grama (Bouteloua gracillis), little bluestem (Schizachyrium scoparium), plains prickly pear (Opuntia macrorhiza), and plains yucca (Yucca glauca). In addition, dominant species of the shortgrass prairie are hairy grama (B. hirsuta), and sideoats grama (B. curtipendula). Black willow (Salix nigra), cottonwood, and salt cedar (Tamarix gallica) dominate the floodplain woodland. Sand sagebrush (Artemisia filifolia) and shinnery oak are unique to the communities named for them. Sand plum (Prunus angustifolia) and lemon sumac (Rhus aromatica) are common in both habitats. Wheat (Triticum aestivum), sorghum (Sorghum bicolor), and alfalfa (Medicago sativa) are commonly cultivated in the study area.

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